



FOCUS

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THE BIG ISSUES

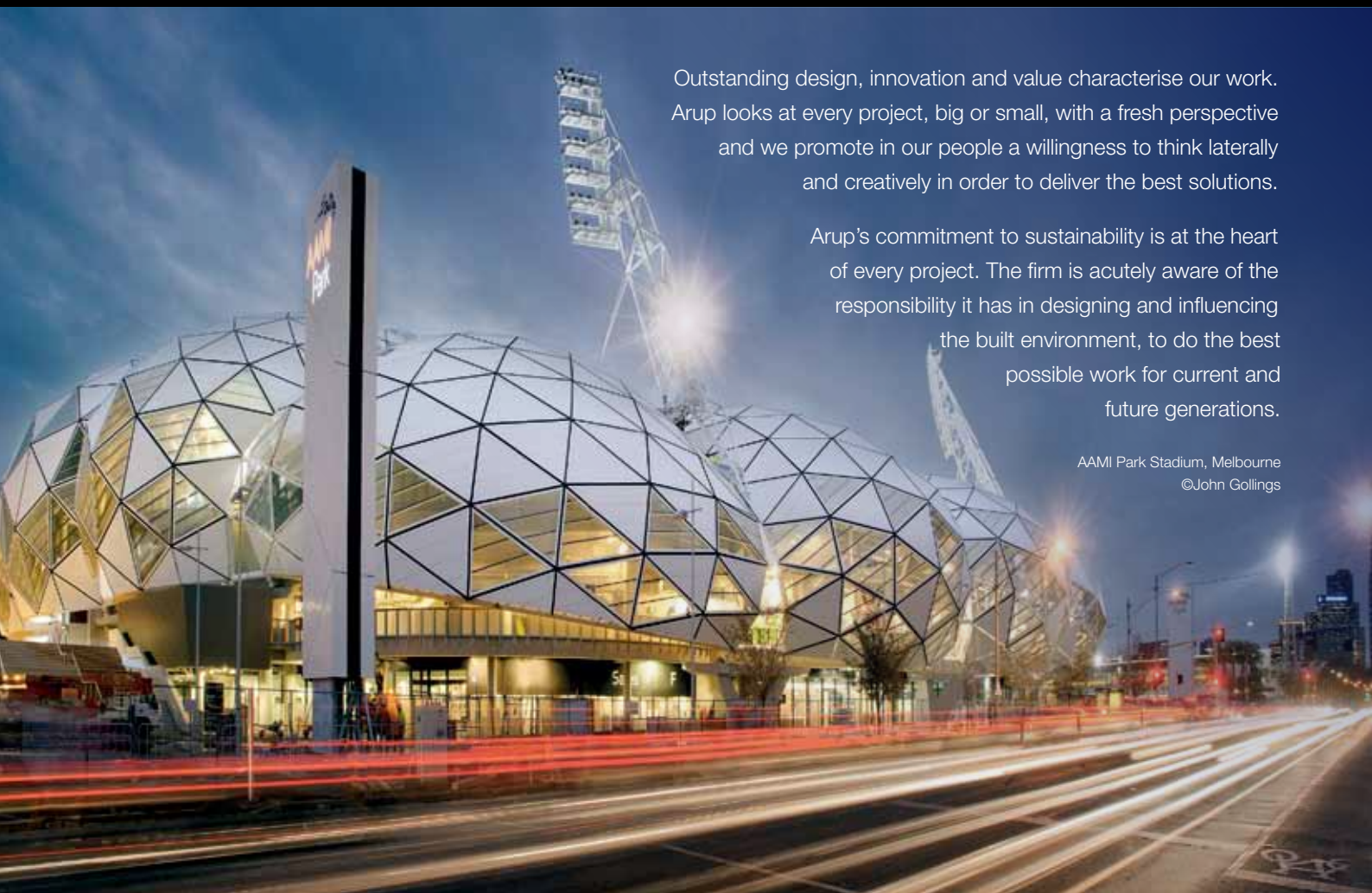
TECHNOLOGY TO SHAPE THE NEXT DECADE

The Big Issues – what lies ahead for Australia in the Academy's key areas of interest and influence? ATSE leaders look at the future for the nation in the second decade

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5

Energy options: choices, costs and attitudes

By Martin Thomas

10

Water: what is the future for Australia?

By John Radcliffe

14

Renewing our focus on food

By Julian Cribb



Front cover: Pinning our hopes on Australia's future.
Photo: iStockphoto



Growing food for the world (see page 14).

- 17 Climate change impacts: the next decade
- 21 STEM education in Australia: keys to future excellence
- 24 Broadband: it's needed, and needed now
- 26 Australia needs women in the corner offices
- 29 International collaboration to meet national priorities
- 32 ATSE hosts Chinese Engineering Academy visit to Australia
- 32 Spotlight on infrastructure and services for 2030
- 33 Science and technology key to economic development
- 34 'Cloud' computing has big potential: ATSE report
- 44 ATSE in *Focus*

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 pieces on topics of national interest, particularly the Academy's key interest areas – climate change impact, water, energy and education – will be considered for publication. Items between 800 and 1500 words are preferred. Please address comments, suggested topics and article for publication to editor@atse.org.au.

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ATSE is an independent body of eminent Australian engineers and scientists established to promote the application of scientific and engineering knowledge to practical purposes. ATSE *Focus* is produced to serve this goal.

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CEO: Dr Margaret Hartley

Editor: Bill Mackey

Technical Consultant: Dr Vaughan Beck FTSE

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING (ATSE)

Address: Level 1, 1 Bowen Crescent, Melbourne

Postal Address: GPO Box 4055, Melbourne, Victoria 3001

Telephone: 03 9864 0900

Facsimile: 03 9864 0930

Email: editor@atse.org.au

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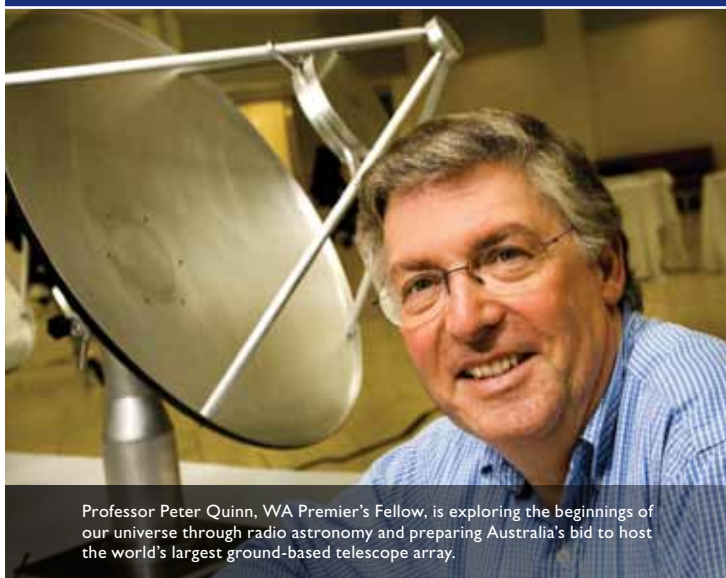
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Energy options: choices, costs and attitudes

The development of consistent, nationally harmonised regulations takes time. Currently, major power system investors view Australia as an unattractive haven for power system investment.



By Martin Thomas AM FTSE

mhthomas@bigpond.net.au

Australia, the Luckiest Country, is overabundantly endowed with energy sources from which it can choose. Each has its devotees, often passionate for one source to the exclusion of others. Each has widely varying characteristics – economic, technological and environmental. But, as always, such an *embarras de richesses* makes choosing even harder. So what are the options?

Coal, gas and hydro

Coal – both black and brown – supported by natural gas with hydro power back-up do the heavy lifting in energy supply in Australia today. Proven coal combustion technologies offer us the lowest source of low-cost baseload power for our homes, our factories and our businesses – typically in the region of \$35 to \$45/MWh (or 3.5 to 4.5 cents/kWh) at the power station terminals.

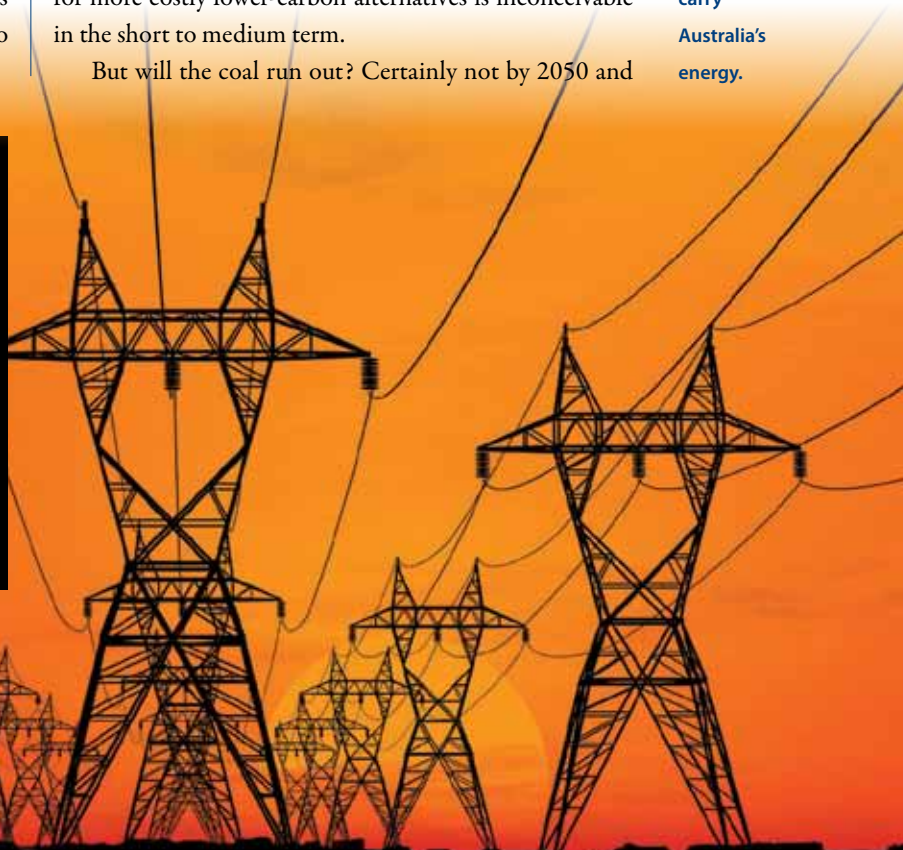
But coal is ‘under attack’ for many reasons – not least the widely held and scientifically supported concern that, although coal remains extraordinarily abundant, man-induced carbon dioxide may be, or already is, contributing to climate change through global warming well above the rate that would have occurred in the far slower natural course of events.

Coal’s cost is hard to beat. It is the reason why around 80 per cent of Australia’s secure grid-supplied power comes from coal. The coal industry supports thousands of jobs and communities and has done so for an exceptionally long time to world standards of performance. Investment, much from overseas, in our mines and power stations is huge and far from amortised. Early retirement of coal to make way for more costly lower-carbon alternatives is inconceivable in the short to medium term.

But will the coal run out? Certainly not by 2050 and

Powerlines
carry
Australia’s
energy.

This article traverses the principal options for Australia to 2050 and beyond and seeks to generate intelligent informed debate. The opinions expressed are those of the author, but he acknowledges with respect a number of ATSE reports, including the recently launched *Low-Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*. Strongly commended, that report provides some exhaustive economic analysis of a number of the options discussed.



well beyond if new mines are opened and new power stations built. But will they be built? Many commentators, including prospective investors, express severe doubt.

Why is this so? Investors say the investment climate is far too uncertain; Australian energy policy, shared between all States and the Commonwealth under our complex Constitution (framed for the island state paradigm of the 1900s) is confusing and changing, certainly not conducive to major long-term investments where policy stability is critical. Carbon pricing, an unusually vexed, politicised and complex issue upon which there is little national or international consensus, offers no certainty at all to new capital.

Meantime reserve plant margins (the spare plant capacity available but unused at system maximum demand to cover unplanned plant outages) are falling as they are absorbed by load growth on one hand and plant redundancy on the other. It is estimated that the system will be dangerously at risk of inadequate margin by 2015 if new baseload plant is not built soon. Sadly, hydro power, apart from at the margin, is not a candidate. Our ancient eroded land offers limited hydro potential, most of which is either developed or forever protected.

Planners are unworried though, saying that the 'dash to gas', using well-proven aero-derived gas turbines, either open-cycle or combined with a steam cycle, offers an eco-

nomie solution with only half the carbon dioxide emissions of coal. Despite the inevitable rise in the price of gas in the years ahead, this will almost certainly turn out to be the preferred – and only practical route – to meeting load growth without breakthroughs in 'clean coal' or 'zero carbon' technologies or commercial success with carbon capture and storage (CCS). This technology, in which much has been and continues to be invested, is still far from proven, potentially costly and absorbs substantial parasitic power. Specific costs (\$/kWe and \$/MWh) to the system are likely to be above those for competing low-carbon technologies.

Coal, gas and hydro will all be an essential part of the generation portfolio for decades to come. Our lights must stay on, our industries must compete. But they offer no prospect of meeting targets for carbon reduction so enthusiastically embraced by politicians and populaces of all stripes. Coal's share of Australian electricity generation will decline.

Demands and targets

So what are these demands and targets? Due to population increase, a strong economy and rising living standards, especially near-universal air conditioning, electricity demand grows inexorably. Forecasters predict doubling or more of demand by 2050 and may well be right without a

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game changer. Apart from committed environmentalists, most Australians view such growth with feelings of inevitability and some complacency. Few offer a solution.

Policy makers, endorsed by government and supported by the people, have set various carbon reduction targets – some truly heroic. A five per cent CO₂ reduction by 2020 from 2000 levels supported by the economically costly mandated renewable energy target (MRET) of 20 per cent renewables generation could be achieved – but not without far more effort (as well as price incentives) in energy demand and end-use efficiency.

But a full 60 per cent CO₂ reduction from present levels by 2050, with even an 80 per cent reduction mooted, is beyond the realms of possibility without massive reconfiguration of the generation portfolio with related evolution in electricity transmission, distribution and use. As yet there is little sign of such change – ‘business as usual’ prevails. Arm wrestling with ownership models at state level distracts from the real goals.

The national electricity supply system is responsible for providing safe, secure, reliable, affordable electricity to all consumers who can pay the price, as well as some who cannot. If challenging carbon and other emission reduction targets are to be met, change will need to be far more than incremental. The policy environment must be stable (to attract and hold the massive necessary investment capital) and far sighted (decisions taken now will shape this century). The regulatory environment, while protecting against improper practices and guiding standards and performance, must be sufficiently light-handed to encourage private capital to invest. The private sector is far more efficient in managing investment and market risk and reward. That is its role.

Frustratingly, the hills are alive with the sound of special pleadings from articulate industry sectors and partisan political positioning with the eye on marginal voters. Some technologies have already attracted localised and inconsistent market-distorting subsidies of which others can only dream. This is no way to determine the way ahead. Rational policy formation and the development of consistent nationally harmonised regulations take time. Currently, major power system investors view Australia as an unattractive haven for power system investment.

It is pleasing therefore that the Academy, as well as delivering well-researched independent reports, seeks through CAETS and other bilateral relationships, notably Korea, to help inform longer-term policy directions and technological choices if targets are to be met.

What then are the technological options we must consider if we intend to meet our emissions targets, yet ensuring that the electricity supply industry can and will meet its responsibilities?

2050 ENERGY PORTFOLIO

A prediction for our energy portfolio in 2050 suggests that **coal**, currently supplying some 80 per cent of our electrical energy, will fall to around 60 per cent by 2020 and 30 per cent by 2050 – although this is still very substantial given the doubling of demand!

Gas, both natural and coal seam, will soon move rapidly to take up coal's declining share, perhaps reaching 15 per cent by 2020 – but probably remaining at that level before declining. Gas, being thermally more flexible than coal, will play a key role in smoothing peaks and valleys arising from mismatches between ‘spiky’ renewable electricity supply and system demand.

Renewables, especially **wind** and **solar**, will certainly advance – especially once large-scale storage technologies become economic. Solar thermal with storage appears very attractive but costs are still huge. As pollution pressures bite harder and carbon is priced, **geothermal** (commercially proven by 2020) and **nuclear** (proven worldwide but yet to be accepted in Australia) will both assume roles of low-emission technologies of choice – with cost the decider. By 2050 also it is very probable that Australia will be connected to Asia – exporting and importing electricity in response to global markets.

Wind, solar and other renewable energy sources

Renewable technologies, especially solar, are huge success stories for Australia. Our research leaders are world-class and we have plentiful sun and wind. These industries thrive and growth rates are massive, albeit from a low base. Research grants, a host of industry subsidies and the impending carbon price all play their part in this success – and promising industries in most countries enjoy such support in their developmental years. Eventually the industries mature and learn to survive in the market, provided they meet its needs. Renewables will one day be supported by the price on carbon (and on other emissions they avoid), but not more than that. All technologies must compete on their merits in a tough world markets.

So what is their likely future for these renewables in the Australian portfolio? Unfortunately wind and solar both suffer from low capacity factors – typical commercial maxima are 40 per cent and 15 per cent although averages are lower. Neither does the wind blow nor the sun shine constantly or evenly. Both technologies remain very costly, especially solar, and both need considerable real estate compared to alternatives.

Both are enhanced by energy storage – for example hydro-pumped storage for wind and thermal storage for concentrating solar – but storage, and the related load management technologies, are also costly. Without stor-



Confronting the world of cybercrime.

Global dependence on electronic communication continues to grow at an astounding rate. However, this rapid growth in our use of Information and Communications Technology (ICT) has been matched by a boom in cybercrime, with issues around terrorist activity, child pornography, counterfeiting and identity fraud being very real crimes with devastating impact.

Research at UniSA is playing a vital role in enhancing global online security and safety. Jill Slay, Professor of Forensic Computing, leads the Information Assurance Group within the Advanced Computing Research Centre which undertakes collaborative research in Forensic Computing, Information Assurance and Critical Infrastructure Protection.


Professor Slay's cross-disciplinary research is focussed on finding ways to help solve the increasingly sophisticated research questions that link IT security and organised cybercrime. This encompasses the systems security of modern enterprises and taking a holistic perspective, examines the provision of new technologies or processes as security controls or as a means to collect electronic evidence.

With a variety of collaborators in industry and state and federal governments, research is being undertaken that draws on social science, anthropology, law, drugs and crime, police and justice studies, as well as systems and communications engineering and IT.

Important outcomes are being delivered around this work and include novel software to enhance Voice over IP security and software to aid law enforcement in visualising and analysing large amounts of evidence. Through the Zero Skills Analysis Program, developed by UniSA and the South Australian Police the identification of electronic evidence of crimes has improved, by allowing police officers without specialist IT training to conduct analysis in the field.

This internationally significant research at UniSA is helping to deliver critical infrastructure protection, and increased security from e-crime. In our increasingly cyber-dependent world, it is ultimately helping us all to be more safely connected.

For more information about research at UniSA visit unisa.edu.au/research



The surge in cybercrime is reflected in the increase in the amount of electronic crime evidence requiring analysis, which has increased 100,000 times over the last 10 years.¹

¹Slay, J & Schulz, F 2006, 'Development of an Ontology Based Forensic Search Mechanism: Proof of Concept', Journal of Digital Evidence, Security and Law, 1(1), pp. 25-34.



age, both require standby power availability to support baseload supplies. This also adds cost and contributes to of system-stability problems when load swings are rapid.

Wind and solar will always be part of the portfolio – perhaps quite a small part, as neither is suited to bulk baseload supply. But these and other renewable technologies such as waves and tides will thrive and prosper. Even 10 per cent of the electricity system investment forecast to 2050 is a huge business opportunity. The popularly promoted proposal ‘Zero Carbon Australia 2020’, based on solar and wind technologies is, unfortunately, beyond rational or economic realism but serves to help stimulate the debate we have to have.

Geothermal energy

Geothermal heat is massively abundant in the heart of the Australian continent and is in commercial service overseas. The Cooper Basin has some of the world’s hottest dry rocks, at 200°C to 270°C some three to five kilometres below the surface – the hottest spot on earth outside volcanic zones. The granite rocks have natural radiogenic minerals producing their own heat, trapped by overlying insulating rock – in effect a natural nuclear reactor. The big prize lies in tapping this resource using hot fractured rock (HFR) technology – a challenging engineering task, as some are finding. Once successfully captured and controlled, the fluid temperatures are not such as to give rise to any insurmountable thermal generating problems. High voltage direct current (HVDC) is the most promising energy route to the markets it will serve.

It is claimed that at present energy usage rates Australia’s high temperature resources would be sufficient for approaching 1000 years. While yet to be proven at commercial scale, HFR is sufficiently promising to predict that it will play a significant part in Australia’s low-emissions baseload-generation portfolio, hopefully from around 2020.

Nuclear energy

Nuclear power generation has served the international community with remarkable safety for more than 50 years. Today nuclear is in the generation portfolio of some 30 countries (though not Australia), with some 441 civilian power reactors providing nearly 15 per cent of the world’s electricity. Australia has nearly 40 per cent of the world’s low-cost uranium resources and is the third-largest uranium yellowcake exporter, fuelling the world’s fast-growing reactor fleet. Yet Australia is the only G20 country to continue to reject the nuclear option.

The reasons are economic and political. Australia has a low-cost coal abundance against which nuclear electricity cannot yet compete – its sent-out electricity cost being some 20 to 50 per cent higher. Politically, neither Federal

nor State Government policies yet allow nuclear generation, nor is open debate encouraged. Community attitudes remain uncertain, although observably changing as Australia’s policy of denial is increasingly questioned. Policies will undoubtedly change, probably quite soon, through community debate and better understanding.

Nuclear, with its minimal carbon footprint, will increasingly prove economically and politically attractive as emission-reduction pressures grow, carbon is priced and CCS costs and impacts are factored into coal. New generations of intrinsically safe reactors, both large customised and small modular, are being standardised and the smaller units, derived from ships and submarines, will become nearer mass-produced commodity items using extremely cheap fuel. Nuclear has a particularly high capacity factor, typically over 90 per cent, making it well-suited for secure baseload supplies. Once built, the low marginal cost of nuclear generation makes it especially suitable for charging electric vehicle (EV) batteries at night. Nuclear will certainly take its place in Australia’s generation portfolio, probably from around 2025.

Looking to the future

In network evolution, the so called ‘smart grid’ promises change. Brought about through growing distributed-generation opportunities, as well as the self-managed intervention of intelligent, well-informed, price-conscious customers and their agents, distribution grids of the future will employ smart metering and an ever-growing array of programmable measurement and control devices. Plug-in electric vehicles (PHEVs) offer vast discretionary system storage and load-levelling potential; they too will markedly impact future urban system development and management and will be taken up rapidly as oil prices climb and battery technology advances further – as they surely will. The challenge will be to develop international standards and protocols to avoid ‘rail gauge’ issues from the outset – but the trains of numerous gauges already have a considerable head of steam – standardisation will be far from easy!

The world’s energy patterns are changing; Australia’s are changing too. We live in a global marketplace. ◀

Concluding as a principal of Sinclair Knight Merz, DR MARTIN

THOMAS AM FTSE had an extensive career in energy consulting and then became founding MD of the CRC for Renewable Energy, ACRE.

Other roles included deputy chairman of Australian Inland Energy, directorships of Tyree Group and Enviromission, chairmanships of Austenergy, NSW Electricity Council and Sydney 2000 Olympic Energy Panel. He is chairman of Dulhuntly Power, adviser to ZBB Energy and was a member of the Uranium Mining, Processing and Nuclear Energy Task Force. He is a past president of the Institution of Engineers, Australia and of the Australian Institute of Energy, and now chairs ATSE’s Energy Forum.

Water: what is the future for Australia?

Subsidies reduce the cost of water and exacerbate the inefficient price signals users already receive, yet most water utilities are still attracted to the siren-call of offered subsidies.



By John Radcliffe

john.radcliffe@csiro.au

Most of Australia is just emerging from the longest drought since recorded European settlement. The community has become cognisant of Australia's water limitations as never before. There has been much debate as to whether this was natural climate variability or represents evidence of climate change potentially arising from global warming.

But with governments rushing to invest in new water infrastructure, how should we manage our water resources and water supply systems in the future so that they are used responsibly and efficiently, while recognising that riverine and groundwater environments need sufficient water for their ecosystems to operate effectively?

Can we continue to put our faith in such instruments as the Intergovernmental Agreement on the National Water Initiative, even though it has no legislative backing and is really only an unenforceable 'gentlemen's agreement'? Perhaps it needs more 'teeth', comparable to European Union Water Directives.

The 1994 COAG Water Reform espoused two principles. The first was to separate out the title of land from rights to water and make each separately tradable. There has been progressive development of water markets. In 2008, there was trade of 1600 gigalitres (GL) of water allocations ("temporary trades") and 900 GL of water entitlements ("permanent trades").

However, there are still some distortive constraints on trades, including the limit of no more than four per cent of water being able to be traded out of districts in Victoria, either to other states or the Commonwealth Water Holder.

The second 1994 COAG principle was to separate out the management of water resources from the operation of water supply systems, which were to become commercial businesses through the adoption of pricing regimes based on the principles of consumption-based pricing and full-cost recovery.

We are now seeing some recidivism. A merger between Melbourne Water (a water supply wholesaler), the Port Phillip and Westernport Catchment Management Authority and the Central Coastal Board, is due to be com-

pleted in June 2011. The Queensland Bulk Water Supply Authority, trading as Seqwater, a new statutory authority acting as a water wholesaler with 25 dams, 47 weirs and 46 water treatment plants, is also responsible for water resource management on 1.2 million hectares of catchment.

Should we insist on the previously agreed separation of functions or should we move to a more collaborative approach to water resource management and supply services? Is that equitable for other water entitlement holders? Have the water businesses been able to act commercially or are they being constrained by the governments on top of them?

What of the capital that is being invested in water supplies? Desalination has been chosen for the Gold Coast, Sydney, Melbourne, Adelaide and Perth, with \$10 billion committed on construction for building six desalination plants which between them can produce 485GL water a year, an amount roughly equivalent to the total annual residential drinking water consumption of NSW and the ACT.

A further \$2.5 billion has been spent on three advanced water-treatment plants with the capacity to produce 85GL a year of drinking water from Brisbane's wastewater.

Over-investment?

Though initially driven by the constraints of drought, some of these schemes provide for water supply needs well into the future. Is there a risk of over-investment potentially leading to a high cost to current consumers for excess capacity? There have been recent debates about the necessity for and adequacy of cost-benefit analyses for these projects. We may need better standards for the initiation of such major public investments.

This brings us to the basis by which the capital is secured. The chief executive of one of Australia's largest water utilities has made it clear that she sees that there is no need for subsidies and urban water projects should be fully funded by water users, as was implied in 1994. That assumes that prices are set on an objective economic basis.

A 2008 Productivity Commission paper commented

that subsidisation can frustrate cost-recovery objectives and deter appropriate investments. Subsidies reduce the costs of water and exacerbate the inefficient price signals already received by users.

Yet most water utilities are still attracted to the siren-call of offered subsidies. There is independent economic regulation in Victoria, NSW and the ACT, thereby providing transparency and rigour in price setting, but there is still a need to establish independent economic regulation in Queensland, South Australia, Western Australia, Tasmania and the Northern Territory.

In the future, we will have to look forward to clearer market signals covering water use and greater competitiveness in the supply of water services. Australia has yet to establish a good track record in either of these areas.

Governments have tended to use water-pricing regimes to achieve equity, environmental, revenue and economic efficiency objectives simultaneously. As Mike Young and Jim McColl have pointed out, this approach violates a golden rule in policy development – to avoid conflicts, use a separate instrument to achieve every objective and, once an instrument is assigned to one objective, don't try to use it to achieve another objective.

A wide variety of pricing structures continues to be adopted, though it is noteworthy that the NSW Independent Pricing and Regulatory Tribunal (IPART) has moved away from the otherwise widely adopted inclined block tariffs. As yet, 'postage stamp pricing' remains the norm. There has been no implementation of scarcity pricing.

Many home-occupiers receive no price signals at all with regard to water use as this is still paid by landlords. Water bills may be sent so infrequently that any price signal messages are effectively disconnected from the time of use.

However, the first signs that there is potential to change current pricing and charging models have appeared. Melbourne's biggest retailer, Yarra Valley Water, recently advised that it was starting work on a range of water options for households and businesses, including:

- a 'high security' water tariff, where customers pay a higher price for an unrestricted supply;
- a 'scarcity' tariff, where customers pay a cheaper price on the grounds they will consume frugally and face supply restrictions sooner than customers on more expensive plans;
- an 'environment' tariff, where customers would pay extra to ensure their water is delivered using environmentally friendly methods such as green power, or to ensure extra flows are returned to stressed rivers; and
- a 'community' tariff, where customers would pay extra to ensure that groups such as sporting clubs had access to water through rainwater tanks and other means.

These options would give consumers a choice of level of service, although how these alternatives would be implemented and monitored is as yet unclear.

Similarly, there has been a diverse approach to sewage charges, with little evidence of innovation and little recognition of volume treated.

However, Yarra Valley Water has adopted a novel approach through customers now paying a fixed charge of \$277.80 per year plus \$1.7196 per kilolitre of sewage produced. The sewage volume charge is identified as an assumed proportion of the metered water returned to a sewer. The identified percentage is different for houses and flats and varies with season. In winter it is assumed that 90 per cent of all the delivered water returns to the sewer. In summer the assumed percentage is less. Those who can show that they have adopted greywater recycling can apply for their assumed percentage to be lowered.

Market signal

This represents the beginnings of a market signal, albeit crude, for the wastewater generator.

Many of Australia's wastewater treatment plants are being extended to generate recycled water for irrigation, third pipe supply to houses in new suburbs – for toilet flushing, car



Ultrafiltration membrane units at the Glenelg Wastewater Treatment Plant produce recycled water for toilet flushing and amenity irrigation at Adelaide Airport and irrigating the Adelaide Parklands – an impressive but expensive \$75 million project.



PHOTO: JOHN RADCLIFFE

PHOTO: SA WATER CORPORATION



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washing and garden use – and for urban amenity plantings.

Stormwater has suddenly changed from being a hazard to becoming a water resource. The City of Orange, NSW, is already using treated stormwater for drinking.

The adoption of wastewater and stormwater recycling should in future be economically driven. To achieve this successfully, it needs to be preceded by adoption of drinking water charges that are rigorously and fully priced.

Competition is starting to be implemented at the householder level with the advent of more self-installed water sources – domestic water tanks (though often subsidised by government grants) and domestic groundwater bores (for which generally there is no resource charge and little regulation, with Perth the most obvious example).

These sources are beginning to have an impact on the operations of retail water companies as was recently highlighted by Shaun Cox, Managing Director of Melbourne retailer South East Water, in a presentation to the June 2010 ATSE International Workshop – ‘Water and its interdependencies in the Australian economy’. He pointed out that stimulation of competition for its core product was leaving water utilities with an increasingly “stranded” monopolistic asset base.

The other well-known example is from the City of Salisbury, SA, which has been selling recycled stormwater for industrial and amenity use as an alternative to reticulated Adelaide tap water from the SA Water Corporation, albeit with various subsidies accepted to generate the capital to do so.

More recently, the two competitors have come together with Salisbury recycled stormwater and SA Water recycled Bolivar wastewater being mixed for use in the suburban Mawson Lakes third-pipe system. These developments, though now of some standing, are probably still

in advance of the legislative framework to do so.

There are electricity and railway industry models that offer some examples for the establishment of competition where monopoly service providers have previously operated. Australia's first water competition legislation, the *NSW Water Industry Competition Act 2006*, picks up aspects of such models. However, the legislation has not provided a ‘level playing field’ in that Government Business Enterprises are currently excluded.

The National Water Initiative could be amended to better provide for competition options to be realised. We need further modelling of how water systems can be configured and owned to allow retail purchasers a choice of water supplier and the legislative structures that may be required to achieve such an outcome.

Ultimately, Australia's water services will need to be driven by clear economic signals which have likely been derived from established competitive supply systems based on equitably achieved ownership of water entitlements secured from scientifically sound water resource plans. Any social needs for water should be separately funded. ◀

Further Reading

National Water Commission Waterlines 1-30,

www.nwc.gov.au/www/html/591-introduction---waterlines.asp

Young, M.D and McColl, J.C. - Water Droplets 1-17,

www.myoung.net.au/water/droplets.php

DR JOHN RADCLIFFE AM FTSE is Chair of the ATSE Water Forum.

He was previously a Deputy Chief Executive of CSIRO, Director-General of Agriculture in South Australia and was a National Water Commissioner from 2005–08.

World's rivers in crisis

Australian scientists have contributed to a global-scale analysis that could aid the identification of areas most at risk of water security failures.

The paper, titled ‘Global threats to human water security and river biodiversity’, includes a spatial accounting framework that provides a global analysis of threats to fresh water that, for the first time, considers human water security and aquatic biodiversity simultaneously.

The Australian researchers were: Professor Peter Davies, Director of the University of WA's Centre of Excellence in Natural Resource Management; Associate Professor Caroline Sullivan from the School of Environmental Science and Management at Southern Cross

University; and Professor Stuart Bunn from the Australian Rivers Institute, Griffith University.

The research shows the world's rivers – the single largest renewable water resource for humans and a crucible of aquatic biodiversity – are in a crisis of ominous proportions, according to a new global analysis co-authored by three Australian researchers.

The report, published in the journal *Nature*, is the first to simultaneously map the effects of pollution, dam building, agricultural runoff, the conversion of wetlands and the introduction of exotic species on the health of the world's rivers.

The grim portrait of the world's rivers shows that nearly 80 per cent of the world's human population live in areas where river waters are highly threatened, posing a major

threat to human water security and resulting in aquatic environments where thousands of species of plants and animals are at risk of extinction.

The study, *Nature's* cover story, is the first to explicitly assess both water security and biodiversity in parallel. Fresh water is widely regarded as the world's most essential natural resource, underpinning human life and economic development as well as the existence of countless organisms ranging from microscopic life to fish, amphibians, birds and terrestrial animals of all kinds.



Australia needs to reinvest in farming and food.

Renewing our focus on food

To assure its own food security in an increasingly food-insecure world, Australia will require renewed focus on science, technology, economics, food policy and the national diet.



By Julian Cribb

julian.cribb@work.netspeed.com.au

The same week as we celebrated World Food Day 2010 in October, drought in Russia and downpours in North America thrust world corn prices to their sharpest one-day rise since 1973. For the second time in three years the impact of regional food setbacks was transmitted to consumers globally in a matter of days. “We are beginning to realise that the era of food surpluses has come to an end,” commented the UK *Financial Times*.

The context in which Australia must shape its future agriculture and food policies is one of a world in which global food demand will double by the mid-century. At the same time the resources needed to satisfy it – water, arable land, fossil energy, mined nutrients, fish, technology and stable climates – will become much scarcer or increasingly unaffordable for farmers.

Strategic think tanks in the US, the UK, Scandinavia and Australia are already warning about the consequences of this for conflict and refugee crises, for economic shockwaves and food price hikes, even in affluent and otherwise food-secure countries.

At present these shocks are fairly small and well-spaced. By 2060, with 10 billion people aspiring to a Western diet, they will be tectonic and one will spill into another. Countries that imagine themselves secure now will discover that, in a globalised world, they are not.

It is important to note that it does not have to be this way. Humanity does not have to bow to a growing cycle of scarcity and crisis – indeed, if we prepare ourselves, we can

prevent them. What is most needed is leadership, both national and international, to put in place the measures that will avert the building cycle of regional food shortages and their wider impacts.

Food production cannot be turned on and off like a tap, at the whim of global markets or politicians. It may take decades for a new technology or farming system to be widely adopted; meantime, drought, poor returns and global competition can eradicate local food industries.

To deal with such issues requires forethought and planning on timescales ranging from decades to half a century or more. It requires the integration of water policy with land policy, energy policy, science policy, health and food policy and climate policy. (Anyone who doubts the scale of the task has only to reflect how long it is likely to take to regenerate the Murray–Darling Basin alone, its industries, communities and ecosystems.)

Based on the key impending scarcities in global food production, there are some essential measures Australia can adopt now in order to avoid the impacts of food insecurity in future.

Recarbonise, rehydrate: we need a nationwide plan to rebuild the fertility, carbon and water retention of our landscapes – agricultural, pastoral and natural. In particular we need to find ways to retain more of the 50 per cent of rainfall now lost to evaporation continent-wide to carry agro-ecological landscapes through warmer times ahead and maximise our ability to lock up and retain carbon in the soil.

Recycle, re-nourish: mined nutrients are finite and likely to become costlier than oil in future, so we need a national plan to harvest fresh water and nutrients as they pass through our great cities and return them to food production – agricultural, peri-urban, urban and to novel intensive industries such as biocultures which will in turn produce food, feed, fuel and other valuable products.

Re-energise: whatever farmers use to grow and transport their produce in the 2030s, it probably won't be fossil fuels. Peak oil calls for a crash national R&D program to develop the farm and long-distance transport energy sources and systems of the future to sustain food production. Whether it is algal biodiesel, 2nd generation biofuels, hydrogen fuel cells, solar electrics or boron ion batteries we need to start right now, to avoid being caught unprepared by the next oil price shock.

Reinvest in knowledge: after two of three decades of disinvestment in agricultural science, technology and extension, policymakers need to understand that these hold the key to our future food security – and maybe that of our region also. Instead of slashing the public investment (as the Productivity Commission has recommended) we should double it.

In particular we should invest in:

- irrigation and land and water science – areas that have suffered irrational demolition in recent years include Land & Water Australia, the CRC for Irrigation, the CSIRO Irrigation Division, and large parts of state governments' irrigation research effort;
- soil microbiology – with a view to enhancing the biological potential of our landscapes and crop and pasture yields;
- building bridges between organic and high-intensity farming with the goal of developing science-based low-input eco-agricultural systems that recycle, re-use and conserve;
- developing food systems (including urban ones) which are cushioned against climate shocks; and
- research into frontier science areas such as re-engineering of the photosynthetic pathways in crops and trees, to boost yields and lock up more carbon.

Share knowledge: to help stabilise our neighbouring region against food insecurity (and ease the disturbing trend to foreign acquisitions of Australian land and water) we need to build a new multi-billion-dollar knowledge export industry, based on our expertise in areas such as, for example, landcare, dryland farming, water management and drought strategy. The mining sector has already done this, so it is perfectly feasible for agriculture and natural resource management (NRM).

Reinvest in people: our agricultural education system is falling apart and is in desperate need of reinvestment and revitalisation. We need to train a new generation of farmers and urban food producers equipped to overcome the scarcities ahead. We need to encourage our best youth back into a field which will be central to the human destiny this century.

Re-educate Australians about food: up to half of all the food produced in Australia is wasted or sent to landfill, calling for an urgent effort to end the waste, through education, technology and recycling. Up to half of all Australians, including our children, now die from diet-related disease, calling for national education about healthy eating, both to save lives and to rein in the biggest budget blowout in Australian history, in healthcare. We should educate our children to eat healthily, sustainably and with a renewed respect for food. This can be assisted by introducing a Food Year in every junior school in Australia, teaching all subjects through the lens of food.

Reinvest in food: the UN FAO points out that massive global reinvestment will be needed to head off food scarcity in the mid-century – yet adds this will not happen while farm returns are so bad and farm productivity sliding. The overwhelming economic signal from global markets to farmers is "grow less". This is due to a market failure driven by the growing imbalance in market power between 1.8 billion producers and the handful of corporates who buy their produce or sell farm inputs. Finding a solution to this economic distortion, without harming price signals, is a key challenge – otherwise new technologies and sustainable systems will not be adopted fast enough. One option is to compensate farmers for their stewardship, on behalf of society, of land, water, atmosphere and biodiversity. Others should be explored.

If Australia can successfully address the challenges outlined in this article we will earn the right to be a leader of the endeavour to sustain the global food supply. It is a role for which our farming, scientific and technical expertise equips us well. All that is presently lacking is an appreciation, both among our leaders and Australians at large, that this lies at the heart of our security in the 21st century – and a renewed focus on the one thing most elemental to human survival: food. ◀

Space constraints here prevented the discussion of population, which is covered in chapter 10 of 'The Coming Famine: the global food crisis and what we can do to avoid it, CSIRO Publishing, 2010 (see review Focus 162 (June 2010), page 40).

JULIAN CRIBB FTSE is an author, journalist, editor and science communicator and principal of Julian Cribb & Associates, which provides specialist consultancy in the communication of science, agriculture, food, mining, energy and the environment. His career includes appointments as newspaper editor, scientific editor for *The Australian*, director of national awareness for CSIRO, member of numerous scientific boards and advisory panels, and president of national professional bodies for agricultural journalism and science communication. His latest book, *The Coming Famine*, explores the question of whether we can feed humanity through the mid-century peak in numbers and food demand.

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The STELR Stage One Project 2009-2010 is supported by the Australian Government.

STELR is a key initiative of the Australian Academy of Technological Sciences and Engineering (ATSE) www.atse.org.au



"At the end of the STELR project, students were surveyed and they loved the practical experiments on biofuel, energy transfer, solar cells and wind turbines and said they would not change anything about the project because it was fun. That is a huge vote of confidence for the project because when students are having fun they are engaged and they are learning."

– Louise Macfarlane, Box Hill Senior Secondary College, Victoria

"I'm blown away with STELR... you're doing a fantastic job."

*– Matthew Rapley, Science Teacher,
Caroline Chisholm College,
New South Wales*

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Climate change impacts: the next decade

The issue is about more than just whether the climate is changing and the impacts ... it is also about why the issue exists and why managing it has been difficult.



By Graeme Pearman

graemepearman@megalink.com.au

Projecting the future, even only a decade ahead, can be achieved by extrapolating current trends and/or using insight concerning the fundamental processes of the involved systems. Either way, uncertainties will exist.

This is certainly true with climate change and the likely emerging impacts of that change. Nevertheless, foresight has enormous potential benefits for seizing opportunities and avoiding pitfalls. In the end, it is about the management of risk, albeit recognising that in some cases anticipation of outcomes will turn out to be useful, if not essential, while in others, in the light of experience, it may be seen as having been a waste of effort.

Both the changes that have occurred to the global and regional climate over recent decades and our theoretical understanding of the climate system make it likely that for the next decade the trend towards warmer global average temperatures will continue. There will be year-to-year variations in average temperatures and even more so in climatic parameters at the regional level. The natural climate system is variable and that variability will continue.

The challenge through this coming decade will be to cope with both the variability and the change with as little impact on human and natural systems as possible.

The past century has already seen an inexorable increase in the pressure of the high-pressure ridge that lies over the southern half of Australia. There is growing observational evidence that this reflects a strengthening of the Hadley circulation, the movement of warm tropical air pole-wards in the upper atmosphere to the mid latitudes where it descends and is responsible for the aridity across these latitudes in both hemispheres.

These observations agree with many theoretical mod-

els of the climate, and are implicated in the long string of low-rainfall years in the south-west of Western Australia since the 1970s and in the Murray–Darling and Victoria over the past decade or so. It is probable that this trend will continue with concomitant impacts on water supplies, power generation, potable water use, agricultural production and natural ecosystems.

In this regard, conflict over the use of a diminishing resource, as already apparent in the Murray–Darling Basin, is likely to only grow.

Through this next decade we may also see some of the first signs of other climate impacts in Australia, including more extreme sea-levels events associated with both higher sea levels and also more intense storms. Exposures around the national coastline including sandy beaches and in the major cities will occur with little predictability in terms of exact timing, but consistent with a steadily changing frequency of such events. Similarly it is likely there will be a change to the frequency of those occasions conducive to bushfires.

Lower water availability will demand engineering responses: pipelines, desalination, dams and groundwater options. These options will likely expose sectoral differences and needs across the economy and conflicting purposes. In addition there will be a need for ongoing improvement for reduced human demand for water. It is likely this will evoke serious rethinking of long-held views about such things as regional development, the role and nature of agriculture in the economy, trading as a market force in managing diminishing resources and ownership over natural resources including water – as well as natural ecosystems and their component species.

At all times knowledge will be accumulating in terms

Contributions are welcome

Opinion pieces on topics of national interest will be considered for publication in *ATSE Focus*. Items between 800 and 1500 words are preferred. They must list full name, title/role, organisation (if relevant), city of residence and email address for publication. Please address to editor@atse.org.au

of our theoretical understanding of the climate system and the systems dependent on the state of the climate. Part of this will be observed impacts across the world with a likely ongoing loss of water from the major glaciers (currently contributing around a millimetre of sea-level rise per year), a non-zero chance of the entire loss of sea ice in the Arctic during the summer and the concomitant efforts by nations of that region to claim ownership of resources that become more readily accessible – already involving Canada, China, Norway, Russia and the US.

It is likely that such pressure on international relationships and national security will not be confined to the polar regions. There will be ongoing evidence of change to ecosystems in migration, plant and animal behaviour, breeding times and so on. The impact on island nations of our region will grow in profile. Together, these observations will provide local stimuli for both adaptive and mitigative responses.

A consequence of both the observation of change and theoretical understanding may be that the magnitude of

the risks associated with climate change will become more apparent, demanding stronger actions. For example a warming target of 2°C may become viewed as unacceptable risk, albeit perceived differently by different countries and sectors of the economy, heightening efforts to pursue a 350ppm global concentration target.

While this may be driven by the falling water availability in some countries, it is possible that the poorly appreciated risk to the natural ecosystems that currently exists will become more apparent both from an ecosystem services and a planetary stewardship point of view.

Land management

This perspective may highlight the need for addressing methodologies for not only limiting the emissions of carbon, but tackling the task of removing greenhouse gases already in the atmosphere through land-management technologies.

It will raise serious consideration of the possible need for geo-engineering of the climate system itself. Compa-

Rising sea levels: we'll need to adapt

The authors of a new book have called for the development of more robust international ocean and ice sheet monitoring and modelling programs designed to help community adaptation planning keep pace with the threat of rising sea levels.

"The good news is that a recent concentration of science resources is improving our insight into ocean and ice dynamics, and scientific measurement of the rate of sea-level rise," says the book's lead

editor, CSIRO Fellow and oceanographer Dr John Church FTSE.

"The way the world responds to climate change will become increasingly reliant on a sophisticated integrated atmosphere, ocean and ice observing network generating data on future climates and from which global and regional sea-level rise can be projected.

"The key question is where and how sea-level rise and associated extreme events will have their impact," Dr Church says.

The 420-page book, *Understanding Sea-level Rise and Variability*, is the work of more than 90 scientists from 13 nations, led by Dr Church, Dr Philip Woodworth from the UK's Proudman Oceanographic Laboratory, Dr Thorkild Aarup from the Intergovernmental Oceanographic Commission and Dr Stan Wilson from the US National Oceanic and Atmospheric Administration. It provides a comprehensive overview of current knowledge on the science of sea-level rise, identifies the major impacts, assesses past sea-level change and the factors contributing to sea-level rise, and assesses how extreme events at the coast will change.

Dr Church says coastal development has accelerated over the past 50 years. Many of the world's megacities are situated at the coast and new infrastructure worth billions of dollars is being constructed. These developments assume that the stable sea levels of the past several millennia will continue. This assumption is no longer true.

"Populations in low-lying islands and deltaic regions are particularly at risk. We cannot ignore sea-level change because it has the potential to change forever the crowded coastal fringes of our continents."

John Church, with the book – *Understanding Sea-level Rise and Variability*.



PHOTO: CSIRO

nies already exist around the world to invest in such technologies and reap the benefits of a future price on carbon. Such technologies vary from relatively small-scale land-management projects, to global-scale engineering efforts to modify the energy budget of the planet.

The essential development over the next decade will be the formulation of a shared global view on appropriate research protocols and national actions in geo-engineering that truly reflect the very serious potential danger of some of these technologies – and the potential dangers of narrowly focussed researchers or nations acting according to their own interests rather than those of the wider global community.

A consequence of a drive towards a low-carbon future has ramifications for energy sourcing, production and infrastructure – and investment in existing energy generation methods. But it will open up enormous opportunities for new businesses in low-carbon emission and energy-efficiency technologies.

This transition has begun, but the next decade will see this intensify. Australia may have missed some of these opportunities, but many are still available for relatively early movers. The changes will be seen in a revolutionary move towards electric-drive vehicles, decentralisation of power supplies, diversification of electricity generation options such as geothermal, solar, wind, the development and deployment of energy storage systems, smart grids and energy management systems.

Huge improvements

Above all we will see huge improvements in energy efficiency of homes, commercial buildings and industrial processes and transport. This will create issues that will need resolution – such as the impact on disadvantaged members of the community of inevitably higher energy costs, disadvantaged companies and industrial sectors and the role of more controversial energy sources such as nuclear.

The climate change issue is about more than just whether the climate is changing and how it may physically impact on our societies. It is also about why the issue exists and why it is that managing the issue has, so far, been difficult. The connection to the drivers of change – human behaviour and societal institutions – has yet to be seriously explored (despite some early signs in the literature). This is likely to change through this decade.

Climate change results from the way we source and use energy and this, in turn, reflects our affluence, what we perceive as success and progress, livability, acceptable lifestyles and our cultures. It reflects our population size, our attitudes to immigration, and the nature of the way we build cities and communities and manage the land. It highlights

the diverse methods we have for dealing with threats, such as avoidance, denial, resignation – to name a few ‘coping’ mechanisms – and the barriers that exist for the incorporation of expert advice from all manner of experts into policy formulation.

In particular it highlights the sectoralisation of our communities, through the disciplinary base of knowledge generation, the targeted efforts of companies and the departmentalisation of governments, each tending to work against holistic considerations in policy formation and decision making. It stems from the way social institutions have evolved and how these, including our governance, financial, economic and cultural systems, have countenanced the underpinning causes of climate change.

Climate change may indeed be illustrative of the non-strategic nature of social evolution – its development in largely incremental steps with little control imposed from longer-term strategic aspirations and needs especially from a society-wide perspective.

Through this decade we may find that the climate change issue becomes much more of

a reflection on where this relatively directionless evolution has led us, its strengths and its non-sustainable weaknesses.

This will challenge our notions of the rationality of our decisions, the largely unconscious drivers of our aspirations and needs – and how fundamental to dealing with all issues of sustainability is a new focus on where we are directed. ◀

DR GRAEME PEARMAN AM FAA FTSE was educated at the universities of Western Australia and Wisconsin. He joined CSIRO in 1971, was Chief of the Division of Atmospheric Research 1992–02 and contributed more than 150 scientific journal papers. He is now a consultant, Adjunct Senior Research Fellow at Monash University and serves on several boards and science advisory panels. His current work includes holistic/resilient strategies for energy futures, transport technologies, and human behaviour in the climate-change issue. He is chair of ATSE's Climate Change Impact Forum.

PHOTO: ISTOCKPHOTO



Climate change may illustrate the non-strategic nature of social evolution.

Storm clouds near Griffith, NSW.

PROSPERING IN A CHANGING CLIMATE

PHOTO: GREGORY HEATH, CSIRO

The SA Division hosted jointly with the SA Premier's Climate Change Council a half-day seminar in Adelaide in November titled *Adaptation in South Australia: Prospering in a Changing Climate* attended by more than 100 people.

It was jointly chaired by Fellow and Council Chair Mr David Klingberg AO FTSE and SA Division Chair and ATSE Director Professor Mike Miller AO FTSE, with a strong array of speakers.

The Keynote Address *Prospering in a Changing Climate* was delivered by Dr Mark Howden, CSIRO Climate Adaptation Flagship theme leader and Honorary Professor at Melbourne University, School of Land and Food.

He noted that climate change would likely bring drier, hotter conditions and generally more intense climate events to southern Australia, challenging many elements of our society and perhaps even our values. But, he said, change also brings opportunity and outlined some of the actions we could take now to enable a more effective climate change response, bringing prosperity in the face of change.

The seminar was themed in four areas, with speakers delivering 10-minute presentations. The themes were Climate Knowledge; Resilient, Well Functioning Natural Systems and Sustainable, Productive Landscapes; Resilient, Healthy and Prosperous Communities; and A Way Forward: Working Together Within Your Regional Communities.

The seminar was summarised by Professor Jean Palutikof, Director of the National Climate Change Adaptation Research Facility, Griffith University.

SOUTH-EAST CLIMATE IS CHANGING TOO

Despite recent rainfall in parts of eastern Australia, a new report indicates an increasing risk of below-average rainfall and runoff into streams, and drier conditions into the future in south-eastern Australia.

The South Eastern Australian Climate Initiative (SEACI) report, *Climate variability and change in south-eastern Australia*, highlights the effects of climate variability and change on the water resources of the south-east.

A key finding is that the recent 13-year drought was unprecedented in the historical record in terms of its extent, reduced year-to-year rainfall

variability, and the seasonal pattern of the rainfall decline. As a result of the nature of the changes in rainfall, the reductions in runoff have been greater than expected.

"While 2010 has brought welcome rains for much of south-eastern Australia, there is growing evidence from SEACI research that a long-term trend towards a drier climate is taking place," said Program Director, CSIRO's Dr David Post. "Changes to large-scale atmospheric circulation patterns are impacting on rainfall and runoff in the south-east, particularly in the southern Murray–Darling Basin and Victoria."

These observed changes indicate a shift in the overall climate of south-eastern Australia, similar to what has been experienced in rainfall and runoff in south-west Western Australia since the 1970s.

IS THE ANTARCTIC SNOW STEALING OUR RAIN?

Researchers have found that increased snowfall in the Antarctic may be linked to the drought in south-west Australia over the past 30 years. Analysis of ice cores drilled at Law Dome, a site just inland from the Casey station, has revealed that snowfall variability may be linked to climate in the Australian sector of the Southern Ocean and south-west Western Australia.

Dr Tas van Ommen, principal research scientist with the Australian Antarctic Division in Hobart, said the ice cores provide a record of annual variations in snowfall and provide a record that stretches back over 750 years.

"Over the past 30 years, the cores indicate that there has been a significant increase in snowfall in that area," he said, adding it "lies well outside the natural range recorded over the past 750 years".

"This inversely correlates to the occurrence of a significantly lower rainfall and subsequent drought that has been experienced in the south-west of WA. So when there's extra moisture at Law Dome, the same circulation pattern is starving WA of moisture."

Dr van Ommen, a speaker at 'Going South', ATSE's Phillip Law Commemorative Antarctic Science seminar in September, presented his research results from the analysis of ice cores during a recent seminar, 'Antarctic Ice Cores and Australian Climate', at Curtin University in Perth.

STEM education in Australia: keys to future excellence

STEM education is an essential component of infrastructure for a prosperous, informed and scientifically and technologically competent nation.



By Lesley Parker and Alan Finkel

l.parker@curtin.edu.au alan@finkel.net

Like a considerable number of ATSE Fellows, each of us has written a great deal about the past, the present and the future of education in Science, Technology, Engineering and Mathematics (STEM). In this article, we focus on the future, summarising the needs and anticipating the consequences of not satisfying those needs. We consider what needs to change and what ATSE – as a national organisation and as an agent and leader of change – has done and must do to make change happen. Although we recognise the issues at all levels of education, this article focuses on the school level.

A significant investment in Science, Technology, Engineering and Mathematics (STEM) teachers is required at this point in Australian educational history. This is necessary in part to compensate for the previous underinvestment and in part because of the uniqueness of STEM as a subject area in which essential knowledge is advancing rapidly.

Australia is currently at a critical period in the development and implementation of the new Australian Curriculum – a document likely to be highly influential during the next decade and beyond.

Reviewing recent ATSE deliberations and recommendations for STEM education, we find that, consistently, ATSE submissions and publications of the past decade or so (for example, in *Focus* 147 and 159, in the ATSE contribution to the 2008 Review of Engineering Education and in a 2002 report of the ATSE research project *The Teaching of Science and Technology in Australian Primary Schools*) have conveyed strong messages regarding:

- the importance of effective STEM education for the future of Australia, to ensure both scientifically and technologically literate citizenry and to alleviate projected skills shortages in the workforce;

- the underinvestment by successive governments in STEM education at all levels;
- the kinds of policies and practices that need to be put in place to improve STEM education;
- the need to identify teaching contexts that will make STEM relevant and exciting, for teachers and students; and
- the need to increase the visibility and appeal of careers in science and engineering.

While these messages all remain valid, we see school STEM education as an essential component of infrastructure for a prosperous, informed and scientifically and technologically competent nation. With a few exceptions, much of the focus of past initiatives in school education has been on student learning (or the lack thereof) in STEM and on motivating students to pursue STEM studies and careers.

Small pockets of reform have emerged throughout the whole country and literally hundreds of initiatives have been implemented – usually one-off, dependent on a ‘champion’, dependent on special (usually very little) funding and with unclear long-term outcomes.

At the national level, the impact of all these efforts is frustratingly little. Enrolments in the so-called enabling subjects – physics, chemistry, mathematics and biology – appear to have stabilised at a low level without recovering from the significant decline of the past decade, while the performance of Australian students in international tests in science and mathematics has slipped and the list of projected shortages in many workforce areas dependent on STEM continues to grow.

What is missing? Is there some factor that can be addressed more directly than in the past that could arrest these declines? Our reading of the literature leads us to be-

Letters to the Editor

ATSE *Focus* welcomes letters from readers in response to articles. Please keep letters brief to enhance publication prospects. Longer letters may be run as contributed articles. Please address to editor@atse.org.au

lieve that there is such a factor – the teacher. We emphasise that we are not ‘teacher-bashers’ – indeed we share a strong admiration for teachers and the miracles they work in some schools. However, one of the points of agreement amongst researchers in STEM education is that the teacher is the most important factor in influencing student learning.

As has been pointed out by researchers previously:

- the quality of an education system cannot exceed the quality of its teachers; and
- the only way to improve outcomes is to improve instruction.

The only way to improve instruction in STEM is to ensure that teachers have adequate opportunity to acquire essential STEM content and the requisite skills to teach that content.

ATSE taking action through STELR

Participation rates in the enabling sciences in the senior years of secondary schooling in Australia declined in the 1980s and 1990s, and levelled off over the most recent decade. One of the primary reasons for the low participation rates is that most secondary school students do not perceive the enabling sciences or mathematics as relevant to their lives, despite the manifest importance of science and technology in our modern society. As a consequence, a significant proportion of Australian students do not elect to study these subjects at senior levels.

ATSE’s Science and Technology Education Leveraging Relevance (STELR) project is a national science-education initiative which aims to reverse these lowered participation rates. Following two years of testing in a small number of schools, in calendar year 2010 the ATSE STELR Stage One Project has been incorporated into the curriculum of 182 schools throughout Australia. Funding was provided by the Australian Government and the project is supported by sponsors from the mining, chemical and energy sectors.

STELR taps into the high level of concern the majority of students have about global warming and climate change, shown through surveys of students, by using the theme of renewable energy. Since one of the most effective ways of reducing greenhouse gas emissions is the widespread adoption of renewable energy technologies, students see these technologies as being highly relevant to their lives.

STELR is designed to give all Year 9 or 10 students, whatever their background and abilities, the experience, confidence, skills and insights that will inspire and enable them to further their studies in the sciences, mathematics and technology. Whether they eventually choose a career in these areas or not, STELR contributes to their science literacy skills, such as an appreciation of the role of science in society and of the utility of evidence-based thinking. STELR operates within the curriculum so that all students at the year level participate in the program, not just selected students.

STELR inspires and empowers practising teachers to teach science more effectively. To help achieve this, STELR incorporates contemporary teaching and learning practices and, in particular, an inquiry-based learning approach that engages and challenges students and teachers. In addition, STELR provides extensive resources to all participating schools, including classroom equipment needed for the program, student and teacher booklets in print and electronic form, a web site, teacher professional learning and ongoing teacher support.

Inconvenient truth

Most recently Randi Weingarten, President of the American Federation of Teachers, has emphasised that it is one of the inconvenient truths of education that even the best teachers need “tools, resources and support to do their job well”.

A primary school teacher wanting to introduce more science to her class said to one of us recently: “I went to the curriculum cupboard but the cupboard was bare.”

STEM teachers in Australia have been, in many ways, the victims of the government underinvestment referred to above. We are alarmed that this situation appears to be continuing even today, at this critical period of activity related to the new Australian Curriculum.

The recent announcement from the Australian Curriculum, Assessment and Reporting Authority (ACARA), the body charged with developing the curriculum, indicated that: “Once Ministers endorse the curriculum in December [2010], it will be available for implementation from 2011 by those jurisdictions and schools wanting to commence implementation in 2011... [with] substantial implementation in all schools by the end of 2013.”

It is alarming that there is little acknowledgement of the rapidity of this implementation and of the considerable extra demands on teachers and teacher educators who have to come to grips with the new curriculum. The announcement implies that support for teachers will be limited to “achievement standards, work samples and a range of information and curriculum planning resources to support schools prepare for implementation”.

ATSE has many concerns about the Australian Curriculum and has conveyed these concerns to ACARA. A particular concern is that the timeline for implementation is too short and that implementation issues, particularly in relation to teacher development, are not being addressed. It is not enough to provide material to “support schools” and to expect the schools to budget for the embedding of these in the work of teachers.

ATSE considers that the challenges of implementation are dominated by five major, inter-related issues:

- teachers’ STEM knowledge and skills, with implications for both pre-service and in-service education of teachers;
- renewal of the workforce, to address the ageing of the current workforce and increasing demands placed on STEM educators, in terms of rapidly advancing knowledge;
- widespread availability of relevant teaching materials to drive the adoption of contemporary courses and teaching practices;
- support for in-curriculum initiatives such as the ATSE STELR project – initiatives designed to reach all students in a particular year level rather than just the ones whose teachers volunteer; and

- strong and practical support for the use of information and communications technologies in teaching of STEM.

ATSE maintains that responsible, modern curriculum development demands the development of a detailed plan to ensure that these and other implementation and evaluation issues are addressed, with adequate budgetary support. This situation highlights the need for a radical re-think of the pre-service and in-service education of STEM teachers.

We conclude this article with some suggestions about what such a radical re-think might encompass:

- a dedicated budget, of sufficient proportions and with sufficient longevity to resource a sustainable model of STEM teacher in-service training, administered by body external to ACARA;
- a requirement that pre-service teacher education in STEM for primary and secondary teachers be carried out collaboratively by scientists, engineers and teacher educators, with the provision to universities of budgets specific and appropriate to this model (perhaps through ALTC);
- inducements and rewards for science graduates to undertake postgraduate education training and enter the teacher workforce;
- strengthening of the prerequisites for popular university STEM courses to encourage more students to choose STEM subjects at school; and
- recognition of and reward for STEM teachers who gain additional STEM qualifications that demonstrably enhance their teaching and their students' achievement.

None of these comes cheaply, but STEM education has special needs. If these needs are to be addressed satisfactorily, then ATSE Fellows must play their role in ensuring that teachers in our schools have the kind of support necessary for effective teaching. ◀

EMERITUS PROFESSOR LESLEY PARKER AM FTSE is Chair of the ATSE Education Forum. Her career has included leadership, research, teaching and policy in all sectors of education, at State, national and international levels. Most recently she was Senior Deputy Vice Chancellor of Curtin University (1997–04), and Inaugural Director of the national Carrick Institute of Learning and Teaching in Higher Education (2005–06). In 2008 she received the Australian Learning and Teaching Council's Career Achievement Award. Currently, while maintaining a commitment to science and mathematics education at Curtin, she is also working on educational projects in Australia and overseas.

DR ALAN FINKEL AM FTSE is a neuroscientist, entrepreneur and philanthropist. Since 2008 he has been Chancellor of Monash University, where he received a doctorate in Electrical Engineering in 1981. He then served as a postdoctoral research fellow at ANU, before founding and later selling Axon Instruments, a global science and technology company based in the US. He co-founded the science magazine *Cosmos* and has endowed a Chair in Global Health at Monash. He is a former Director of ATSE and a winner of the ATSE Clunies Ross Award. In 2009 Dr Finkel was appointed as the Chief Technology Officer of Better Place Australia.



ATSE STELR Project Manager Peter Pentland (third from left) works with teachers during the 2010 STELR professional development workshop in Perth.

Broadband: it's needed, and needed now

The benefit from broadband infrastructure is justified solely by the social and productivity gains realisable in the areas of health, environmental and resource management.



By Terry Cutler

cutler@cutlerco.com.au

Many of us have been talking about broadband for at least the past two decades. Actually, different groups have been having different conversations. That, I think, is why we have made so little progress. The announcement of the National Broadband Network and the establishment of NBNCo have tilted discussion and debate towards an unhelpful focus on just the infrastructure rollout and what is a massive civil works program.

We need to get a little more perspective, especially around the topic of why we need this infrastructure and how we could put it to good use now. By focusing on the public benefits from possible applications we might also promote a more informed discussion around the possible network service architectures and the public policy issues around access, pricing and regulation.

I argue strongly that the national benefit from broadband infrastructure could probably be justified solely on the social and productivity gains realisable in the areas of health, environmental and resource management. That is without also looking at what we can learn from past patterns of adoption or from emerging trends in demand. It is time we moved away from the simply sloganeering that broadband will simply enable people to download movies and pornography faster and that "it is a conspiracy against taxpayers".

In the case of population health we know we have a major problem. Health and social assistance employ 1.2 million people, and the workforce grew by 12 per cent between 1995 and 2000. Nonetheless, this professional workforce is ageing and everyone predicts major skill shortfalls in the near future. My health sector colleagues also tell me that there is little correlation between the number of doctors and health outcomes. More staff is not the simple answer.

This is because national health budgets are escalating out of control. Australia currently spends about \$100 billion a year on healthcare, or 10 per cent of GDP, and this is predicted to double before the end of the coming decade. This is because the demands on the system continue to

increase. Our population is ageing. The 2010 Intergenerational Report estimated that the percentage of Australian aged over 65 will grow from 13.5 per cent today to 19.3 per cent by 2030.

We are also living longer. Average life expectancy increased by around 30 years over the past century. But there is not necessarily a commensurate improvement in the quality of life as these trends are accompanied by an increase in the incidence of chronic disease and preventable ill-health. Mental health problems are also on the rise. Moreover, health outcomes are not distributed evenly across communities and levels of health literacy are also uneven but generally disturbingly low. This means that people's ability to manage their own health and well-being and to use health support services effectively is limited. Less than 10 per cent of current budgets is allocated to preventative health.

These demand-side pressures are compounded by supply-side inefficiencies, often making the health system a dangerous place to enter. Legacy institutional frameworks produce workforce and service delivery silos and there are wide disparities in the availability of services across the country.

Against this backdrop it would be naïve to suggest that eHealth solutions are the silver bullet. A broad health reform agenda would probably encompass changes in the roles of health professionals, an increasing policy focus on prevention and the promotion of wellbeing, as well as increasing efficiency through technology platforms.

To date a lot of the eHealth implementations have focused on siloed parts of the system. The potential lies in our use of information and communications platforms to reinvent business models and processes across the whole system, as has happened in other service sectors such as wholesale trade, financial services and communications itself. These sectors, significantly, were the main source of Australia's productivity growth from 1994 to 2004. The rhetorical question is "if we can get such gains in other sectors why cannot we do the same in health?"

Starting point

As a starting point we need to recognise that the health system is a complex ecosystem. The transformational power of the digital revolution is the way it enables networked operations, linking previously disconnected parts of the system. The network platforms enable information flows and it is access to information and better information exchanges that facilitates better health outcomes through changed operational processes.

Seamless access to patient health records, medication data, and care plans makes the whole system more intelligent – and citizen access to online health information, triage services, and medical peer to peer consultations through all the forms of teleconferencing promote a more joined-up and collaborative framework for service delivery.

Professor Peter Brooks reminds us that “80 per cent of diagnoses can be made by taking the patient history alone”, which is why online consultation and triage has such potential to treat people outside our costly acute-care facilities. It also provides better service access for people in non-metropolitan areas. In Queensland, a Professor of Geriatrics runs the Geriatric Ward at Toowoomba Hospital, which is 130 kilometres from Brisbane, from his office at Brisbane’s Princess Alexandra Hospital. There are numerous similar examples around the country.

But what if we could do the same thing with people in their own homes, particularly as more people become housebound? How much would become possible with a high definition Skype-like service and remote monitoring like the health equivalent of a smart energy grid? Think of the savings and convenience of ePrescriptions and “call back” forms of care.

In addition we can provide the tools to help people become more informed about health issues and better placed to manage their own well-being, not to mention the fact that preventative health measures and social inclusion will be enhanced through better communication linkages between family members and friends, especially for the housebound or isolated.

Ubiquity is important

Only two things hold us back from realising the potential. The first is that within health and community services we need to re-examine the current business models and incentive structures across the sector to facilitate different ways of doing things. Second, the example of eHealth has some important implications for the way we think about broadband infrastructure.

First, ubiquity is important. We can create institution-to-

institution links now, but we need extensive household coverage to realise a truly citizen-centric and cost-effective health system. We also know from experience that networked solutions only take off when there is a tipping point in the level of penetration. The more people are linked in, the more beneficial the system becomes for everyone. That is why it is useful to focus on applications that can drive take-up and use.

Second, eHealth and other like examples highlight the need for the high capacity symmetrical bandwidth that fibre links facilitate. Present copperwire and wireless-based solutions are predominantly built around an asymmetrical model where there is far greater download capacity than upload.



PHOTO: ISTOCKPHOTO

Finally, thinking about the uses we could make of broadband infrastructure reminds us that – to assess the benefits, and costs – we need to look at the value proposition across the whole service delivery architecture, not just the costly infrastructure platform.

The Australian Government is committed to broadband communications, it is committed to better health outcomes, it looks to better environmental management, and it is promoting more efficient energy systems. This provides an opportunity to join the public policy dots and to bring forward significant public benefit outcomes. ◀

Broadband infrastructure would support productivity gains in health.

DR TERRY CUTLER FTSE is an industry consultant and strategy adviser in the information and communication technology sector, Principal of Cutler & Company and Deputy Chairman of CSIRO. He has held numerous important advisory and decision-making positions with Australian government agencies, including roles as Chair of the Review of the National Innovation System, the Information Policy Advisory Council, the Industry Research and Development Board, the Australia Council and the Australasian CRC for Interaction Design.

Australia needs women in the corner offices

“One shattered stereotype was that women don’t desire the top job as much as men.” – Bain & Company 2010



By Susan Pond and Bronwyn Holland

susan@pondemail.com

bronwyn.holland@eng.uts.edu.au

Despite an undeniable body of evidence that companies with higher percentages of women in their leadership perform better financially, the upper echelons of corporate Australia remain a largely male domain (Ernst & Young 2010). Women constitute 45 per cent of the workforce but represent only 11 per cent of managers in the private sector, 10 per cent of board members and two per cent of ASX200 Chairs (EOWA 2010, AICD 2010).

These hard economic and demographic realities are driving the big end of town to set and report on objectives to increase the representation of women on boards and in senior executive positions. From January 2011, ASX listed companies will need to disclose their gender diversity policies, show how they have met measurable objectives and account for any lack of progress. Federal Sex Discrimination Commissioner Elizabeth Broderick says that mandatory quotas may be introduced if voluntary objectives are not met.

Recent findings about the rates of progression, retention and participation of women in the science, engineering and technology (SET) workforce are sobering. Engineers Australia reports that female engineers comprise nine to 11 per cent of the workforce and that 77.8 per cent of female engineers were in lower responsibility level positions (levels 1 to 3 on a scale of 5). This is reflected in their remuneration: 30 per cent of females reported earning less than \$60,000 compared with 24 per cent of men. Only 10 per cent of female engineers, compared to 15 per cent of males, reported earning more than \$121,000.

The 2009 report by Professor Sharon Bell to FASTS (the Federation of Australian Scientific and Technological Societies), *Women in Science: Diversity, Productivity and Opportunity*, found that women comprised 22.3 per cent of full-time professionals in design, engineering, science and transport and 15.2 per cent in ICT in 2008 and that these figures had not changed significantly in 10 years.

The study also found that women in SET fields in universities continued to be segregated vertically by level of seniority. This is illustrated graphically by the notorious ‘scissor’ diagram in which early differences in achievement by women at undergraduate levels are followed by a cross-over at lecturer level as men ascend in seniority.

The persistence of vertical segregation in higher education SET should be a priority for redress and at the forefront of debate about productivity and innovation policy. Yet the dimension of gender was noticeably absent from the National Skills Audit of 2006 and sidelined by the Bradley Review of Higher Education of 2008. Professor Bell expressed concern that the current equity focus on ‘multiple disadvantage’, together with the high rate of female participation in higher education, had overshadowed the reality of low numbers and lack of progression by women in SET fields. She also noted that “persistent gender inequality impacts negatively on men as well as women by narrowing choices and reinforcing historic workforce patterns. It also limits the range of responses available to meet other equity group targets as these groups are constituted by women and men in roughly equal proportions”.

If the number of women participating and progressing in the SET fields is not addressed, the implications for Australia’s prosperity are concerning – especially in light of the ‘lag effect’ of the deepening skills shortage on the scoping and delivery of major projects and infrastructure.

CSIRO has projected that 230,000 to 340,000 additional jobs will be necessary in the next 10 years to make the transition to an environmentally sustainable society. Dr Peter Ellyard, the Australian futurist, projected in a recent ABC Radio National interview that 70 per cent of the jobs and services projected for 2030 do not exist yet. Lack of human capital, female and male, will inhibit Australia’s potential to create the industries required for a low-carbon economy, let alone service the current mining boom and that projected for the agricultural sector.

Changes in the workplace need to be led by those with the power to recruit and hold the executive team to the performance goal of attaining gender parity. The Council of Executive Women has commissioned a handbook for CEOs to assist them to attract, retain and promote female talent and is working towards that goal with the Australian Securities Exchange (ASX), the Australian Institute of Company Di-

rectors (AICD) and the private and public sectors.

The *Harvard Business Review* (September 2010) reviewed promotion outcomes for women and men, all of whom had received mentoring, in its article 'Why Men Still Get More Promotions than Women'. It reported the difference was that men had also enjoyed the support of an influential internal sponsor in the organisation. Without internal champions, women have less influence and can end up cycling through mentoring programs without progressing to more senior ranks. The message is clear: women, like men, require mentors and internal champions.

Retention a challenge

Retaining SET-educated women in the workforce is a challenge. Surveys of their female membership by Engineers Australia and the Association of Professional Engineers, Scientists and Managers Australia (APESMA) have found that the reasons women consistently give for contemplating leaving their field are: lack of flexible working conditions, lack of career development, workplace culture and pay inequity. The 2010 APESMA survey (*Women in the Professions Survey Report 2009-10*) of 1100 female members reported significant rates of bullying (40 per cent), discrimination (38 per cent) and sexual harassment (19.3 per cent) in their professional employment.

The survey cohort comprised 58.6 per cent women qualified in science and 30 per cent in engineering. The average age was 38 years. Disturbingly, almost one-quarter of respondents (23.9 per cent) expected to have left their profession within five years. This was higher for the private sector, at 29 per cent.

Australia's divergent rankings on educational attainment for women (ranked 1st internationally) and on women's labour force participation (ranked 44th) for the Global Gender Gap Index of the World Economic Forum underscore this point. This low retention rate translates for Australia into a poor return on the country's investment in its female human capital and markedly lower rates of lifetime earnings and retirement savings for women.

The striking convergence on the issue of retention in both business and universities means that it is no longer legitimate to concentrate on 'changing the women to fit the system'. The collective leadership of Australia public, private and civil sectors has to take responsibility to change the system. The reasons why women leave science and engineering provide the roadmap. They point to opportunities for organisations and professional bodies to invest their efforts and resources strategically.

What is needed is systemic provision of flexible conditions, parental and carer leave, transformation of adverse and hostile workplace cultures, redress of gender pay inequ-

Figure 1 Academic profiles by gender, natural and physical sciences 2007

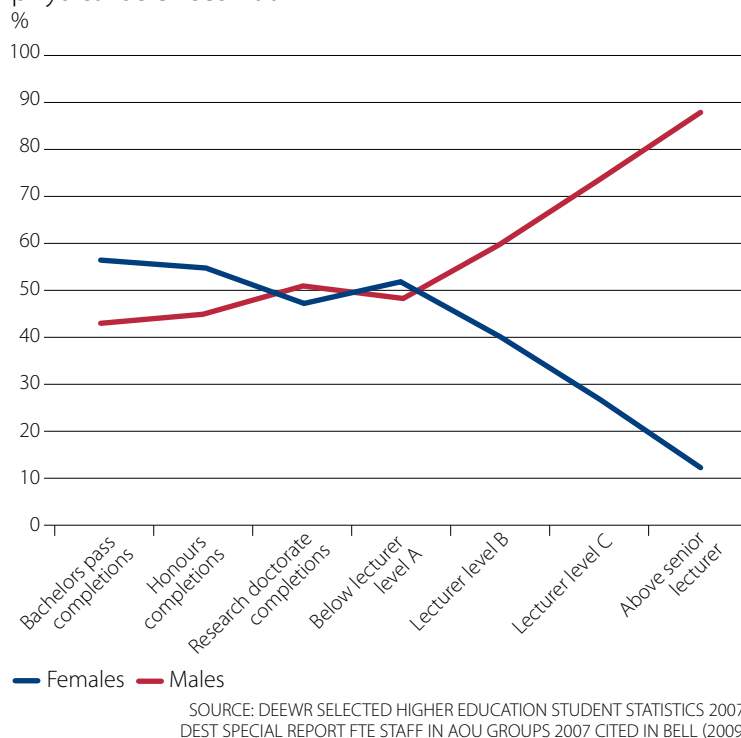
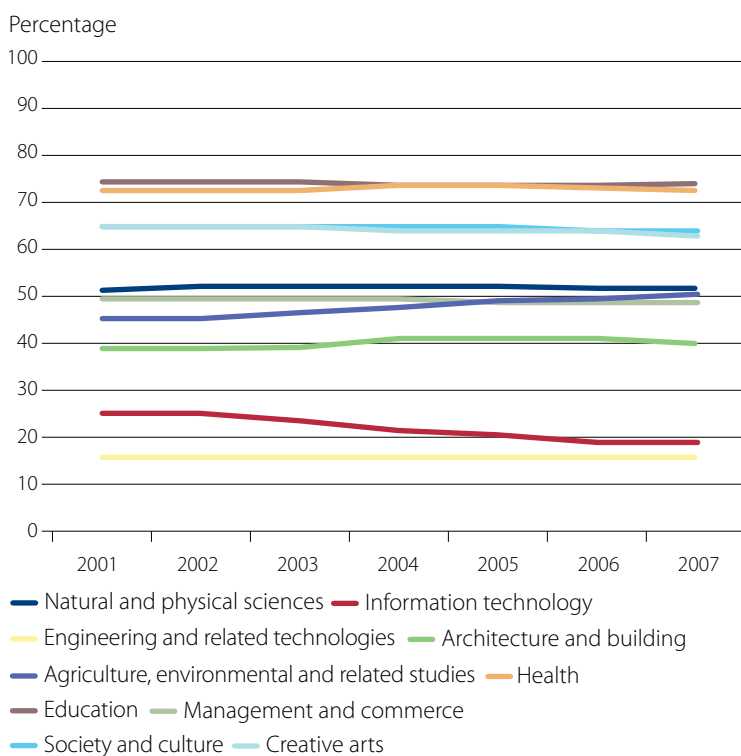


Figure 2 Female higher education enrolments by broad field of education 2000-07



ities and, most importantly, buy-in by leaders at all levels in all organisations to make gender parity a priority that is underpinned by KPIs. The power of the adage that 'you can't be what you can't see', is as true for undergraduates looking for senior women faculty members as it is for gradu-

are recruits looking for women in line management and on the Board of their company.

The extent to which talented and capable women are choosing against SET careers is another front for a systemic approach. In the FASTS study, Professor Bell and her colleagues found that women's participation in higher education continued to be segregated horizontally by field. Women were concentrated in biological sciences, agriculture and environmental studies. In regard to SET, she was forced to conclude that "not much has changed" compared with the 1995 survey by Women in Science and Engineering (WISE).

Recruiting more women undergraduates has long been proposed as the best single 'fix' for the declining enrolments in engineering courses. This and equity concerns have underpinned the many programs and initiatives designed to engage girls with the possibilities of engineering as a choice of study and career. These initiatives are recognised for their contribution to attracting and sustaining

undergraduates. However, equity education and outreach cannot prevent the attrition of female graduates in a workplace where women are not valued.

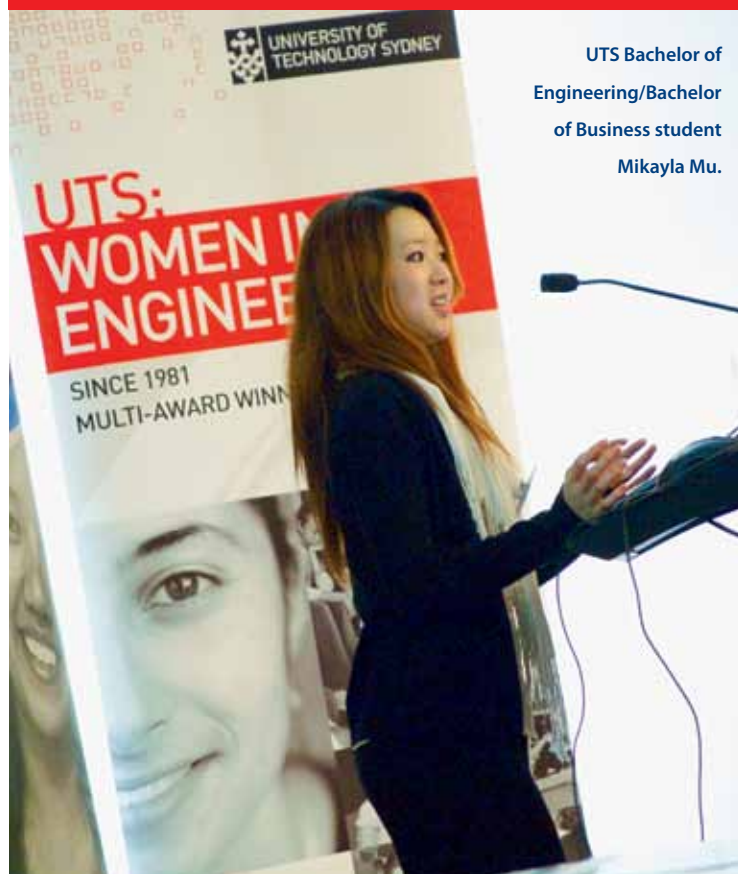
A renewed effort to ensure greater gender equity in universities has been released by Universities Australia as a *Strategy for Women: 2011-2014*. This assigns responsibility for leadership to Vice-Chancellors and includes goals for increased recognition of the contributions of women to the productivity and advancement of Australia's universities; increased representation of women at all levels, including Indigenous women; and an increased proportion of women in senior leadership positions.

The Australian National Engineering Taskforce (ANET, www.anet.org.au) launched two projects in March 2010. The first will "study demand and supply of engineering skills", the second will "research pathways for engineering education in the vocational education and training and university sectors."

ATSE is a partner with ANET and also has its own program, named STELR (see page 22), which is designed to capture the imagination, spark the motivation and win the confidence of young people in high school – young women in particular. ATSE will continue to act to help secure the national interest of future prosperity by broadening the participation of women in technological sciences and engineering at all levels of seniority.

■ A further reading list is available by emailing editor@atse.org.au ◀

ATSE concerns itself with industries and professional appointments in science, engineering and technology (SET). Women constitute 6.5 per cent of the ATSE Fellowship. Of the 28 Fellows elected in 2010, four are women. The first female non-executive director of ATSE was appointed in July 2010. Major Board Committees and Topic Forum leadership groups are bereft of women. ATSE resolved at its August 2010 Board meeting that "it will act internally, proclaim its position publicly and influence other organisations to promote the role of women in technological sciences and engineering."



UTS Bachelor of
Engineering/Bachelor
of Business student
Mikayla Mu.

DR SUSAN POND AM FTSE has a distinguished record in medicine, science and business. Currently, she has a professorial appointment in the Dow Sustainability Program at the US Studies Centre where she leads the biofuels and bioenergy program. Dr Pond is also on the Boards of ATSE, Commercialisation Australia, ANSTO, the Centenary Institute and the University of Sydney Science Foundation for Physics. Her previous senior appointments include Chairman and CEO of Johnson & Johnson Research, Professor of Medicine at the University of Queensland and Chairman of the Australian Drug Evaluation Committee and AusBiotech.

BRONWYN HOLLAND leads the Women in Engineering & IT Program at the University of Technology, Sydney. The award-winning program was most recently recognised as a gold initiative for advancing women in science by the PRAGES project of the European Commission. Ms Holland seeks to combine participatory decision-making in technology and practice for sustainability, with equity and access to education and opportunity in science, engineering and technology. She welcomes the renewed attention to barriers to women's participation and progress in these fields in Australia and wider recognition of the need for a systems approach to identifying and dismantling them.



International jet aeroplanes promote economic and cultural collaborations across the global community – reflected by the number of airline routes around the world.

International collaboration to meet national priorities

Our competitive advantages will be tested as the populous countries of Asia continue to industrialise and to seek skilled workers to support their economic growth.



By Michael Manton

michael.manton@monash.edu

As a country with a population of 22 million in a global community of nearly seven billion, Australia must depend upon international interactions to advance its economic and cultural well-being. A key reason for this dependence is that we have an open economy, where we promote international trade of goods and services. Our international trade has essentially doubled over the past decade – and world trade has at least doubled each decade since 1950. The competition in world trade is expected to become more ardent as nations endeavour to ensure their access to food, water and energy in the future.

The number of undernourished people in the world continues to grow, and it is not clear how the expected 75 per cent growth in demand for food will be met by 2050. The export of agricultural products includes the implicit export of water and energy. The complex interaction between food and energy was highlighted in recent years when a number of countries unthinkingly moved their agriculture from food stock to first-generation biofuel stock.

As the world population continues to grow, international cooperation will be essential to assure global access to food, water and energy while maintaining vigorous world trade

While global trade is an important influence at regional and national levels, it is clear that global communication is effective in promoting international awareness and cooperation by individuals. Internet access in Australian households

has grown from 16 per cent in 1998 to 72 per cent in 2009. Such trends are apparent throughout most of the world, such that 22 per cent of people in Asia now use the internet.

However, there are significant national differences – for example, 32 per cent of people in China use the internet, while the figure is only seven per cent in India. Access to the internet means that people anywhere can be aware of the cultural and economic trends everywhere else. Global communication is clearly driving greater international interactions at all levels.

Not only is there global communication, but also people are much more mobile than in the past. People as well as information move readily around the world. This trend is driven by global urbanisation, which has increased from 30 per cent in 1950 to 50 per cent now. It is expected to be 70 per cent by 2050. People commonly move house and change jobs and they wish to travel to new places.

The means for international travel is provided by jet aeroplanes, with jet travel currently increasing by five per cent each year. Mobility is especially important for Australia, where we have a large inflow of foreign-born people with tertiary qualifications supporting our economy and enhancing our culture. Our competitive advantages will be tested as the populous countries of Asia (especially China) continue to industrialise and to seek skilled workers to support their economic growth.

International collaboration is vital for economic devel-

opment and stability in the global community. However, a recent review of Australia's innovation system by the Department of Innovation, Industry, Science and Research (DIISR) suggests that we underperform on most measures of collaboration and networking, with less than 20 per cent of businesses having any collaborative arrangements. This strategy of isolationism is inexplicable in the light of continuing evidence that collaboration is essentially a necessary condition for significant innovation.

While there is some concern about innovation in Australia, the trends in strategic research and development are more encouraging. The Forum for European-Australian Science and Technology cooperation (FEAST) has recently carried out a bibliometric study of collaboration in journal publications. It is found that the proportion of Australian publications with international co-authorship has increased from 21 per cent in 1991 to 44 per cent in 2005. In fact, the number of papers with international collaborators is growing at twice the rate of Australian-only authored papers.

Signal motivation

These trends are very significant because the number of citations of papers with no international collaboration is much lower than those with European or US collaborations. Indeed the highest citation rates occur for papers with collaborators in both Europe and the US.

The national need to promote international collaboration

is a signal motivation for ATSE to undertake activities that promote Australian technological sciences and engineering (TSE) around the world and enhance Australian TSE capabilities through international engagement. The Academy also has a role in regional capacity building through the Crawford Fund Ltd, which is a subsidiary company of ATSE with a focus on international agricultural research.

The international program of ATSE implements activities that relate directly to the ATSE Topic Forums, which currently focus on energy, water, climate change impacts, and education. There is also a working group on health and technology. Over the past couple of years, international workshops have included issues on future energy options, water and its interdependencies, climate change and the urban environment, and smart technology for healthy longevity. An international education workshop on collaboration between industry and universities is planned for 2011. All of these activities underpin key aspects of the Topic Forums and ensure that the international program is well integrated with the overall objectives of the Academy.

The priority areas of the Academy are well aligned with the Australia's national research priorities and with the national innovation agenda. These national issues all benefit from international collaboration, and ATSE's international activities include a range of bilateral projects related to the national agenda.

For example, ATSE and the National Academy of Engi-

CSIRO's supercomputer is our 'greenest'

CSIRO's graphics processing unit (GPU) cluster is now Australia's 'greenest' supercomputer ranking 11th on an internationally recognised list of the world's 500 fastest and most energy efficient supercomputers – the Green500 List. Announced at the international SC10 supercomputing conference in New Orleans, the Green500 List is a ranking of the TOP500 supercomputers by energy efficiency (performance speed per Watt of energy consumed). It highlights the growing power consumption of the world's fastest computers and encourages owners to reduce their carbon footprint by using technology that improves energy efficiency.

"We knew we had a fantastic computational facility in our GPU cluster, but we are particularly delighted to near the top of the Green500 List," said Group Executive Information Sciences CSIRO, Dr Alex Zelinsky FTSE.

"GPU computing really fits well with our e-Research strategy and has proven to be a great success for CSIRO over the past year. This new high performance computing technology has accelerated our scientific research and put us on the world stage alongside China, Europe and the US."

GPU-based supercomputers are twice as energy efficient as regular central processing unit (CPU) supercomputers, completing calculations around 10-100 times faster than CPUs. GPUs are also much cheaper to purchase and occupy half the rack space which reduces cooling and data centre costs.



CSIRO's recently upgraded GPU cluster combines 254 Intel CPUs with 64 NVIDIA Tesla S2050 GPUs.

PHOTO: CSIRO

neering of Korea are developing collaborative activities associated with the concept of green growth that is being promoted by the government of Korea. Bilateral activities with India are underpinned by the Australia-India Strategic Research Fund. It is anticipated that a similar arrangement will be developed between the governments of Australia and China.

The international activities of the Academy include bilateral exchanges aimed at promoting long-term collaborations at the institutional level. Exchanges have been carried out with China, Japan and Singapore in which emerging leaders in priority areas spend about two weeks visiting key institutions in the host country. The candidates are selected on the basis that they have established reputations in their areas of expertise and that they are recognised as future leaders of science and technology.

In Australia, ATSE Fellows act as ambassadors for the visitors and they advise on the institutions to be visited. Each exchange program begins with an orientation session and ends with a debrief session where all visitors attend. The debrief sessions often involve earlier participants in the overall program. These interactions aim to promote enduring multi-disciplinary networks among the participants.

Many of the ATSE international projects involve specialised workshops that bring experts from Australia and overseas countries together to consider future directions in priority areas. These workshops sometimes provide a forum for collaborating experts to enhance their interactions. However, more often the participants have not worked together in the past, so a workshop is then effective in stimulating new ideas that should be carried forward collaboratively. To facilitate that process, ATSE has commenced a 'next-steps' program that allows participants from earlier international workshops to meet together to develop proposals for submission to appropriate funding agencies.

Expertise and networks

The international program of ATSE has been supported by the DIISR International Science Linkages (ISL) program. The program draws on the wide range of expertise and networks of Fellows to efficiently deliver long-term outcomes, including enhanced access to overseas expertise and the promotion of Australian capabilities overseas. The ISL program is currently under review, and it is anticipated that the Government will continue to recognise the efficiency and effectiveness of the program in supporting national priorities.

In addition to the bilateral activities aimed at promoting international collaboration, the Academy also supports the work of the Council of Academies of Engineering and Technological Sciences (CAETS), which provides a forum for national TSE academies around the world. Through CAETS, the Academy has extended its project on low-

carbon energy options to an international group so that comparative studies can be carried out. Future activities with CAETS could include collaborative efforts to promote TSE education – in particular, to encourage more young people to recognise the excitement of the technological sciences and to become scientists and engineers. Such an activity would build on the national success of the ATSE Science and Technological Education Leveraging Relevance (STELR) project – see page 22.

The CAETS forum should allow individual academies to link not only with each other but also with international projects involving other forums. For example, the International Council for Science (ICSU) and the International Social Science Council (ISSC), which provide forums for national academies of science and social science respectively, have developed collaborative programs on topics such as global environmental change and disaster risk. Many of the challenges facing the world today, such as the attainment of economic sustainability, involve technological as well as scientific and social aspects. It would therefore seem desirable for effective collaborations to be nurtured between all these international forums.

It is clear that international collaboration should be a foundation element of most TSE activities in Australia, which is a small country in a large world community. The Academy, working with government and other partners, plays a significant role in promoting the national TSE agenda through a range of international collaborative projects.

In the future, international collaboration will be especially important in enhancing innovation in Australia. ◀

Further reading

- DIISR (2009) *Powering Ideas. An Innovation Agenda for the 21st Century*. Commonwealth of Australia.
- DIISR (2010) *Australian Innovation System Report 2010*. Commonwealth of Australia.
- Hajkowicz S & Moody J (2010) *Our future world. An analysis of global trends, shocks and scenarios*. CSIRO, Canberra.
- Matthews M and five others (2009) *A Bibliometric Analysis of Australia's International Research Collaboration in Science and Technology: Analytical Methods and Initial Findings*. FEAST Discussion Paper 1/09.

PROFESSOR MICHAEL MANTON FTSE has a part-time position in the School of Mathematics at Monash University. He also provides consultative services in climate and weather. He is a Director of ATSE and chairs the ATSE International Strategy Group. Until 2005 he was the Chief of the Bureau of Meteorology Research Centre in Melbourne. He continues to be involved with the planning and implementation of international activities associated with global environmental change.

ATSE HOSTS CHINESE ENGINEERING ACADEMY VISIT TO AUSTRALIA

The Academy hosted the visit to Australia in November by Professor Zhou Ji, President of the Chinese Academy of Engineering, who led a small CAE delegation on a round of top-level meetings and delivered a lecture to an Academy audience and attended the ATSE AGM in Sydney.

Dr Zhou has served President of Huazhong University of Science and Technology (HUST), Director-General of the Hubei Provincial Department of Science and Technology, Mayor of Wuhan city and Minister of Education.

He met Senator Kim Carr, Minister for Innovation, Industry, Science and Research; Professor Margaret Sheil FTSE, CEO of Australian Research Council; Professor Penny Sackett, Chief Scientist of Australia; and Professor Peter Dowd FTSE, Chair of Group of Eight universities and Deans of Engineering committee.

He also lunched with the NSW Governor, Professor Marie Bashir AC CVO FTSE and Academy guests, and delivered a lecture to an ATSE audience in Sydney, following the Academy's half-yearly Assembly meeting.

He met with NSW Chief Scientist and Engineer, Dr Mary O'Kane FTSE, and attended



Professor Zhou (third from left) makes a point in his meeting with the Academy's President, Professor Robin Batterham (right) and International Chair Professor Michael Manton (second from right).

ATSE's Annual General Meeting in Sydney and its AGM dinner and Oration.

Professor Zhou then visited Perth for meetings with University of WA leaders – including Professor Alan Robson AM FTSE, Vice Chancellor, and Professor Dongke Zhang FTSE,

Winthrop Professor of Chemical Engineering – and the WA Education Minister Elizabeth Constable before returning to China.

He also unveiled a plaque to inaugurate the Chinese Cultural Experience Centre at The Confucius Institute at UWA.

SPOTLIGHT ON INFRASTRUCTURE AND SERVICES

Australia's infrastructure needs for the next two decades went under the spotlight in November at a day-long ATSE seminar in Sydney.

'Australia 2030: Meeting the Demands for Effective Infrastructure and Services' questioned whether Australia's international, commodity-based economy could expand sufficiently to support not only population growth but also the improved standard of living envisaged by that population. It examined – in a carbon-constrained world – how secure our coal exports are and how practical are alternatives to coal-fired baseload electricity. It also discussed food, water and energy security within a rapidly changing global economy.

The seminar was opened by Dr Richard

Sheldrake FTSE, Director General, Industry & Investment NSW. Mr Sheldrake is a new Fellow of the Academy. Lead speakers were Professor Ross Garnaut, Vice-Chancellor's Fellow and Professorial Fellow (University of Melbourne) and Distinguished Fellow of Economics (ANU), and Mr David Murray, Chair, Future Fund Board of Guardians.

NSW Chief Scientist and Engineer Professor Mary O'Kane, an Academy Fellow, chaired the morning session and the Academy's President, Professor Robin Batterham, chaired the afternoon session.

Other speakers included: Dr Shaun Larkin, Managing Director, HCF; Emeritus Professor Cliff Hooker, University of Newcastle; Mr

John Howarth, Executive General Manager, Transmission Services, AEMO; Dr Geoffrey Annison, Deputy Chief Executive, Australian Food and Grocery Council; Mr Ross Young, Executive Director, Water Services Association of Australia; Ms Cate Collins, Head of Sustainability, Lend Lease Asia Pacific; and Dr David Singleton, Chair, Global Infrastructure Executive, Arup Group.

Dr Sheldrake said demand for NSW's food and fibre products and mineral resources was at an all-time high – which wasn't about to change. His department had 700 scientific staff working with the State's primary producers on meeting these vital demand issues, he said today – in the face of a population explosion, food security issues, climate change, limited

SCIENCE AND TECHNOLOGY KEY TO ECONOMIC DEVELOPMENT

Although still in its “middle stage” of industrialisation and at an “historical key point”, China recognised that science and technology constituted a “primary productive force” for economic development. Professor Zhou Ji told an ATSE audience in Sydney during his Australian visit.

Professor Zhou said the traditional ways of development – constrained by population, resources and environment – could not last any longer and there was an urgent need to change the pattern of economic development at a quicker pace.

“The Chinese Government is now formulating the 12th Five-Year Development Plan, directing the scientific development over the next five years between 2011 and 2015,” he said.

The plan stressed the mission of the Chinese engineering, science and technology community was to support development and lead the future – and included three major tasks:

- upgrade and optimise industrial structure, developing and nurturing emerging industries and creating new economic growth points through industrial technologies such as energy saving,

environment protection, information, bio-engineering, high-end manufacturing, new energies and new materials;

- promote sustainable economic and social development – by changing the previous pattern of high-input, high-consumption economic development to a “novel path of industrialisation with high scientific and technological elements, good economic effectiveness, low resource consumption, low environmental pollution and full utilisation of human resources”; and
- improve people's livelihood – particularly with eco-friendly agricultural technologies delivering high yields, quality and efficiency and health technologies to improve standards of living.

The Chinese Academy of Engineering sought further collaboration with ATSE, Professor Zhou said, and suggested:

- joint strategic research programs to address common engineering problems;
- joint academic activities, including “frontiers of engineering” symposia and discussions on key issues and problems in engineering sciences and technologies; and



Professor Zhou addresses the Academy AGM in Sydney.

- joint engineering personnel exchange, with particular focus on young engineering talent.

FOR 2030

water resources and greater pressures on the biosecurity of plant and animal production.

“I am a great believer in the ability of good science and research to come up with solutions that underpin the decision-making and planning process,” Dr Sheldrake said.

NSW scientists were involved in research in agriculture, timber production, fisheries, minerals exploration, geology and clean coal technology. They were also researching cross-sector issues such as animal and plant biosecurity, biofuels and bioenergy, climate change and variability, and water use efficiency.

Protecting NSW's \$10 billion agricultural industry was a top priority of the NSW Government, he said. Exotic diseases would have a crippling effect on animal and plant industries and would impact significantly on the national GDP, which underpinned the NSW Government's investment of \$57 million in a major capital works upgrade of its front-line biosecurity laboratories.

Dr Sheldrake said Industry & Investment NSW had been working on critical areas such as ruminant methane emissions, soil carbon availability and sequestration for 20 years, long before climate change became fashionable.

“And we continue to invest in RD&E to address the climate challenges by developing options to reduce emissions and sequester carbon and to help producers adapt to future climates (such as drought-tolerant plant varieties),” he said.

Research collaboration was central to achieving infrastructure goals and his department's researchers were working with all 11 NSW universities and a number of others around the country and internationally; 12 Rural Research and Development Corporations; and 11 Co-operative Research Centres, Dr Sheldrake said.

“I am a great believer in the ability of good science and research to come up with solutions that underpin the decision-making and planning process.”

– DR RICHARD SHELDRAKE

'CLOUD' COMPUTING: HAS BIG POTENTIAL: ATSE REPORT

There are valuable opportunities for Australia governments, business and researchers in 'cloud' computing – but the Australian Government needs to ensure these opportunities are grasped and unnecessary barriers removed.

This is a key finding of an ATSE report, *Cloud Computing: Opportunities and Challenges for Australia*, released in October, which examines the likely impact on Australia of cloud computing – a business estimated to be worth US\$20 billion world-wide and growing rapidly.

It notes that governments, businesses and researchers can all benefit from the adoption of cloud computing services and governments can use the advantages of cloud computing to provide services more efficiently to a broad range of customers.

It says businesses can develop new services based on cloud computing as well as using the cloud to manage data-intensive activities more efficiently. The major reduction in capital costs that cloud computing provides makes it attractive to small and medium-sized enterprises (SMEs) with limited access to capital.

Cloud computing provides a means of accessing a shared pool of configurable computing resources (including networks, servers, storage applications and services) that can be rapidly provided, used and released with minimal effort on the part of users or service providers. There are different types of clouds, ranging from those that are publicly accessible to private clouds with restricted access. These clouds can utilise software, platforms and infrastructure services as needed. Cloud computing offers important advantages:

- users pay per use for services and infrastructure, reducing the need for capital investment;



Craig Mudge addresses the Cloud Computing Report launch in Canberra.

- it is scalable – when additional resources are needed they can be accessed;
- its software facilitates the manipulation of large databases;
- processors and data storage device size ensure economies of scale and energy use; and
- it can enable entirely new innovative business services.

The Report – launched by Mr Neville Stevens AO, Chair of the Board of NICTA, at the NICTA Canberra Research Laboratory – notes use of cloud services raises new issues in regard to privacy, security, trust, data transfer capacity and lock-in with service providers. Privacy legislation – which pre-dates the development of cloud-based services – needs to be reviewed. It says these issues can all be addressed and managed, but some changes to laws and regulations may be required.

It will be particularly important for government to protect the interests of consumers and SMEs. Both should be able to seek redress for failures on the part of cloud service providers. For SMEs, the cloud offers exciting opportunities, but they will need government assistance to manage the risks.

The Report notes that many areas of research are becoming increasingly data-intensive and that cloud-computing facilitates the efficient management and use of very large databases – and greatly reduces the cost of computation when segmentation of the task and parallel processing are possible.

The Report makes a number of recommendations, which include:

- the Australian Government should take a whole-of-government approach to new security and privacy issues arising from the use of cloud computing, by establishing a new taskforce to review the adequacy of current legislation and identify what steps need to be taken to ensure a supportive regulatory environment;
- the Government's Commercialisation Australia Program, which assists researchers, entrepreneurs and innovative companies to convert ideas into successful commercial ventures, should actively encourage new businesses that are cloud-focussed in their Internet-scale applications;
- the Department of Broadband Communications and the Digital Economy should review and policies of commercial and other providers to ensure that unnecessary impediments to the uptake of cloud computing are minimised; and
- Australian universities should expand their courses to build knowledge and skills in cloud computing.

The Report resulted from a study, funded in part by CSIRO and NICTA, conducted by a working group of ATSE Fellows and experts from outside the Academy – and supported by a Steering Committee of ATSE Fellows, chaired by Mr Peter Laver AM FTSE. Dr Craig Mudge FTSE, Chair of Pacific Challenge, was the Principal Author of the Report.

ATSE GIVES VALUE TO ISL-SAP PROGRAM

The Academy has completed and lodged its five-year self-assessment of the International Science Linkages-Science Academies Program (ISL-SAP) program it conducts for the Australian Government.

The self-assessment demonstrates that the Academy adds very substantial value to the program through securing additional resources, both direct funds and in kind. An overall average multiplier of 2.85 of the direct funding was calculated, taking the overall value of the ISL-SAP program delivered by ATSE to \$10.6 million over the period.

ISL-SAP is a targeted program that accelerates the linkages of Australian researchers to the international research frameworks of critical partner countries in areas of research that have been designated as national priorities. The aim of this linkage is to position these researchers in an environment that yields research collaboration, funding and, ultimately, innovation that benefit Australia through an accelerated pathway.

ATSE administers a part of the ISL-SAP on behalf of the Government. Using its extensive international linkages and the support of its 800-strong Fellowship, ATSE has implemented programs of international exchanges, missions, delegations, the Sir Mark Oliphant conferences and workshops, the total value of which was \$3.53 million for 2005–10.

ATSE adds value to the program through securing additional resources both in direct funds and in kind. This value is significant, being at an overall average of 2.85 multiplier of the Government investment. This took the overall value of the ISL-SAP program delivered by ATSE to \$10.6 million for the period.

The strategic outcome of the five years of implementation was the accelerated development of Australian technologists, scientists and engineers towards a greater competitive edge in their research, enabling them to better contribute to innovation – and to Australian competitiveness and prosperity.

A secondary outcome was the capacity of this group of researchers, and their institutions, to link the next cohort of Australian researchers within their sphere of influence to international

research frameworks that focus on areas of national priorities.

Australia's size and distance from the rest of the world made investment in international science and technology cooperation relatively more important than for many other countries, ATSE noted.

COLLABORATION

The review said international collaboration had many direct and indirect economic benefits including:

- bringing Australia key skills, capabilities and an access to large infrastructure;
- facilitating the participation of Australian experts in research activities of global significance, bringing ownership to Australia;
- enhancing reputation of Australian science and technology;
- increasing quality of research publications, as measured by citation impact, with Australian authorships;
- enhancing access to international expertise and networks of researchers that facilitate major programs of global and national significance to be addressed;
- providing a stimulating environment which triggers new ideas, technologies and innovations;
- sharing of costs and risks;
- facilitating access to new funding opportunities;
- providing access to data, samples for testing

and analysis, cutting-edge technology, equipment and infrastructure; and

- increasing opportunity for the cultural and professional development of Australian scientists.

ATSE VALUE

ATSE noted it had a unique capability in opening new – and enhancing existing – international linkages for science and technology collaboration. Core elements included:

- ATSE's fundamental objective – to promote the application of technological scientific and engineering knowledge to practical application for the benefit of Australia's wellbeing and economic development;
- ATSE's access in its Fellows to approximately 800 of Australia's outstanding applied scientists, engineers and technical experts – across academia, industry and government covering all major research institutes and universities – to ensure that international collaboration programs attract appropriate and timely participation;
- ATSE's high level of credibility and status associated with its Fellows; and
- ATSE's strong collaborative and strategic linkages at the international level through bodies such as the Council of Academies of Engineering and Technological Scientists (CAETS) and through its formal bilateral arrangements with sister academies worldwide.



Dr Calum Drummond FTSE (left) and Professor Max Lu FTSE (right) celebrate signing an MoU with Min Guoquan, Director of Shanghai Nanotechnology Promotion Centre, at Australia-China Science and Technology Week at the 2010 Shanghai World Expo.

WHEN CLIMATE CHANGE AND URBANISATION INTERSECT

The world has now passed the point when half of the human population lives in urban areas. This has been a gradual process, as cities have been the home of some humans for several millennia. But the pace of urbanisation is increasing and cities face new challenges from the effects of human activity on global systems which in turn impact on urban life. Climate change is a significant one of those challenges.

The need to better understand the intersection of climate change and urbanisation was the basis for a workshop, 'Impacts of Climate Change on Future Urban Societies', held as part of the Australia-China Science and Technology Week at the Shanghai World Expo in August 2010. The workshop was organised by the Shanghai Association for Science and Technology (SAST) and ATSE and was sponsored by the Department of Innovation, Industry, Science and Research (DIISR).

The meeting was officiated by Professor Robin Batterham AO FREng FAA FTSE, President of ATSE, and it was formally opened by Ms Lyndall Sachs, Commissioner General for Australia, Professor Penny Sackett, Chief Scientist of Australia, and Dr Yu Tao, Vice President of SAST. During the workshop, Professor Sackett formally launched the report of the ATSE Workshop on Climate Change and the Urban Environment, held in July 2009 in Melbourne.

The workshop brought together about 20 experts in air quality, architecture, climate, economics, geography, health, land management, town planning, transport and water management from China and Australia. A range of topics on the impacts of climate change on future urban societies was considered. Several talks were oriented towards environmental and engineering issues, but socioeconomic issues were also covered. A number of key insights were developed at the workshop.



Professor Sackett addresses the workshop.

URBANISATION IN AUSTRALIA AND CHINA

China and Australia have very different populations and are at different stages of economic development. It is relevant to ask whether there is a basis for effective cooperation on urbanisation issues. The clear answer is that many of the problems associated with urbanisation are common to both countries, particularly when it is noted that Australia is one of the most urbanised countries in the world and China's rate of urbanisation is very high.

It is apparent in both countries that cities are the main consumers of energy, water and food, and hence they are the main sources of the greenhouse gases associated with climate change. Both have cities that are exposed to climate threats such as destructive storms and marine inundation, urban heat stress, flooding, and water scarcity. The well-being of each nation's society will be strongly influenced by the impacts of climate change on their cities.

SCOPE OF URBAN AREAS

The challenges linked to urbanisation are multi-disciplinary and multi-sectoral, and an integrated approach to planning and management is essential to effective resolution of urban problems. It is particularly important to include the peri-urban areas in any analysis, as they represent the interactions between urban and rural areas. The latter often include fertile agricultural land that is gradually lost as a food source as cities expand with growing populations.

Many major cities are located in coastal

areas owing to economic factors related to overseas trade. These areas are susceptible to particular problems of flooding, both from storm surge and from downstream flooding in river deltas. The threats of storm surge, exacerbated by sea-level rise, are being recognised and managed in many coastal cities around the world.

LIVEABILITY

It is apparent that land-form determines the liveability and resource efficiency of urban areas. For example, air quality is affected by the local topography and micro-climate as much as by the emissions of pollutants. Moreover the extent and intensity of the urban heat-island effect is also largely controlled by the land-form of a city. Factors such as air quality and over-night minimum temperature have significant impacts on human health and well-being, and they are affected by the rising temperatures of climate change.

Because cities are the main consumers of water, energy and food, it is important that the delivery of these services (including waste management) is as efficient as possible. The efficiency and effectiveness of the management of water, energy and food are greatly affected by the urban land-form. A particular challenge in waste management is the anticipated global decline in the availability of phosphorus ('peak phosphorus'), which is currently lost as waste from urban areas but which is a vital nutrient for food production.

All cities have spatial variations in the

factors that influence liveability, but these variations tend not to be random. There is a consistent negative correlation between liveability and socioeconomic status of urban neighbourhoods. Improvement in liveability and resource efficiency will require major investments in the retro-fitting of existing buildings and infrastructure, as well as in the design and development of new structures.

MONITORING

The effective analysis, management and planning of urban areas depends upon the availability of reliable information on the nature of cities. Well-defined indicators of both environmental and socioeconomic factors need to be developed and used consistently, so that the time history of individual urban areas can be analysed and so that meaningful comparisons can be made between different cities. Such indicators should be monitored consistently and continuously so that progress can be detected and understood. The introduction of warning systems, especially for extreme

events, will require development of effective monitoring and prediction of key indicators.

GOVERNANCE

Although technical solutions exist for many of the problems in current urban design, implementation of change is often constrained by governance processes. Community acceptance of change can be a significant constraint to the adoption of new procedures. However, there are examples of effective behaviour modification in a number of Australian cities where substantial reductions in urban water usage have been achieved through public education programs delivered in conjunction with tighter regulations.

The understanding of these socioeconomic processes requires the contributions of social sciences to analyse governance structures and the behaviour of communities. Recognising the linkages and dependences, governance needs to be integrated both across sectors and between levels of government. The interactions between governments at local, state/provincial and national levels are especially important. It is often found that change is initiated by

champions at the local level, from where it is gradually adopted at state and national levels. The identification and support of these individual champions is a critical factor in managing future change in cities.

CONCLUSION

The workshop provided an effective and pleasant forum for experts from China and Australia to consider both the similarities of and differences between our urban areas. The stimulating presentations and interesting discussions led to the reinforcing of a number of existing research relationships and to the identification of new collaborative opportunities between China and Australia.

This report was provided by Dr Jago Dodson, Deputy Director of the Urban Research Program at Griffith University; Dr John Radcliffe AM FTSE, Chair ATSE Water Forum; Dr Xin Yang, Department of Environmental Science and Engineering, Fudan University, Shanghai; and Professor Michael Manton FTSE, ATSE Director and Editor of the Report of the July 2009 Workshop.

AWARD FOR RESHAPING SCIENCE TEACHING

Ms Debra Smith, head of science at Centenary High School in Brisbane's western suburbs, has received the \$50,000 Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools for inspiring thousands of students and helping to redefine the senior science curriculum in Queensland and across Australia.

Ms Smith, who has won an array of teaching awards over the past 20 years, has been a strong supporter and promoter of ATSE's STELR Program over the past two years

and has attended ATSE's teacher PD programs.

Over 30 years of teaching she has not only inspired thousands of students, she has helped redefine how science is taught in Queensland and across Australia. She believes that science teaching has to be practical and experimental. She has brought that approach to her own chemistry classes and also to the development of extended experimental learning in senior teaching in Queensland.

Ms Smith has the numbers to show that her approach works. Her school's senior science scores are well above the state average. Thirty-one per cent of students chose senior chemistry in 2008; similar schools in Queensland achieve less than 20 per cent. In 2009, 26 of the school's top 29 students chose science degrees. Not only are more students retaining science subjects in senior school, of students going on to

university, 46 per cent are choosing science.

For the past decade she has been head of science at Centenary High School. It's a young school that opened in 2000 and has grown to 1100 students. Ms Smith manages a team of 19 teachers and has seen large changes in the way that science is taught.

"For me, science is the most important subject in school," she says. "Without our work there would be no scientists, and young people would be much less able to make informed decisions about the impact of science and technology on their lives."

■ **Victorian Division Chair Dr Glen Kile FTSE is quietly basking in the glow of his son's success. Dr Benjamin Kile, a scientist at the Walter and Eliza Hall Institute in Melbourne, was awarded the \$50,000 Science Minister's Prize for Life Scientist of the Year. His discoveries will extend the life of blood transfusion products and help explain how cancer starts.**



Debra Smith

PHOTO: BEARGAGE PRODUCTIONS

LAST OF THE FRESH SCIENTISTS

Bushfire prediction, conductive bioplastics, lizards' resistance to cancer, waste food chains and silk microchips – these are among the research interests of 16 of Australia's top young scientists named as Australia's Fresh Scientists for 2010. Fresh Science is designed to:

- Enhance reporting of Australian science;
- Highlight and encourage debate on the role of science in Australian society; and
- Provide role models for the next generation of Australian scientists.

Previous *Focus* editions have showcased the work of 11 of the 2010 Awardees. This edition takes a look at the work of the final five.

Silk microchips for medical testing

Silk could provide a sophisticated new way of monitoring health, Peter Domachuk, a physicist from the University of Sydney, has found.

He and his colleagues have created microchips using silk fibres – and demonstrated that these microchips can measure oxygen using haemoglobin embedded in the silk.

Their aim is to embed a wide range of proteins so they can run dozens of blood test simultaneously at the point of care instead of waiting for the pathology laboratory.

Silk fibres, he says, can be formed into tiny platforms or “bio-chips” that should allow medical testing and measuring of vital signs to be undertaken more rapidly and cheaply than current technology allows.

The protein that underpins the strength of silk, fibroin, can be purified to form a clear

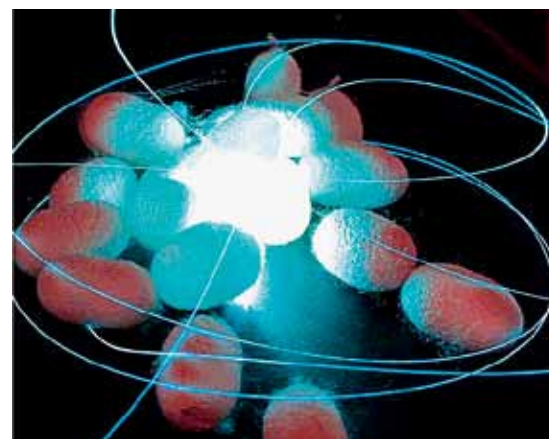
material that can be used to display tiny drops of thousands of different biochemical compounds in patterns where they are no farther apart than the width of a human hair. These test compounds can then be simultaneously exposed to and react with body fluids such as human blood.

“The particularly interesting thing about silk is that the biochemical compounds it holds retain their activity,” Peter said.

“This biochemical activity enables extra sensitivity for monitoring and detecting medical conditions. And fibroin is transparent and can be formed into structures to control light which can be then used as a sensitive probe for improved medical testing. What’s more, silk doesn’t trigger the human immune response when it comes into contact with tissue.”

This combination of factors makes silk a

unique candidate for implantable biochips— devices like electronic microchips that can sit in or under the skin and detect chemicals in the blood.



Silk cocoons illuminated by laser light in an optical fibre.

Wind the key factor for bushfire weather danger

Wind speed plays a bigger role than temperature in creating dangerous conditions for bushfires, says Dr Andrew Dowdy, a physicist from the Bureau of Meteorology.

In fact, temperature is the third-ranked factor in predicting severe bushfire weather

conditions behind wind speed and low humidity, Andrew says. He hopes that a greater understanding of weather conditions associated with bushfires will result in better preparation, faster response and a reduction in the damage they cause.

His work with the Bushfire Cooperative Research Centre has led to new possibilities for predicting bushfire conditions based on the weather.

“In future, we hope people will be thinking, ‘Tomorrow is going to be *windy*, dry and hot so it could be dangerous for bushfires’ rather than just focusing on the temperature.”

As a practical outcome of this research, a publicly available website has been set up with maps of bushfire weather forecasts throughout Australia, together with ratings in terms of local climate. It is at www.cawcr.gov.au/projects/fire_wx/index.php.

The work was funded by the Bushfire CRC.

Andrew has also studied the occurrence of fires caused by lightning, particularly “dry-lightning” that occurs without significant rainfall.

A common scene in Australia.



PHOTO: BUREAU OF METEOROLOGY

Aussie lizard reveals cancer secrets



The three-toed skink.

PHOTO: NADAV PAZARO

A compound produced by a pregnant lizard may provide important information on the origins and treatment of cancer in humans, according to zoologist Bridget Murphy from the University of Sydney, who discovered the protein, which is pivotal to the development of the lizard placenta.

"Our egg-laying ancestors probably never got cancer, but things changed when we started having live young," she said.

"Embryos need an extensive network of

blood vessels to allow them to grow. So do tumours.

"I found that the three-toed skink, which gives birth to live young, uses a particularly powerful protein to encourage the growth of blood vessels. The only other place where this protein has been found is in pre-cancerous cells grown in the laboratory," she says.

Future research on unlocking the secrets of how the protein works might well provide the basis of new therapies for cancer, and to promote wound healing or the regeneration of blood vessels in patients with heart disease.

The protein belongs to a group known as vascular endothelial growth factors (VEGFs) which help to produce blood vessels in the uterus during pregnancy. Bridget became interested in the group as part of a study of the evolutionary origins of live birth.

Using techniques to measure which of the VEGF genes were present and active in lizards, Bridget discovered the first known natural source of VEGF111 in the three-toed skink (*Saiphos equalis*), a shy Australian lizard which lives underground.

Waste is a waste: pigs reduce the burden

A biotechnologist from the South Australian Research and Development Institute (SARDI) has taken using 'everything but the pig's squeal' to new lengths.

Through clever recycling of pig waste, Andrew Ward has been able to produce feed for aquaculture, water for irrigation and methane for energy. His 'waste food chain' can be applied to breweries, wineries and any system producing organic waste.

"We can turn waste into food, save money, save water, and improve the environment just by being a bit smarter," Andrew says.

The pig effluent is initially fed into an airtight, two-stage digester. This breaks down the chemical compounds that smell and kills potentially dangerous bacteria, while producing methane bio-gas as well as nutrients which can be used to stimulate the growth of tiny seaweeds or microalgae.

Andrew's studies showed that the digested piggery effluent is a safe nutrient source for the commercial scale production of algae which can then be used for aquaculture.

"Once we had the algae growing, we knew we could recreate the ocean food chain from algae to zooplankton to fish," he says.

"We use two small native SA water fleas, *Moina australiensis* and *Daphnia carinata*, which can form the basis of commercial fish meal. By carefully establishing the best conditions for growth and reproduction, the water fleas can be produced more quickly than with existing methods. This makes the system more efficient and the technology financially viable."



PHOTO: ANDREW WARD

At the heart of the system - the water flea *Daphnia carinata*.

Electric plastics: better bionic eyes and ears

A young University of NSW researcher has created conductive bioplastics that will transform the performance of bionic devices such as the Cochlear ear implant and the proposed bionic eye.

"Our plastics will lead to smaller devices that use safer smaller currents and encourage nerve interaction," says biomedical engineer Rylie Green. "Using conductive plastics for medical electrodes is set to revolutionise the performance of bionic implants. They will improve both safety and versatility."

"The plastics can carry natural proteins, which will aid the survival of damaged and diseased nerves," says Rylie, whose research was published in *Biomaterials* earlier this year.

Her plastics are already being tested in prototype bionic eyes and she hopes they will find application in bionic ears, robotic limbs – wherever researchers are attempting to integrate electronics with the human body.

Bionic devices made out of metals have smooth surfaces that generate scar tissue around the implant and larger and larger

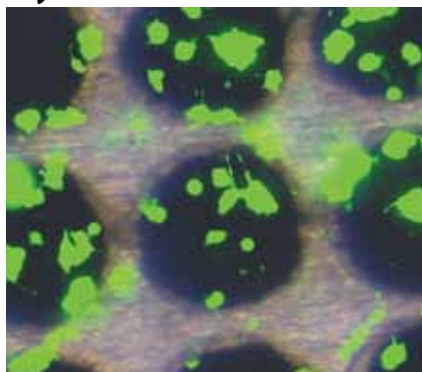


PHOTO: RYLIE GREEN

Neural cells growing on the conducting bioplastic electrodes.

electrical currents must be used to stimulate the nerves through the scar tissue.

Conductive plastics or polymers have rough surfaces which encourage the attachment of cells, meaning they offer potential for improved performance and longevity when implanted in the body as electrodes.

Additionally, the highly textured polymer surface can pass electrical current to cells more efficiently than smooth metals.

IAN POINER LEADS RESEARCH ON WHAT LIES UNDER THE SEA

Scientists in Australia have joined colleagues from around the world to conduct the first global census of life under the sea, which has created the world's largest repository of data about marine species, including nearly 30 million records of marine life – now publicly available for the first time – 2600 research papers and 34 books.



Ian Poiner

The first census project, with Dr Ian Poiner FTSE, CEO of the Australian Institute of Marine Science, chairing the steering committee, included more than 2700 scientists from 80 countries and 670 institutions. They took part in 540 expeditions, amounting to 9000 days at sea, plus countless days in laboratories and archives.

One of the largest scientific collaborations ever conducted, the Census of Marine Life (www.coml.org) was a 10-year scientific initiative to assess and explain the diversity, distribution, and abundance of life in the oceans.

"The first global census of marine life shows life in Planet Ocean is richer, more connected and more altered than expected," Dr Poiner said.

The Great Barrier Reef and Ningaloo Reef formed part of one of the 17 census projects. As part of the survey into coral reefs, between 300 and 500 new species were discovered.

Innovation, Industry, Science and Research Minister, Senator Kim Carr, said he was very proud of the work carried out by the 167 Australian scientists as part of a groundbreaking international research network.

"The health of our ocean environment is critical to our industries and our way of life," Senator Carr said. "The knowledge we have gained through the Census team will help us to improve our ocean management and protect our natural marine treasures."

The launch of the project was marked by the release of maps, three books and a highlights summary. The now-completed documentation in books and journals, plus the accumulating databases and established websites, videos and photo galleries report the first Census. They present an unprecedented picture of the diversity, distribution and abundance of all kinds of marine life in Planet Ocean – from microbes to whales, from the poles to the tropics, from tidal shores to the deepest depths.

Oceanic diversity is demonstrated by nearly 30 million observations of 120,000 species organised in the global marine life database of the Census, the Ocean Biogeographic Information System (OBIS). The OBIS directory of 'names and addresses' of known ocean species has established a reference against which humanity can monitor 21st century change. It also delineated vast areas of ocean that had never been explored.

"We prevailed over early doubts that a Census was possible, as well as daunting extremes of nature," Dr Poiner said. "This cooperative, international 21st century voyage has systematically defined for the first time both the known and the vast unknown, unexplored ocean."

According to Dr Poiner, the beauty, wonder, and importance of marine life are hard to overstate. "All surface life depends on life inside and beneath the oceans. Sea life provides half of our oxygen and a lot of our food and regulates climate. We are all citizens of the sea.

"And while much remains unknown, including at least 750,000 undiscovered species and their roles, we are better acquainted now with our fellow travelers and their vast habitat on this globe."

BLIND INVENTORS REVOLUTIONISE COMPUTER ACCESS

For many blind people, computers are inaccessible – it can cost upwards of \$1000 to purchase 'screen reader' software – but two blind computer programmers have solved this problem.

Queensland University of Technology (QUT) graduate James Teh and business partner Michael Curran have developed a free, open-source program called NVDA (Non Visual Desktop Access), which provides a synthetic voice to read the words on a computer screen as the cursor moves over them.

As the mouse moves the cursor up and down the screen, a beeping sound becomes higher and lower in pitch to indicate where the cursor is located. NVDA has been translated into 27 languages, thanks to volunteer translators.

To date, there have been more than 50,000 downloads. With the number of blind and low vision Australians expected to double to 600,000 in 10 years' time (according to Vision Australia), NVDA has the potential to impact a significant number of lives.



James Teh with the trophy he and Michael Curran won in the 2010 New Inventors grand final show.

"A sighted person takes for granted that they can sit down at any computer and use it," Mr Teh said. "We really are in the information age – everything is online these days. So access to computers for the blind and vision impaired is incredibly important, which is why we wanted our software to be free."

Mr Teh, who majored in software engineering at QUT, said blind students typically didn't have the funds to purchase screen-reader technology at the time in their life when they most needed it. Now NVDA can be downloaded on to anyone's personal computer free of charge.

"It can also be copied to a USB stick, which can be used on any PC at school or university, with no installation required," he said.

Mr Teh and Mr Curran have been working on the project since 2006 and have future plans, including touch screen options for the blind and vision impaired.

NVDA can be downloaded at www.nvda-project.org.

Forest biodiversity, climate change and governance

Illegal logging is estimated to affect some 70 countries. But there is a lack of knowledge of the actual contribution of illegal logging to deforestation and forest degradation.



By Luca Tacconi

luca.tacconi@anu.edu.au

Deforestation and forest degradation result in loss of biodiversity and contribute about 15 per cent of global anthropogenic emissions of greenhouse gases. Land clearing for agriculture and pastures are the main causes of deforestation. In the short term, deforestation may contribute to an increase in the production of crops. However, the long-term impacts are likely to be negative.

Climate change is expected reduce crop production in developing countries as a result of decreased rainfalls, changes in the seasonal distribution of rainfall and higher temperatures. The loss of biodiversity may also lead to a decrease in the production and diversity of agricultural crops, with possible negative effects on human health as emphasised by the World Health Organization.

There has been so far a failure to develop effective international consensus on actions to reduce the loss of biodiversity. But there has been progress on an international agreement to reduce emissions from deforestation and forest degradation (REDD) in developing countries. The need to implement such a mechanism was recognised in the 2009 Copenhagen Accord on climate change, and there are great hopes that a final agreement on REDD may be reached at the next meeting in Mexico in December 2010.

A REDD mechanism would provide developing countries with financial incentives to reduce deforestation and degradation. These payments are a form of compensation for the revenues from agriculture and plantations that they would have to forego. Given that there is a significant but not complete overlap between carbon stocks and reservoirs of biodiversity, positive developments on the REDD front also need take into account forest biodiversity.

What can Australia do to support the implementation of REDD?

Tropical forest conservation

With the allocation of \$273 million to the International Forest Carbon Initiative (IFCI), Australia was one of the first countries, in 2007, to devote significant support to the



development of a REDD mechanism. This is an important initiative, but a more encompassing view of policy options is needed to improve tropical forest management in a way that leads to reduced emissions as well as biodiversity conservation and benefits for rural people.

To be more effective, IFCI should implement demonstration activities at a provincial level rather than only at a project level. Demonstration activities are aimed at showing how REDD can be implemented in practice. Many tropical forest countries, including Indonesia which is the main recipient of funding from IFCI, have a degree of decentralised management of forests.

Appropriate systems to involve lower levels of government in forest conservation need to be designed and tested. These programs have to address the governance factors that influence forest management.

Corruption and illegal logging are widespread in tropical forest countries. There are, therefore, concerns that unless corruption is controlled, it would be difficult for countries to implement REDD in an effective, efficient and equitable manner.

The impact of corruption on deforestation may start with the design and implementation of land use plans, which classify forests for various uses – such as conservation, production and conversion to other uses. The land use al-

An acacia plantation in Sumatra, producing fast-growing timber for pulp and paper.

location process should take account of ecological criteria to identify areas that are significant for conserving biodiversity or where soils are not suitable for conversion to other uses.

Illegal logging has been estimated to affect some 70 countries. Reported statistics appear to be, however, rather uncertain and show a large degree of variation, partly because different definitions are often used and confusion arises. Similarly, there is lack of knowledge of the actual contribution of illegal logging to deforestation and forest degradation, but it can be expected that, due to its nature, illegal logging is more likely to result in forest degradation than in deforestation.

Capacity building programs should therefore support improved regulatory frameworks aimed at reducing corruption and illegal logging, and support for the strengthening of law enforcement capacity.

Strengthening activities should also build national-level institutional capacity to map carbon stocks and deforestation coupled with the design of protected areas for biodiversity conservation, and the allocation of agricultural lands. Unless biodiversity conservation and agricultural production are explicitly considered, carbon conservation activities could have less than undesirable impacts. These assessments should also consider politically acceptable outcomes – protected areas would ideally be evenly distributed across local government areas, to avoid burdening too much any one area.

Community and indigenous advocacy organisations and academics have cautioned that the implementation of REDD without due regard to social and livelihood issues could have negative impacts on local communities like those of some existing protected areas. To provide benefits to local stakeholders, governments of tropical forest countries could use a mechanism for Payments for Environmental Services (PES) to share funding obtained through REDD activities.

PES schemes provide the custodians of environmental services such as clean water, biodiversity and carbon sequestration with financial or other rewards for their role in providing these services. Governments could therefore use PES to provide incentives for reducing emissions on private or community lands, according to the amount of carbon conserved by those stakeholders.

Recent research conducted at the Australian National University shows that PES can have positive livelihoods impacts, but certain design and property rights issues need to be addressed. Strengthening programs to enhance the capacity of governments to implement PES should therefore be supported.

Policy initiatives

To support forest conservation in neighbouring countries such as Indonesia and Papua New Guinea in an effective and efficient way, policy initiatives should also be adopted within Australia.

The Rudd Government had assessed the options to reduce the import of timber derived from illegally harvested logs. However, it did not reach the point of implementing any of the measures.

The new Government should consider the introduction of a domestic regulatory framework on illegal timber products. This would complement the support provided through the aid program to reduce greenhouse gas emissions and to conserve biodiversity.

Finally, funding is needed for the actual implementation of REDD after the initial capacity-building phase. Various assessments, including the Stern Review of Climate Change, have noted that to substantially reduce deforestation, developed countries will need to allocate significant financial resources for developing nations – estimates range between \$10 and \$40 billion per year. This large amount of resources is unlikely to be available from government coffers, especially in the current environment of high public debts. Markets will have to be tapped, taking us to one of the most politically sensitive issues – the pricing of greenhouse gas emissions.

While designing a carbon-pricing mechanism, the new Government should consider the development of regional or bilateral carbon markets with tropical forest countries. Allowing a regulated, limited share of emissions from forestry in the region to offset emissions in Australia would contribute to lower carbon prices in Australia. Limiting the amount of forestry credits allowed as offset would ensure the price of carbon is sufficiently high to bring about a reduction in emissions by Australian polluters.

This proposal could be implemented regardless of whether Australia adopts an emission trading scheme (ETS) or a carbon tax. Forestry carbon certificates could be exchanged directly in the ETS market. In the case of a carbon tax, a fund could be set up to hold some of the revenues from the tax and purchase forestry carbon credits.

We need to realise that setting a price on carbon would provide an increased incentive to governments in the tropics to address illegal logging. And the lower the carbon price, the larger the size of emission cuts that could be achieved at the same cost in Australia. This would provide a significant contribution to our efforts to address climate change and to reduce the loss of biodiversity. ◀

ASSOCIATE PROFESSOR LUCA TACCONI is Director of the Environmental Management and Development Program at the Crawford School of Economics and Government, at the Australian National University. He convenes the Master of Environmental Management and Development, co-convenes the Master of Climate Change, and is the founding director of the Australasian Network for Environmental Governance. He was a speaker at the 2010 Crawford Fund Parliamentary Conference in Canberra.



Institute Trustees (from left) – Professor Alan Robson, Greig Gailey, Dr Ric Smith, Ann Pickard, Sam Walsh and Tim Shanahan.

UWA LAUNCHES ENERGY INSTITUTE

An Energy and Minerals Institute at the University of Western Australia (UWA) will help position WA as a national and international hub for resources expertise, according to its backers.

Dr Ken Michael AC FTSE, Governor of WA, launched the Institute recently and UWA Vice-Chancellor, Professor Alan Robson AM FTSE, said the Institute would advance the university's commitment – over almost a century – to supporting and developing the state's key industries.

The Institute would be a gateway connecting government, industry and business with academia in the areas of energy, minerals, exploration and mining, environment, policy and business, and community engagement, Dr Michael said.

The Board of Trustees, chaired by Mr Greig Gailey, includes Rio Tinto's Executive Director and Chief Executive (iron ore), Sam Walsh, Shell in Australia Country Chair Ann Pickard, former diplomat Dr Richard C. Smith, Executive Director Development at CSIRO Dr James Bradfield Moody, and President of Stainless Steel Materials for BHP Billiton, Glenn Kellow, plus Professor Robson, Professor Robyn Owen (Deputy Vice-Chancellor Research) and Tim Shanahan (Director, Energy and Minerals Institute).

Mr Gailey was Chairman of the Minerals Council of Australia, Chairman of the International Zinc Association, President of the Business Council of Australia and is currently a non-executive director of the Australian Davos Connection Ltd, the Victorian Opera and Caltex Australia.

TELSTRA AWARD FOR MINING WOMAN

Melanie Gordon has been awarded the Queensland Telstra Young Business Woman of the Year in recognition of her outstanding achievements in the mining industry. She is also a recipient of the 2008 Queensland Resources Council's Resources Award for Women.

The UQ Mechanical Engineering graduate was the first woman

appointed as Maintenance and Engineering Manager at BHP Billiton in an Australian operation, and the youngest woman appointed to an operational management role in BHP Billiton worldwide.

Ms Gordon believes that diversity in the mining industry is important and she strongly encouraged more women to join the sector.

"Diversity is a good thing as it leads to better decision making and a more rounded approach to business. I really hope that my award will encourage more women to consider starting their career in the resources sector and benefit from what this industry can provide," she said.

Ms Gordon is one of 10 members of BHP's Asset Management Council, which is responsible for the strategic direction of maintenance at its Queensland coal mines and manages 164 people who maintain the BHP Billiton Mitsubishi Alliance (BMA) underground Broadmeadow mine.

POLICY INACTION WILL HAMPER OIL AND GAS

The Australian oil and gas industry's peak body has released its *State of the Industry 2010* report, which shows ensuring strong future investment in oil and gas production and exploration will require improved regulatory efficiency, an internationally competitive fiscal regime, and a thoughtfully designed national climate change policy.

Australian Petroleum Production & Exploration Association (APPEA) Chief Executive, Belinda Robinson, said the report outlined the challenges and opportunities Australia faced in managing its oil and gas resources and that the economic and environmental potential of our gas resources was not yet fully appreciated.

"What we are achieving today flows from the policies of yesterday," Ms Robinson said.

"This report suggests there is a degree of complacency around the capacity of this industry to continue to underpin Australia's economic wellbeing and that the factors driving declining levels of exploration and oil production cannot be ignored."

Of particular concern was Australia's declining oil production and exploration. As recently as 2000, Australia enjoyed a trade surplus in oil and liquid fuels yet rising demand and falling production meant Australia today had a trade deficit in petroleum products of some \$16 billion per annum. Without major new discoveries, this would grow to around \$30 billion per annum by 2015.

State of the Industry 2010 says more thoughtful tax and climate policies are required to ensure the oil and gas industry meets its potential in helping reduce greenhouse gas emissions.

State of the Industry 2010 is available at www.appea.com.au



Ziggy Switkowski moves to RMIT

Dr Ziggy Switkowski has been named as Chancellor of RMIT and will retire as Chair and Director of ANSTO at the end of the year. He has been Chair since 2007.

Innovation Minister Senator Kim Carr said Dr Switkowski had done a "first rate job at ANSTO" and acknowledged his



Ziggy Switkowski

"leadership, dedication and stewardship" of the ANSTO Board.

"During his time at ANSTO, Dr Switkowski has overseen a number of significant achievements ensuring ANSTO

continues to serve the Australian community. Most importantly, during his service, ANSTO's Open Pool Australian Lightwater (OPAL) reactor was successfully brought into operation, providing life-saving nuclear medicines, neutrons for scientific research and irradiation services.

"Another great success story has been the establishment of ANSTO's Molybdenum (Mo-99) plant, which has been in full production for most of 2009-10. This is a great achievement for Australia in light of ongoing world-wide shortages of Mo-99, one of the most important reactor-produced radio-isotopes for medicine globally and in Australia," Senator Carr said.

"There is no doubt that Dr Switkowski has made a tremendous contribution to the organisation and the broader nuclear research field in Australia," said ANSTO Chief Executive, Dr Adi Paterson. "Dr Switkowski has been unfailing in giving solid advice to the Board and providing clear direction for ANSTO, as well as his contribution and input

into the directions for ANSTO's Corporate Plan which lays out the strategic priorities for the organisation to 2015.

"These priorities will ensure that ANSTO can continue to make great contributions in areas of crucial development, including nuclear medicine, climate change research and other peaceful uses of nuclear technology."

Mary O'Kane joins Board

The NSW Chief Scientist and Engineer, Dr Mary O'Kane FTSE, will join the ATSE Board from 1 January 2011 as Vice President, following recent Board elections. The other three Vice Presidents are Professor John Simmons FTSE (re-elected for two years from 1 January 2011) and Mr Peter Laver AM FTSE and Mr John Grace FTSE, whose terms as Vice Presidents finish at 31 December 2011.



Mary O'Kane

Dr O'Kane replaces Dr John Nutt AM FTSE as Vice President following his decision not to renominate. The Board acknowledges Dr Nutt's long and dedicated

service to the Academy, both as NSW Chair and a Member of the Board and Assembly.

Professor Michael Manton FTSE and Professor Mike Miller AO FTSE were re-elected for a further two years as Ordinary Directors.

Alan Robson signals retirement from UWA

The University of Western Australia's Vice-Chancellor Professor Alan Robson AM FTSE has announced his retirement from the position at the end of 2011.

UWA Chancellor Dr Michael Chaney said that despite having been encouraged

to extend his term, Professor Robson had chosen to retire.

"Alan Robson has led UWA with distinction in roles as Deputy Vice-Chancellor and Vice-Chancellor for more than 17 years," Dr Chaney said. "UWA's institutional performance is at an all-time high. By the beginning of 2012, we will have implemented our program of new courses which will position UWA to achieve its ambition of becoming one of the world's top 50 universities by 2050.

The process of selecting a new Vice-Chancellor would begin immediately and should be completed during the first half of next year.

Susan Pond

Professor Susan Pond AM FTSE delivered the Diana Temple Memorial Lecture 2010 "Two worlds of personalised medicine" at the University of Sydney on 15 October – an event supported by the University of Sydney Bosch Institute, the Australian and New Zealand Association for the Advancement of Science (ANZAAS) and the Women in Science Enquiry Network (WISNET). Professor Pond has a distinguished record in medicine, science and business, holds a number of Board appointments and is a professor in the Dow Sustainability Program at the United States Studies Centre at the University of Sydney.

Hugh Bradlow

Success in the development and adoption of 'infotronic' technologies is going to be critical to the future of Australia's economic competitiveness and our standard of living, Dr Hugh Bradlow FTSE, Chief Technology Officer for Telstra, told a recent Lowy Institute lunch. He looked at the coming changes in ICT technologies over the next 10 years and the impact that they are likely to have on human behaviour and economic outcomes, as well as Australia's competitive position in this new world.



Professor Marilyn Anderson receives her Fellowship certificate from Professor Robin Batterham at the AGM Oration dinner in Sydney.

Prominent women join ATSE ranks

Four leading women researchers and business leaders, three of NSW's most senior public servants and two of Australia's prominent academics working overseas are among the 28 leaders in technological science, engineering and innovation elected as Fellows of the Academy.

Technology and research leaders in resources, construction, materials science, engineering, pharmaceuticals, health, energy, water, environmental sciences and public policy development are among the 2010 list of outstanding Australians elected to the Fellowship. The Academy also recognised two new Foreign Fellows in its annual election process.

Professor Marilyn Anderson FTSE – Chief Scientist, Hexima Ltd; Dr Robyn Elliott FTSE – Managing Director and CEO, IDT Australia Ltd; Professor Helene Marsh FTSE – Dean of Graduate Research Studies, James Cook University; and Dr Alison Ord FTSE – researcher and consultant (formerly Chief Research Scientist, CSIRO Exploration and Mining) are the four women elected to the Academy.

The NSW public service trio are Mr Ronald Christie FTSE – Chair, Independent Public Inquiry, Long Term Public Transport Plan for Sydney; Dr Richard Sheldrake FTSE – Director General, Industry & Investment NSW; and Mr Warwick Watkins AM FTSE – Chief

Executive, Land and Property Management Authority, NSW Government.

The two overseas-based research leaders are Professor Ron Hui FTSE – Chair Professor, Power Electronics, City University of Hong Kong; and Dr James Litster FTSE – Professor, Chemical Engineering, and Professor, Industrial and Physical Pharmacy, Purdue University, Indiana.

Resources industry Fellows are Dr David Noon FTSE – Chief Commercial Officer and Vice President, Marketing, Groundprobe Pty Ltd; Dr Brian Smith FTSE – Senior Manager, Research & Development, BHP Billiton; and Dr Paul Zulli FTSE – Manager, Iron and Steelmaking Research, Bluescope Steel.

The full list follows.

FELLOWS

- **Professor David Abramson FTSE** – Science Director, Monash e-Research Centre (MeRC). Professor Abramson is an international expert in supercomputing software systems, whose software systems are used internationally and are well known in the community.
- **Professor Marilyn Anderson FTSE** – Chief Scientist, Hexima Ltd. Professor Anderson is recognised internationally as an outstanding plant molecular biologist whose discoveries has been applied globally and is recognised as an outstanding leader and contributor to community debates on technology
- **Professor Suresh Bhargava FTSE** – Dean, Applied Sciences, RMIT University. Professor Bhargava is recognised as a world renowned researcher and university leader, and has won numerous awards for his outstanding contributions to industry-related research.
- **Professor Suresh Bhatia FTSE** – Professorial Fellow, University of Queensland. Professor Bhatia has made exceptional contributions in the application of chemical engineering to problems relevant to nanotechnology, and has a distinguished record of academic leadership.
- **Mr Ronald Christie FTSE** – Chair, Independent Public Inquiry, Long Term Public Transport Plan for Sydney. Mr Christie is recognised as the most

influential reformer of road, rail, and public infrastructure in NSW.

- **Dr Ian Dagley FTSE** – CEO, CRC for Polymers. Dr Dagley is recognised for his outstanding leadership and research management skills, demonstrated in his role as CEO of a very successful CRC.
- **Dr Robyn Elliott FTSE** – Managing Director and CEO, IDT Australia Ltd. Dr Elliot is a leader in the Australian pharmaceutical industry through the innovative application of chemical and engineering technologies in the development and production of new pharmaceutical products for the international market.
- **Professor Barry Fraser FTSE** – Director, Science and Mathematics Education Centre, Curtin University of Technology. Professor Fraser is recognised for his achievements and leadership in science and mathematics education that have had a transforming impact, nationally and internationally, on capacity building in technological sciences and engineering.
- **Professor Michael Good FTSE** – Australia Fellow, Institute for Glycomics, Griffith University. Professor Good has developed novel approaches to producing vaccines for malaria and group A streptococcus and provided national leadership for Australian science.
- **Mr Alexander Gosling FTSE** – Co-founder and until recently a Director of Invetech. Mr Gosling is a leader in the application of technological sciences and engineering to develop innovative commercial products and processes for world markets.
- **Professor Douglas Hilton FTSE** – Director, Walter & Eliza Hall Institute of Medical Research. Professor Hilton, an inaugural NHMRC Australia Fellow, combines excellence in medical research with personal commitment to clinical translation of his discoveries.
- **Professor Ron Hui FTSE** – Chair Professor, Power Electronics, City University of Hong Kong. Professor Hui is internationally and nationally recognised for his significant contributions to innovative wireless

battery charging technology and sustainable lighting technology.

- **Professor Mark Knackstedt FTSE** – Professor of Applied Maths, Research School of Physics and Engineering, ANU. Professor Knackstedt is renowned for his seminal contributions to science of complex disordered materials through x-ray tomography and numerical modelling and applications to global oil and gas industry
- **Dr James Litster FTSE** – Professor, Chemical Engineering, and Professor, Industrial and Physical Pharmacy, Purdue University. Dr Litster is recognised internationally as a leader in particle technology applied in the pharmaceutical and related industries, and an innovator in engineering education.
- **Professor Helene Marsh FTSE** – Dean of Graduate Research Studies, James Cook University. Professor Marsh is an outstanding environmental scientist who is recognised internationally for contributions to marine mammal conservation and marine protected area management.
- **Mr James McIlvenny FTSE** – Senior Vice President, Performance Products, Dow Chemical Company. Mr McIlvenny led Dow's R&D in China, developed its membrane technology, initiated massive coals-to-chemicals projects and brings Western experience in safety and clean production to China.
- **Dr Matthew Morell FTSE** – Theme Leader, CSIRO Food Futures Flagship. Dr Morell's research on understanding basic biosynthetic processes in grains has resulted in the development of cereal products delivering substantiated human health benefits.



Helene Marsh

- **Dr David Noon FTSE** – Chief Commercial Officer and Vice President, Marketing, Groundprobe Pty Ltd. Dr Noon is recognised for his leadership in the technical and commercial development of a radar system for monitoring slope stability in mines, and for marketing it globally.
- **Mr Roger Olds FTSE** – Managing Director, Coffey International Ltd. Mr Olds is one of Australia's leading technical business people who is passionate about delivering outcomes for the profession and the community it serves.
- **Dr Alison Ord FTSE** – researcher and consultant (formerly Chief Research Scientist, CSIRO Exploration and Mining). Dr Ord is an internationally acclaimed structural geologist responsible for introducing computer-modelling technologies emphasising hydrothermal systems into the Australian and international economic geology communities.
- **Dr Richard Sheldrake FTSE** – Director-General, Industry & Investment NSW. Dr Sheldrake is a senior public servant and scientist who has been a transformative primary industries leader in NSW and Australia.
- **Dr Brian Smith FTSE** – Senior Manager, Research & Development, BHP Billiton. Dr Smith has the most senior technical role in the company – providing leadership in innovative technology for minerals and energy projects
- **Dr John Söderbaum FTSE** – Executive Director, ACIL Tasman. Dr Söderbaum has contributed with perspicacity, authority and insight to Australia's technology development and policy formulation in advanced energy domains of special relevance to Australia.



Warwick Watkins

- **Mr David Stewart FTSE** – Chief Operating Officer, Leighton Holdings. Mr Stewart is a recognised and successful leader in Australian engineering, construction, building and mining, with a career marked by innovation and achievement of the highest order
- **Dr San Thang FTSE** – Senior Principal Research Scientist, CSIRO Materials Science and Engineering. Dr Thang is recognised for his excellent work in co-inventing an effective method for polymer synthesis, known internationally as the 'RAFT' process.
- **Dr Linfa Wang FTSE** – Science Leader, CSIRO Australian Animal Health Laboratory. Dr Wang is honoured for his great achievements and international leadership in the discovery of and fight against emerging zoonotic viruses of major human and animal health significance.
- **Mr Warwick Watkins AM FTSE** – Chief Executive, Land and Property Management Authority, NSW Government. Mr Watkins is recognised at the state, national and international level as one of the most important influential leaders in surveying and spatial systems.
- **Dr Paul Zulli FTSE** – Manager, Iron and Steelmaking Research, Bluescope Steel. Dr Zulli is recognised internationally as a technical leader who has made significant contributions in industrial research related to the steel industry.

FOREIGN FELLOWS

- **Professor David Nethercot FTSE** – Head, Department of Civil and Environmental Engineering, Imperial College London. Professor Nethercot is an internationally acclaimed engineering educator and researcher who has influenced international policy in structural engineering and in international codes of practice.
- **Professor Eric Wood FTSE** – Professor, Water Resources Program, Atmospheric and Oceanic Science Program, Princeton University. Professor Wood pioneered the use of remote sensing and data assimilation in model simulations for understanding water resources and flood and drought risk.

Ian Young



Ian Young will head ANU

The next Vice-Chancellor of the Australian National University, from 1 March 2011, will be Australian higher education leader, and world-ranking coastal and ocean engineer, Professor Ian Young FTSE.

Professor Young has been Vice-Chancellor and President of Swinburne University of Technology since 2003, during which time it has entered international rankings for the first time, doubled its revenue, more than doubled its research citations and significantly increased the number of staff with PhDs.

He previously held senior academic positions at the universities of Adelaide and NSW, James Cook University and at the Max-Planck-Institut für Meteorologie in Hamburg.

Long active in Australian higher education policy and administration, he was appointed by the then Minister for Education, Julia Gillard, as the sector's representative on the Australian Qualifications Framework Council. He is also Chair of Education Australia Ltd and a Director of IDP Education

Pty Ltd, the world's largest recruiting agency for international students.

He has written extensively on issues including international education collaboration, research funding, the linkages between vocational education and higher education and models for educational funding.

Professor Young is one of the most cited civil engineers in Australia, and the only serving Australian vice-chancellor to hold current Australian Research Council grants.

He has published three books and more than 100 journal papers in the fields of coastal and ocean engineering, with research covering areas such as environmental design parameters, the physics of wind-generated waves, satellite remote sensing of the oceans and global climate.

Professor Young also has strong industry links, acting as a consultant to the coastal and offshore industries in Australia, Asia, Europe and the US, as well as to government bodies such as NASA and the US Office of Naval Research. He has a strong track record of generating industry and business support for projects and programs at Swinburne.

Greg Tegart

Professor Greg Tegart AM FTSE was a plenary speaker at the International Conference on Ageing, Disability and Independence 2010 in Newcastle-on-Tyne, England in September. He spoke on Smart Technology for Healthy Longevity, drawing on the recent ATSE report launched in Melbourne in July. The invitation arose from contacts made at the EU/Australia Workshop on this topic organised by ATSE and the French Academy of Technologies in Paris in October, 2009.

Sheree targets neuroscience

Sheree Bergman, from Melbourne's Northcote High School, won the 2010 Extreme Science Experience essay competition and plans to continue her science focus in years 11 and 12 as part of her plan to eventually work in the field of neuroscience. Here she accepts her winner's certificate from Rod Dunstan, ATSE's STELR Project Officer, who coordinated the 2010 ESE at Melbourne Town Hall.

Fellows strong in FOCSA

Academy CEO Dr Margaret Hartley outlined ATSE's international program and the benefits of Australia-China science and technology collaboration at the Third Australia-China Joint Symposium on Science, Technology and Education in Melbourne in October, attended by about 250 delegates.

The Symposium was organised by the Federation of Chinese Scholars in Australia (FOCSA), which is strongly supported by ATSE Fellows. Swinburne's Professor Min Gu FTSE was Chair of the Organising Committee of the Symposium and is FOCSA President. He was preceded by Professor Aibing Yu FTSE (UNSW) and Professor Max Lu FTSE (UQ), the founding President and now its Honorary President.

Australian Research Council CEO Professor Margaret Sheil FTSE addressed the opening session and other speakers included Professor Yi-Bing Chang FTSE (Monash), Professor Dongke Zhang FTSE (UWA) and Professor Liangchi Zhang FTSE (UNSW).

ATSE Fellows support the 1300-strong Federation through its Advisory Board, chaired by Professor Yu. ATSE Fellows participating include Professor Robin Batterham (ATSE President), Emeritus Professor Malcolm Chaikin, Dr Megan Clarke, Professor Dagan Feng, Professor Shixue Dou, Professor Ian Frazer, Professor Yiu-Wing Mai, Dr Jim Peacock, Dr Zhengrong Shi and Emeritus Professor Mark Wainwright.

Symposium sessions covered chemistry and chemical engineering; engineering; ICT, biomedical and health sciences; physical and mathematical sciences; environmental sciences and agriculture; and collaboration, management, business and finance.



Geoff Garrett is new Queensland Chief Scientist

Dr Geoff Garrett AO FTSE will become Queensland Chief Scientist following the retirement of Emeritus Professor Peter Andrews AO FTSE in December this year.

Dr Garrett, the former CEO of CSIRO, has been appointed for a three-year period, reporting directly to the Premier, Anna Bligh.

A Cambridge graduate, Dr Garrett is presently a part-time Visiting Fellow in Innovation with the Australian National University, with an extensive background in research, academia and engineering. His eight-year tenure as CEO of Australia's national science agency was defined by a program of major strategic and operational transformation, including the establishment of the Flagship Programs on the major scientific challenges for Australia – such as water, clean energy, health and climate change.

"I personally congratulate Professor Peter Andrews on his tremendous dedication and many achievements in the role since he was appointed as Queensland's first Chief Scientist in 2003," Ms Bligh said.

"He is leaving a lasting and valuable legacy in a number of areas. He articulated a clear vision for Queensland science and has been a pioneer in building Queensland's thriving biotechnology sector, and he has raised the profile of our tropical research and development opportunities."

Professor Andrews's achievements include successful tenures as Chair of both the R&D Queensland committee and the Smart State Council Standing Committee.

He has also played a significant role in international relations including the Queensland Washington Alliance – a collaboration linking Queensland research and educational organisations with leading scientific, educational, and funding groups in Washington State – and the strengthening of Queensland's relationship with China.

Premier Bligh also acknowledged Professor Andrews' contribution as a champion for science, technology, engineering and math (STEM) education.

"Professor Andrews has put the focus on STEM education as a foundation for Queensland's success in a global knowledge-intensive economy," she said. "He has been passionate about Queensland's future as a smart State and providing strategic advice on how to make the most of our investment in science, R&D and innovation to maximise the social, environmental and health outcomes for all Queenslanders."

Roger Swift

Professor Roger Swift FTSE, President of the International Union of Soil Science and Executive Dean, Faculty of Natural Resources, Agriculture and Veterinary Science at the University of Queensland, was a key figure at the 19th World Congress of Soil Science in Brisbane on the theme Soil Solutions for a Changing World. The Congress is held every four years, brings together soil scientists, researchers, academics and professionals. Professor Swift spoke about the role soil scientists play in feeding the world.

UniSA's ITR marks 25 years and Mike Miller's kickstart

UniSA's Institute of Telecommunications Research (ITR) – was established with a tiny team of three back in 1985, led by a young engineer, to explore the emerging "digital" communications technology.

That young engineer was Michael Miller,

now Emeritus Professor Mike Miller AO FTSE, Director of ATSE and SA Division chair.

Moving from digital communications in its infancy, to the full range of telecommunications research, the ITR is now an internationally respected research facility with more than 60 research staff, including 25 postgraduate researchers, and annual revenue of more than \$5 million – and it has just celebrated its 25th anniversary.

ITR Director Professor Alex Grant says the Institute specialises in wireless and satellite communications technology and is playing a vital role internationally in developing the software and hardware to tackle industry communications challenges.

In its 25 years the ITR has graduated 108 postgraduates with Masters or PhD degrees. Almost 950 research papers have been published by Institute staff and it has generated almost \$90 million in revenue.

Milestones include: working with Optus (then Aussat) to develop Australia's first mobile satellite service; the development of new services and standards for some of the largest satellite companies in the world including Inmarsat (UK) and Intelsat (US); the development of a communications payload for the launch of Australia's first 21st century microsatellite, FedSat (a national project to test and demonstrate new services in space).

Based at Mawson Lakes, north of Adelaide, the ITR also has major satellite tracking facilities and specialist staff have worked on several international and national missions to track satellite including for tracking launches for the International Space Station.



From left) Professors Mike Miller, Bill Cowley, Alex Grant, Andrew Parfitt and UniSA Vice Chancellor Peter Hoj, also a Fellow, celebrate ITR's 25 years.

Field robotics pioneer Hugh Durrant-Whyte heads NICTA

Professor Hugh Durrant-Whyte FRS FAA FTSE has been named the new CEO of NICTA, from mid-December, replacing another ATSE Fellow, Dr David Skellern FTSE, who retires in early 2011. Professor Durrant-Whyte currently leads the Australian Centre for Field Robotics (ACFR) at the University of Sydney.

"We are delighted that Professor Durrant-Whyte has agreed to join NICTA as its CEO," said NICTA Chairman Neville Stevens AO. "We

are confident he will steer NICTA to deliver the next generation of ICT research and commercial breakthroughs and build

the company's capacity and reputation for research excellence and successful commercialisation."

Mr Stevens also paid tribute to David Skellern. "Dr Skellern has put NICTA on the map nationally and internationally. He inherited a fledgling organisation of promise and transformed it into an internationally respected R&D group able to tackle major problems facing Australia. He leaves a great legacy."

Professor Durrant-Whyte brings considerable research and commercial expertise to his new role. He has established a major ARC Centre of Excellence with strong links to industry. He has also spun out a number of companies, most recently Marathon Robotics, which developed free-ranging robots protected by armour plating to train marksmen and recently secured a \$57 million contract with the US Navy.

He has also been involved in numerous projects across Australian industry. These include the automation of the Port of Brisbane, the development of underwater robots off the WA coast, improving food security with flying weed-spraying drones

and large-scale mining automation. In September he was awarded NSW Scientist of the Year for 2010.

"The opportunity to lead a young, dynamic organisation like NICTA is a great challenge," Professor Durrant-Whyte said. "Getting use-inspired ICT research 'out the door' and into the market is one of NICTA's most important tasks, as it generates wealth for Australia. It is an exciting time for ICT research in Australia with the advent of the National Broadband Network and I am confident NICTA can play an important role in finding solutions to some of the pressing challenges we face in sectors such as healthcare, energy, transport and logistics."

The Minister for Broadband, Communications and the Digital Economy, Stephen Conroy, and the Minister for Innovation, Industry, Science and Research, Senator Kim Carr, both welcomed Professor Durrant-Whyte's appointment and paid tribute to Dr Skellern.

Peter Cook wins Greenman Award

The Chief Executive of the CRC for Greenhouse Gas Technologies (CO2CRC), Dr Peter Cook CBE FTSE, has been awarded the 2010 Greenman Award by the International Energy Agency Greenhouse Gas (IEA GHG) R&D Program for his longstanding national and international commitment to carbon capture and storage (CCS) research and development.

The IEA GHG made the presentation during the final session of the International Conference on Greenhouse Gas Control Technologies in Amsterdam recently.



Peter Cook

Dr Cook, a geologist by training, with degrees from Durham University, the Australian National University and the University

of Colorado, initiated CO2CRC's work into CCS in 1998 and the CO2CRC Otway Project in 2004. Dr Cook has championed the development and deployment of CCS technology during his recent career.

The Greenman Award is presented to honour important contributions toward harnessing technology for the mitigation of greenhouse gas emissions.

De Laeter Scholarship under way

A former ATSE Fellow and Vice-Chancellor of Curtin University, the late Emeritus Professor John de Laeter AO FTSE, a giant of Western Australian science, is to be remembered – along with his wife – through a scholarship.

Professor de Laeter led the foundation of Technology Park and Scitech in Perth and was also instrumental in the formation of the Gravity Discovery Centre Foundation, which led to the establishment of the Gravity Discovery Centre (GDC), east of Perth – a unique place that combines art with science and cosmology and astronomy with traditional creation stories.

The GDC Board is organising the John and Robin de Laeter Student Scholarship to support young people undertaking practical summer programs in science communication at the GDC.

Bogdan Dlugogorski

Professor Bogdan Dlugogorski FTSE has been elected a Fellow of the Society of Fire Protection Engineers at its annual meeting held in October in New Orleans, USA, for his contributions to the field of fire safety engineering. Only three other Australians have been recognised by this honour. The purpose of SFPE is to advance the science and practice of fire safety engineering. The Society counts more than 4000 professional engineers among its members, in more than 30 countries around the globe.

Lyn Beazley

Professor Lyn Beazley AO FTSE, Chief Scientist of Western Australia, has been awarded an Honorary Fellowship of the Australian College of Educators.

Double honour for Tanya Monro

University of Adelaide (UA) physicist Professor Tanya Monro FTSE has been named South Australia's Australian of the Year 2011 nominee and South Australian of the Year (Science Category) – and has won a national Telstra Business Women's Award.

The Australian of the Year Awards celebrate the achievement and contribution of eminent Australians who are considered 'role models' in helping to create a better Australia.

Professor Monro, Director of the Institute for Photonics and Advanced Sensing IPAS at UA, was recognised in November for her work in the field of photonics – technology that allows the generation and control of light using glass optical fibres. This enables the creation of new tools for scientific research and solutions for problems in areas such as information processing, surgery, health monitoring, military technology, agriculture and environmental monitoring.

Professor Monro became the inaugural professor in photonics at the University of Adelaide in 2005. Her PhD research focused on developing new classes of optical fibres, for which she received the Bragg Gold Medal for the best physics PhD in Australia. In 2006, she was named as one of the top 10 brightest young minds in Australia by national science magazine *Cosmos* and in 2008 she was awarded the Prime Minister's

Prize for Physical Scientist of the Year. She was elected to the Academy in 2009.

Professor Monro is a member of the SA Premier's Science and Research Council and regularly serves on a range of key national bodies in the area of science policy and evaluation.

As winner of the SA Australian of the Year Award, Professor Monro will join recipients from all other States and Territories as a finalist for the national awards, to be announced on 25 January 2011 in Canberra.

She received the South Australian of the Year (Science Category) award – jointly with Professor Angel Lopez, a biomedical scientist – as a consequence of them being named jointly in August as SA Scientist of the Year.

Professor Monro has also won the White Pages Community and Government Award, which recognises the outstanding achievements of women who work in government departments, statutory bodies or not-for-profit organisations.

Professor Monro was automatically entered into the national finals of the prestigious Telstra Business Women's Awards by winning one of the awards at State level.

Harry Poulos honoured by American engineers

Renowned Coffey International engineer Dr Harry Poulos AM FAA FTSE, a Fellow since 1996, who has done groundbreaking research and practice in foundation engineering, especially pile foundation analysis and design, has been named a Distinguished Member of the American Society of Civil Engineers.

"Dr Poulos has applied his academic research to a wide range of major projects, both in Australia and overseas, including buildings, bridges, tunnels, and offshore structures. His projects include the Emirates Twin Towers in Dubai, the Burj Dubai, the Docklands project in Melbourne and the Egnatia Odos motorway in Greece.

"Through various leadership positions within Coffey, he has made an invaluable

The Burj Al Arab in Dubai.



Harry Poulos

contribution to building a successful professional practice by providing direction for technical development, and by

the application of leading edge geotechnical engineering analysis to practice."

Dr Poulos said career highlights included tall building projects from 1994 – the Burj Al Arab in Dubai and the Emirates Twin Towers.

"Subsequently there have been other buildings, including the Burj Khalifa (known as the Burj Dubai prior to its opening), where we were the geotechnical peer reviewers and worked closely with the structural and foundation designers. At 828 metres tall, this is the tallest building in the world and its height was not revealed until its opening in January this year.

"Another highlight, particularly given my ethnic background, was a major road project in Greece – the Egnatia Odos motorway, which extends 700 kilometres from the western coast of Greece to the eastern Greek-Turkish border at Alexandropolis.

"The motorway passes through mountainous Greek regions which posed formidable engineering challenges and included many bridges in landslide areas. I was part of an expert team looking at a number of difficult issues relating to the stability of slopes and road alignment from 2001–05."

Tanya Monro

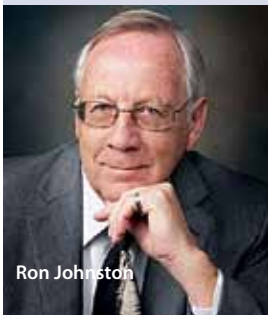


Fellows put new technologies under the microscope

A strong team of Fellows are among 21 Australian experts who will take a hard look at new technologies such as biotechnology and nanotechnology – touted to help Australia fight climate change, stop hunger and disease, and create thousands of jobs.

To fully understand the benefits and risks, the team of experts will put new technologies under the microscope and present their findings to the Australian Government to inform the implementation of the \$38.2 million National Enabling Technologies Strategy.

Announcing the eight-member Expert Forum and 13-member Stakeholder Advisory Council, Innovation Minister Senator Kim Carr said it was important that the Australian



Ron Johnston

community understood new technologies and were confident in their use.

“The Expert Forum includes

technology specialists, researchers and industry representatives who will identify new and converging technologies and highlight any potential implications for Australia.

“The Stakeholder Advisory Council brings together key Australian business, union, non-government, industry, science and research representatives who will use their expertise to advise the Government on the full range of enabling technologies.”

Professor Ron Johnston FTSE, founder and executive director of the Australian Centre for Innovation Ltd, will chair the Expert Forum. Professor Johnston pioneered the development and application of foresight in Australia by leading the highly cited major national study Matching Science and Technology to Future Needs by the Australian Science and Technology Council (ASTEC) in 1995-96.

Two other Fellows are on the Expert Forum: Professor Max Lu FTSE and Dr Deborah Rathjen FTSE.

Professor Lu is Deputy Vice-Chancellor (Research) of the University of Queensland and Director of Research at the Australian Research Council (ARC) Centre of Excellence for Functional Nanomaterials. Professor Lu’s research expertise is in nanoparticles and nanoporous materials for clean energy and environmental technologies.

Dr Rathjen is the CEO and Managing Director of Bionomics, an Adelaide-based biotechnology company. Dr Rathjen has significant experience in research, business development and licensing. She is also chair of AusBiotech, a former member of the Innovation Australia board and its predecessor, the Industry, Research and Development Board, and former member of the Australian Biotechnology Advisory Council.

Professor Chennupati Jagadish FAA FTSE and Professor Ian Lowe AO FTSE are members of the stakeholder body. Professor Jagadish is an Australian Laureate Fellow, Distinguished Professor and Head of the Semiconductor Optoelectronics and Nanotechnology Group at ANU. Professor Lowe is president of the Australian Conservation Foundation and Emeritus Professor of Science, Technology and Society at Griffith University. He has extensive experience in science and technology issues.

Learned Academies strengthen links

Australia’s four Learned Academies have strengthened the mechanisms that link together more than 2000 of the nation’s leading scholars, inventors, thinkers and researchers.

The Fellows of ATSE, AAS, AAH and ASSA constitute much of the nation’s expertise in almost every field of academic enquiry, ranging through agriculture, anthropology, climate change impact, engineering, pure and applied sciences, medicine, philosophy and the arts.

The four academies recently established the Australian Council of Learned Academies



Jacques de Vos Malan

(ACOLA), replacing the earlier National Academies Forum, and ACOLA has now appointed a professional secretariat.

Dr Margaret Hartley, ATSE CEO and Chair of the Directors of the ACOLA Secretariat Ltd, said the four academies had reaffirmed their commitment to work together in activities that promote research and scholarship in science, technological sciences, social science and the humanities.

“We are funded by the Commonwealth of Australia, through the Department of Innovation, Industry, Science and Research, to contribute to the national policy debate on matters of importance to the whole country,” Dr Hartley said.

“In the past five years, the Learned Academies have jointly produced a number of major symposia, conferences and reports. The latest is a report on the formation of attitudes to nuclear power in Australia, essential reading for those considering our future options for the large-scale generation of electricity.”

The inaugural General Manager of the ACOLA Secretariat Ltd is Dr Jacques de Vos Malan. From 2006–10 he was the first CEO of Melbourne Recital Centre, a Victorian Government company established to construct and operate the new concert hall. Dr de Vos Malan is an established composer, whose works form part of the Australian Music Collection held in the National Library, Canberra, the Gaudeamus Foundation Contemporary Music Centre, Amsterdam, and the New York Public Library. As an administrator he has worked for the Victorian Government and the Adelaide Festival Centre.

Peter Lilly joins Curtin in new role

Mining expert Professor Peter Lilly FTSE is returning to Curtin University next year in a new role as Executive Director, Minerals and Energy Strategy.

Professor Lilly joins Curtin from his previous role as Director of CSIRO's Minerals Down Under National Research Flagship. He was formerly Chief of CSIRO's Division of Exploration and Mining. He was also Professor of Mining Engineering (1999–04) and Director of the WA School of Mines (2004–06) at Curtin and is a Member of the WA Government's Mining Industry Advisory Committee.

Professor Lilly will lead strategic business partnerships with the resources industry, particularly through the Curtin Institute of Minerals and Energy (CIME). He will work closely with the Faculty of Science and Engineering, especially the Director of the School of Mines, and Curtin's broader R&D team.

The CIME draws together Curtin's extensive research and education capabilities in the areas of mining, geosciences, minerals and energy economics, petroleum and chemical engineering, environmental health, corrosion technology and sustainability. The institute offers innovative, cross-disciplinary solutions to the challenges faced by both the minerals and energy sectors, and the communities in which they operate.

Professor Lilly has served on the boards of Snowden Mining Industry Consultants (1997–04), the Australasian Institute of Mining and Metallurgy (2001–08) (of which he was President in 2006) and the Australian Prospectors and Miners Hall of Fame (2005–08).

Since receiving his doctorate in South

Africa in 1978, Professor Lilly has held positions in mine operations and development, academia, mining research and consulting engineering, and has worked on projects in 15 countries.

Barry Inglis

The National Measurement Institute's inaugural CEO, Dr Barry Inglis FTSE, has become the 15th president of the International Committee for Weights and Measures. He takes over this role from Professor Ernst Göbel of PTB, Germany, as the first Australian to achieve this honour since the signing of the Metre Convention in 1875 and only the second non-European. CIPM is the peak international expert advisory body under the Metre Convention. Its members have included five Nobel Prize winners.

Ken Conway: engineering's gentle giant

The Academy is saddened to note the death on 20 September 2010 of a great Australian engineer, Kenneth Conway FTSE HonFIEAust, after a short illness. Ken's great passions were his family, engineering, cricket and world travel.

Born in Birmingham, UK, in 1944, Ken was educated and lived most of his life in Australia. He attended All Saints College, Bathurst, where he was school captain, a champion sportsman and won a Commonwealth Scholarship to Sydney University.

In 1966 he joined Sydney Water, armed with a dual degree in Science and Civil Engineering, which was quickly followed by a Masters degree in Water Engineering.

After joining one of Australia's oldest and most respected consulting firms, GHD, in 1973 he rose to Managing Director in 1999 and Chairman in 2002. Ken transformed GHD from an Australian company to an international consultancy with more than 50 permanent offices in 13 countries, doubling the turnover to \$300 million.

His involvement with The Warren Centre for Advanced Engineering at Sydney University commenced as a project fellow



Ken Conway

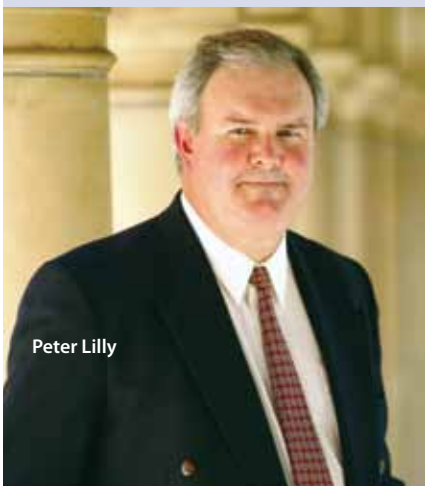
on 'Management of Macro Projects' in 1985 and, subsequently, Chairman of the Macro Engineering Council which it spawned. Following his retirement from GHD in 2004, Ken joined the Board and was appointed Deputy Chairman in 2006, the year in which he joined the Academy.

Three days before his death the EA Excellence Award won by The Warren Centre for its groundbreaking report, *Professional Performance, Innovation and Risk in Australian Engineering Practice*, was dedicated to Ken in recognition of his huge contribution to the success of the project.

At Sydney University, Ken was an Honorary Life Member and Past President of the Civil Engineering Foundation. As a member of the Knox Grammar Council, Ken was Convenor of the Property Committee, overseeing its extensive building program, and a director of the Knox Foundation. He was also President of the Old Boys Union at All Saints Bathurst and a Director of its Foundation.

He was a first grade scorer for the Gordon Cricket Club and the NSW Cricket Association. He found time to travel the world to such events as the British Open golf at Gleneagles, cricket tests at Lords and rugby internationals at Millennium Stadium where he could catch up with his son Kenneth and family in Wales. He had just returned from guided tour of the great Art Galleries of the World when he was diagnosed with cancer.

All of us who have been privileged to know this great engineer, this diplomatic leader, this family man, this avid sportsman and this gentle giant, will greatly miss Ken Conway. – Professor Mike Dureau FTSE.



Peter Lilly

Mel Ward had key role in telecommunications evolution

The Academy is saddened to note the recent death of Mr Mel Ward AO FTSE, former Managing Director of Telecom Australia, aged 68.

Mr Ward, who joined the Academy in 1986, was a Foreign Member of the Royal

Swedish

Academy of Engineering and served

ATSE in a variety of

roles – as a Councillor,

Honorary Treasurer and

ATSE Crawford Fund Board of

Management member, 1997-99.

He was born in Mackay, educated at

Brisbane Grammar School and graduated in Engineering and gained a Master of

Engineering Science qualification from the University of Queensland.

He was involved with the

telecommunications industry for more than 30 years, during which he led many

significant changes within Telecom (Telstra's predecessor) and the industry.

He was appointed Telecom's Chief General Manager in 1984, when it had

some 90,000 employees and annual capital expenditure nearing \$2 billion. In the

preceding years he had been Manager of Telecom's data division, Chief Development

Engineer and General Manager, Commercial Services. He spent the early years of

his career in the Post Master-General's research laboratories and the engineering

development division of PMG/Telecom.

He became Managing Director of the Australian Telecommunications Commission

in 1986 and of Telecom Australia in 1989 – a position he held until 1992.

He served on a number of business, education, management and community

bodies, including as Chairman of the

Victorian Education Foundation and Director of National Mutual Life and the Australian

Ballet Foundation and a member of the Business Council of Australia.

He was a Fellow of the Institution of Engineers, Australia, and enjoyed tennis and golf.

David Smiles remembered for land and water science

The Academy notes with sadness the death in Canberra on 25 October of Dr David Smiles

FTSE, aged 76.

Dr Smiles was rated by those who knew him as "an outstanding scientist who served

CSIRO in the finest of ways".

He made a tremendous contribution in soil physics, industrial filtration, irrigation,

the disposal of muds and slurries, and the diffusion and transport of solutes. He joined

the Academy in 1991.

Colleagues recalled his understanding of environmental physics was superb and he had

a deep appreciation of agricultural science and the land and water sciences more generally.

At the core of his work was the design of elegant, direct and exacting experimental

tests, coupled to elegant and succinct theoretical descriptions; the succinctness often

deriving from his novel use of material coordinates, which

resulted in simpler equations than the more commonly

used spatial coordinates.

Dr Smiles was Chief of the Division of Environmental

Mechanics and then of the Division of Soils from 1979

to 1993. He remained a very active member of the

scientific community, most recently as a post-retirement fellow in CSIRO

Land and Water.

He was a fellow of the Soil Science Society of America (2002) and was a member of

several societies and learned committees – and recipient of the Farrer Medal (1993) for

medal for service to Australian society in environmental science and technology. His work on the interactions between water and porous media earned him a Doctor of Science from the University of Sydney in 1979.

Norm Thomson was a cotton pioneer

The Academy is saddened to note the recent death in Narrabri, NSW, of Dr Norm Thomson

AM FTSE, aged 79, following an extended illness.

A Fellow since 1988, Dr Thomson was a plant breeder with CSIRO from 1958 to

1994. In that time he undertook important research with cotton on the Ord River, in

WA, before moving to Narrabri in 1972 and establishing a plant breeding program that

has now produced some of the best cotton varieties in the world.

All cotton grown in Australia, as well as a large proportion of that grown in the USA,

Brazil and Greece, is from varieties bred by the program he established.

He had been the recipient of much recognition – twice Cotton Researcher

of the Year – and a recipient of the Australia Medal, the Sir Ian McLennan

Award for Contribution to Industry and the Centenary Medal.

Born in Toowoomba, he graduated in agricultural science from UQ,

won his masters from UWA and his PhD from UNE.

His 1988 citation noted that the cotton research unit

he headed was then "arguably the foremost centre of applied cotton research in the world

with major achievements in cotton pest management and

breeding."

It added: "The unit's pest management research has resulted in the

computer-based, on-line, on-farm SIRATAC system being employed on nearly a third of

Australia's cotton area. It was, and remains, the world's first system of its type to be

directly used as an on-farm management tool."

Mel Ward



David Smiles



New Chair for Crawford Fund

The Hon. John Kerin AM FTSE has accepted an appointment as the Chair of the Crawford Fund.

Mr Kerin, who has served as Chair of both the ACT and NSW Committees of the Fund for some years, succeeds the Hon. Neil Andrew AO FTSE, former Speaker of the House of Representatives.

Mr Kerin is an economist and former Labor parliamentarian who served as Minister in a range of senior portfolios, including Primary Industries and Trade and Overseas Development. He was appointed to the CSIRO Board in October 2008.

Megan Clark gives 2010 Lowy Lecture

Dr Megan Clark FTSE, the Chief Executive of CSIRO, delivered the 2010 Lowy Lecture, the Lowy Institute's signature event for the year in Sydney in November.

Titled 'Science and Australia's place in the world', the lecture argued that Australia's science capability is fundamental to our future as a nation and our place in the world.

She commented that we often hear about the importance of a prosperous and sustainable Australia and explored what these terms actually mean and how they might be achieved.

Dr Clark argued that Australia's science capability was fundamental to our future as a nation and our place in the world and explored Australia's capability to be a world-leading nation and the areas where we must have national capability.

STELR plans for 2011

In 2011, the STELR Project will continue to run in all schools that were involved in 2010. The curriculum materials supplied to schools in 2011 are being rewritten for a Year 9 audience and will be closely aligned with the draft Australian Curriculum: Science proposed by ACARA.

Electric circuits will be an integral part of the project before students attempt investigations with solar cells and wind



Ta-Yan Leong

turbines. In 2011 there will be a greater emphasis on the chemistry of renewable energy and the effects of increased concentrations of CO₂ in the oceans. New activities include producing ethanol through fermentation, distillation, a demonstration on making biodiesel, comparison of the energy released by different fuels, the effects of CO₂ on the acidity of seawater and the effects of increased acidity on shells.

Twenty schools from around the country will trial the chemistry activities next year. They will receive class sets of micro-distillation equipment so that students have hands-on experience rather than just observing demonstrations of distillation. Trials began in two Victorian schools in November to refine the written materials.

A December meeting of STELR mentors was scheduled to discuss the support provided to schools this year and into the future.

Fellows serve on ERA evaluation committees

A number of Fellows have been appointed to Research Evaluation Committees (RECs) that will evaluate data submitted for the 2010 ERA initiative by Australia's higher education institutions. RECs are established at the discipline-cluster level and comprise distinguished and internationally recognised researchers with expertise in research evaluation. There are 149 REC members appointed from Australia and overseas, comprising eight RECs.

Professor Paul Haddad chairs Cluster 1 (Physical, Chemical and Earth Sciences), with Professor Min Gu, Professor John O'Connor

and Professor Michael Tobar as members. Professor Mark Randolph chairs Cluster 3 (Engineering and Environmental Sciences), with Professor John Carter and Professor Hugh Durrant-Whyte as members.

Ta-Yan wins CSIRO Lifetime award

The groundbreaking work of CSIRO researchers was recognised recently at the 2010 CSIRO Awards Ceremony, when Innovation, Industry, Science and Research Minister, Senator Kim Carr, presented the 2010 CSIRO Lifetime Achievement Medal to Dr Ta-Yan Leong, who he described as a national asset.

"For the past 25 years, Dr Leong has worked on fostering deep and trusting relationships with international partners such as China. These relationships have been vital to the success of many international science collaborations," Senator Carr said.

ATSE and AAS presented Dr Leong with a card at a farewell dinner in Canberra, which acknowledged his contribution to furthering Australian science and technology linkages overseas and his role in the Australia China Young Scientist Exchange Program.

Excuse me, waiter

A highlight of the WA Division annual meeting was an address to the 22 Fellows and partners attending by Professor Mark Gibberd, Associate Professor of Viticulture and Oenology at Curtin University, titled 'Excuse me waiter – there is a bubblegum character in my wine. How did it get there?'

He briefly outlined a history of mechanisation in Australian viticulture – dispelling romantic notions of vines lovingly hand-pruned and picked – new irrigation technologies to maximise production and quality in the face of a drying climate and survey techniques to map paddock variables and reduce costs by spatially matching inputs to requirements.

He also covered new technologies to keep the Australian wine industry competitive and of high quality, such as different methods for grape maceration and micro-oxygenation during wine maturation.

ADDRESS	TELEPHONE	FAX	EMAIL	WEBSITE
PO Box 3587 Melbourne VIC 3001	(03) 9864 0913	(03) 9864 0930	airg@atse.org.au	www.airg.org.au



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The Grange winery and conference centre offers a highly interactive atmosphere. The 2011 AIRG National Meeting has been set up to specifically offer considerable opportunities for discussion and networking outside the formal program.

Registrants are welcome from all spheres of the management of research, technology and innovation.

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