



FOCUS

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AUSTRALIA 2030

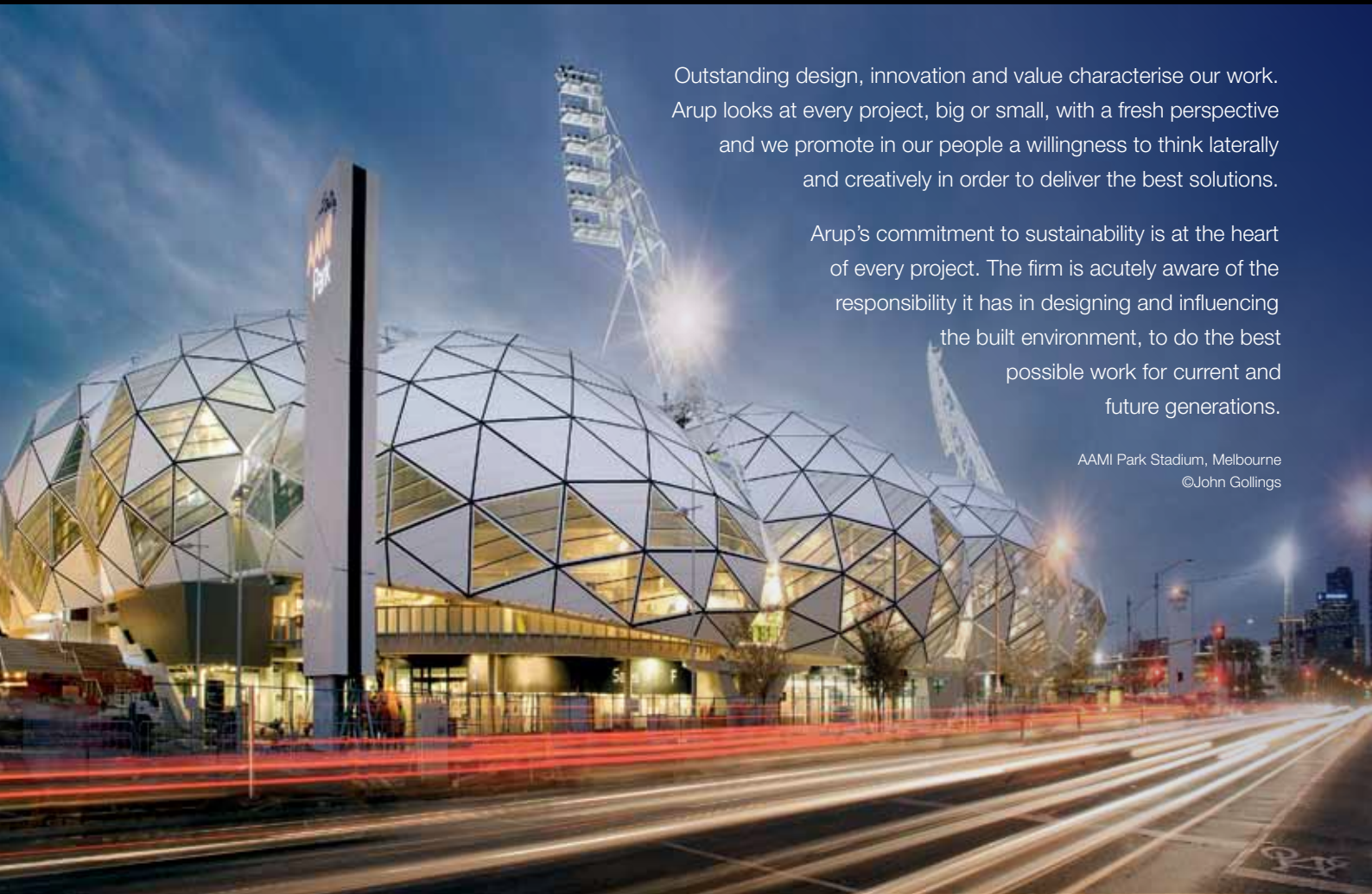
KEY ECONOMIC & INFRASTRUCTURE ISSUES

What will be our requirements for infrastructure and services in Australia in 2030? Leading authorities look at the likely demands two decades from now

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Photo: iStockphoto



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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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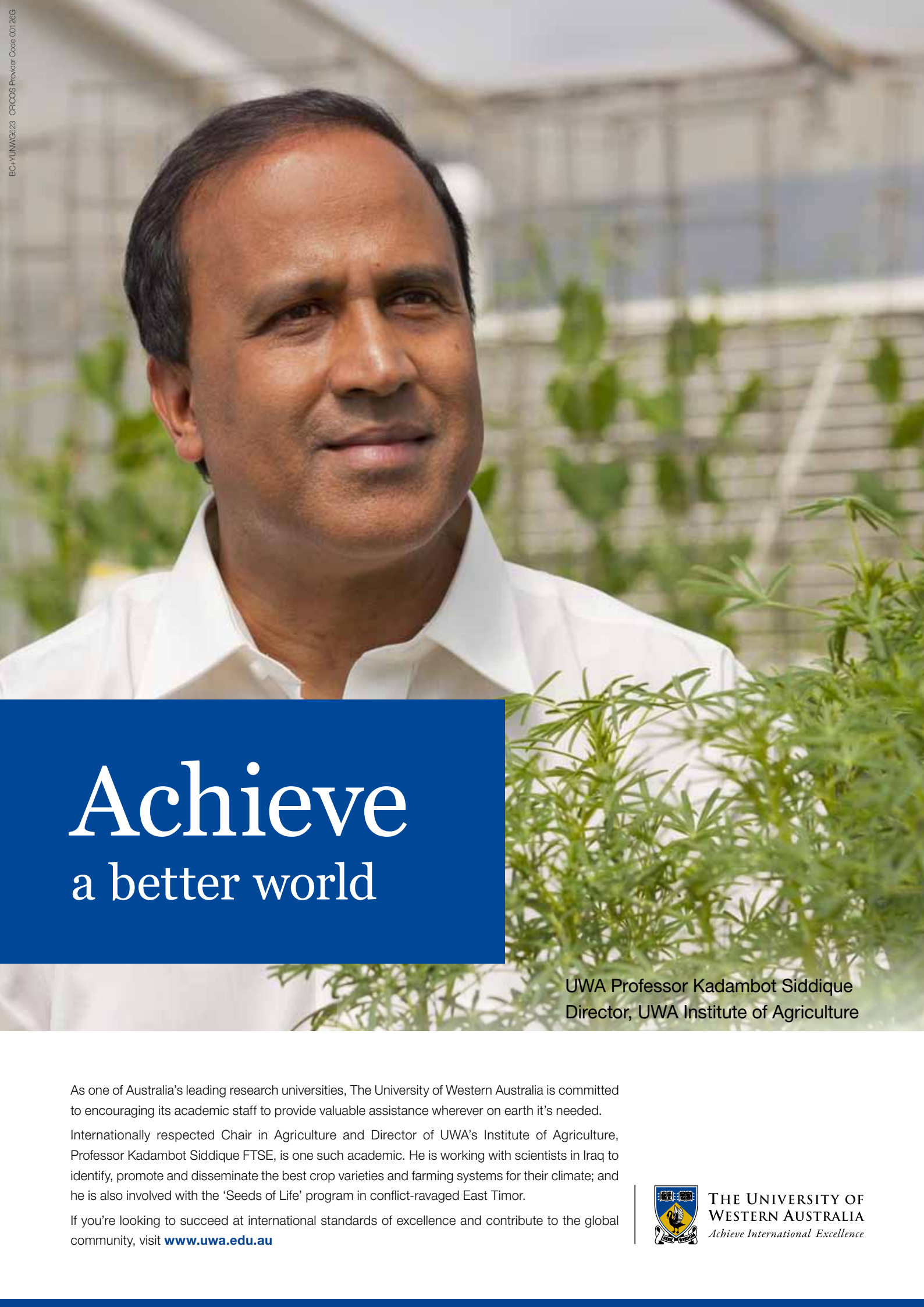
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Innovation the key to productivity in economic recovery

Australia is facing two difficult decades. The current economic buoyancy is a result of mineral exports and is unlikely to be long term. Moreover, there has been a less-recognised decline in labour productivity over the past decade.

Australia must turn its back on political complacency and sectional interest to change. It must come to grips with the existing backlog of infrastructure investment, which population growth and the impacts of climate change will exacerbate.

This backlog can only be financed by domestic saving from fiscal restraint coupled with productivity improvement. Innovation through science and technology will provide the key to productivity improvement.

These were the key messages from the recent Seminar *Australia 2030 – Meeting the Demand for Effective Infrastructure and Services* conducted by the Australian Academy of Technological Sciences and Engineering. Nine distinguished speakers outlined the challenges that Australia and Australians face in the next two decades.

Speakers at the seminar have authored keynote articles for this edition of *Focus*. All the seminar presentations are available on the Academy's website.

Key issues identified during the Seminar:

- Australia is currently riding the resources boom, driven largely by demand from China;
- this boom has stretched Australia's capacity in terms of infrastructure (particularly transport and housing) and driven up exchange rates, making other sectors of the economy less competitive;
- this boom cannot last indefinitely – demand will falter or supply will catch up because all commodity-exporting countries are investing to reduce supply bottlenecks;

- the Global Financial Crisis is not over – fiscal adjustments will take 10 to 20 years to work through;
- the impacts of population growth, climate change, expenditure on the “war on terror” and increasing food and energy costs exacerbate the problems;
- our capacity to support and improve living standards depends on growth in multifactor (real) productivity, not from borrowings;
- there is a large backlog in upgrading critical infrastructure – electricity generation and distribution, airports, seaports, rail and road capacity and urban transport infrastructure;
- expenditure on consumption will need to reduce and savings increase; and
- the paths to achieving sustainable productivity improvement in the economy are through economic reform (for example, taxation reform), improving savings and investment in long-term infrastructure, and scientific and technological innovation.

The genesis for the Seminar was the Intergenerational Report published by the Australian Government in February 2010, which predicted that the population of Australia would reach 29 million by 2030 and 36 million by 2050. These figures created such public furore that the Minister responsible said that: “the population projections were merely a projection from Treasury ... not a target – not an ambition – not a policy.”

Whatever the growth trajectory, an increase in population will place an increase on the demand for all forms of infrastructure ranging from health and education to energy, water, housing and transport.

There is no doubt much of the negative public reaction was rooted in the concern that investment in infrastructure has considerably lagged demand and that

Investment in infrastructure is a key to productivity gains – Melbourne's EastLink.

population increases would only exacerbate the myriad problems people were experiencing with current infrastructure deficiencies.

Moreover the Australian economy must grow to support the standard of living currently enjoyed by most Australians. The Intergenerational Report not only highlighted population growth but also identified the decline in participation rate (those of the population who actually work) and labour productivity as key issues in the decades ahead.

The Seminar was opened by Dr Richard Sheldrake FTSE, Director General, Industry & Investment NSW, who outlined the activities of his Department and the State in food security, clean coal technology, smart grid technology and research aimed at reducing water demand in agriculture. He identified that Industry & Investment NSW saw collaboration with a range of partners as essential in identifying solutions to the challenges through to 2030.

The morning Session Chair, Professor Mary O'Kane FTSE, NSW Chief Scientist and Scientific Engineer, identified the ubiquitous role of ICT in underpinning advances in science and technology and that, like transport, ICT would be fundamental to the development of our infrastructure needs through 2030 and beyond.

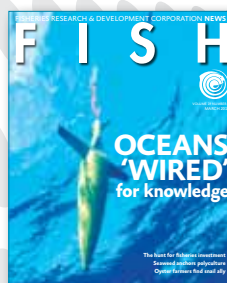
Professor Ross Garnaut AO, Vice-Chancellor's Fellow and Professorial Fellow (Melbourne University) and Distinguished Fellow of Economics (ANU), identified that over the past decade labour productivity had declined significantly and that the extended resources boom (and the Chinese economy) has underpinned the Australian economy (see page 10).

Mr David Murray AO, Chair, Future Fund Board of Guardians, said the Global Financial Crisis could take 10 to 20 years to work through the global economy and the only way to make a sustainable improvement in productivity was through the application of science and engineering (see page 12).

Dr Shaun Larkin, Managing Director, The Hospital Contributions Fund (HCF), noted that health should be identified in functional terms as "a state of complete physical, mental and social well-being" – not merely the absence of disease or infirmity. He said the prevention of chronic disease provided the best opportunity to guarantee the health of Australians in 2030 and business success for health care companies, since at present one per cent of the population consumed 50 per cent of the health care budget. This would require full integration of national and state strategies, programs and services and the implemen-

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CONTENT MATTERS

tation of innovative online health support platforms for both aged care and the general population.

Professor Cliff Hooker FAHA, Professor Emeritus of Philosophy, University of Newcastle, discussed resilience as applied to infrastructure. He noted that resilience analysis is more extensive than conventional risk analysis in anticipating a wider range of factors including climate change, population increases and unforeseen external shocks.

Mr John Howarth, Executive General Manager, Transmission Services, Australian Energy Market Operator, indicated that energy prices in Australia were low by world standards and the current regime of increasing prices would continue (see page 23).

Dr Geoffrey Annison, Deputy Chief Executive of the Australian Food and Grocery Council, said Australia and the world had the ability to produce sufficient food for the foreseeable future certainly until 2030, but this was complicated by geopolitics, food storage and wastage and the fragility of the supply chain (see page 15).

Mr Ross Young, Executive Director, Water Services Association of Australia, noted Australia's significant rainfall variability, which impacted agriculture and urban water supplies (see page 19).

Ms Cate Collins, Head of Sustainability, Lend Lease

Asia Pacific, said the current dwelling shortage in Australia was 130,000 and both availability and affordability were getting worse. Most of the increase in population would be predictably drawn to the major cities. Urban regeneration, densification and infill provided an opportunity to reduce the backlog in housing and made use of existing infrastructure, but major housing developments on urban fringes would continue to be the major contributor to housing stock. These developments must be innovative and sustainable and a particular challenge was key worker housing (that is, housing for nurses, teachers, police, etc who must live within reasonable proximity to where they work).

Mr David Singleton FTSE, Chair, Global Infrastructure Executive, Arup, said population growth would exacerbate the current dilemma in transport, which itself linked to the economy, health services, food distribution, employment and recreation (see page 25).

Summing up, the President of ATSE, Professor Robin Batterham AO FREng FAA FTSE, highlighted two key issues: Australia's decline in labour productivity which, while clearly a problem, was not being addressed by government policy; and the integrative approach needed to achieve optimal outcomes for new infrastructure such as housing and transport. ◀

Seminar recommendations

1 Productivity

Over the next two decades, the Australian economy must grow to sustain an increase in population and to finance the investment in infrastructure that will be required. However, the economy is vulnerable in the immediate future because it is dependent on commodity exports and the influx of capital associated with the mining industry.

Maintenance of living standards will require improvements in productivity which must be enhanced through research and development, innovation and the development of human capital through education.

2 Transport and housing

Transport is a derived form of infrastructure and is integral to the supply chain for goods and people movement for work and recreation. Housing developments, particularly those seeking to address the affordability issue, must incorporate energy and water efficiency in their design as well as cognisance of the needs for transport and amenity.

The benefits of infrastructure can be enhanced through integration with a holistic consideration of sustainability, affordability and the environment.

3 Infrastructure

Infrastructure takes many years to plan, design and build. Unfortunately the complexity of the approval process across local, state and federal jurisdictions and the ability to carry policy through an electoral cycle is an impediment to the timely delivery of infrastructure. Moreover, it has been estimated that funding requirements for infrastructure over the next decade alone will be between \$500 and \$700 billion and it is going to require a combination of funding from both the public and private sectors.

Governments at all levels must allow the private sector to have a greater role in the funding of infrastructure with attractive commercial terms and removal of the impediments provided by political and bureaucratic procrastination.

4 Food security

Australia is a net exporter of protein and calories and can currently support between 60 and 80 million people, depending on the vagaries of the climate. About 90 per cent of the ingredients used in manufactured foods are sourced locally. Ingredients that are imported are used in such staples as bread, breakfast cereals and dairy products.

So food security does not mean food self-sufficiency and Australia is part of a global supply chain for both exporting and importing food products. Food security has a fundamental role in contributing to the health and well being of a culturally diverse Australian population.

Priority must be given to the development of a national strategy on food security that must encompass due recognition of population growth in Australia and overseas, the impacts of climate change, water and land availability for agriculture, rural labour shortages and the need for accelerated research and development in the agri-food sector.

Microplasma – engineering technology for our future.

Research on the surface engineering of microplasma at UniSA's world-class Mawson and Ian Wark Research Institutes is showing exciting potential for medical and industrial applications.

Dr Endre Szili and Dr Sameer Al-Bataineh are leading a team of researchers exploring applications of microplasma technology for high-throughput screening that could be used for early detection of protein cancer markers and monitoring of wound healing. Applications of microplasmas are also being explored for sterilisation through the deactivation or removal of unwanted bacteria.

The success of this surface engineering technology research at UniSA presents enormous potential benefits. For example, the healing and management of chronic wounds alone is a significant medical issue as Australia's second-most billed Medicare item, affecting the quality of life of over 400,000 Australians.

Microplasma technology at UniSA has also been integrated into microfluidic chips for chemically patterning the internal walls of small microcapillary channels down to 50 micrometers wide. This opens a breadth of new applications for microfluidic lab on a chips including advanced fluid flow analysis, monitoring of biological cell systems and controlling stem cell pluripotency inside confined microcapillary spaces for tissue engineering.

This microplasma technology also aligns with the Wound Management Innovation CRC program under the direction of Professor Rob Short from the Mawson Institute alongside Professor Hans Griesser from the Ian Wark Research Institute. Here, plasma technology is being used in developing the next generation of wound dressings that promote active healing.

These significant advances in surface engineering technology again demonstrate UniSA's quest and success in being at the forefront of research that is delivering solutions to the important issues of today.¹

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

"The Mawson Institute's microplasma reactor used for surface engineering micrometer chemistries with high precision and accuracy."



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Research Institute



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¹The research areas associated with these niche technologies, namely physical chemistry, chemical sciences and materials engineering received recent Excellence in Research for Australia (ERA) rankings which confirmed research performance above world-class standard.

Growth, cycles, climate and structural change: two hard decades ahead

The Dog Days come when the community's expectations of rising living standards run ahead of the economy's capacity to support increased expenditure.



By Ross Garnaut

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Australians are enjoying the best of days, at least in relation to material standards of living. Over the past two decades we have enjoyed the longest period of rising living standards, unbroken by recession, in history – our own, or that of any other developed country.

It shows. We are back near the top of the developed world's league tables for per capita income, if we convert the national accounts into a common currency at the going exchange rates. Since early 2008, Australian income per person has exceeded that of the US, and the gap has kept growing. Our community's expectation of living standards has grown even faster than the capacity of the economy.

At the same time, our political culture has adjusted to these good times. Reform and structural change now means that there are no losers. Reform to most Australians now means a tax cut or improved service for myself. Business expects no less, and sees part of its core business as placing pressure on government to ensure that no reform is contemplated that would mean that its own business is a loser.

This is the world of the Great Australian Prosperity of the Early 21st Century. It is also the world of the Great

Australian Complacency of the Early 21st Century.

There was a substantial increase in Australian average productivity relative to the US from about 1988 to nearly the end of the 20th century but from the end of the century, our productivity relative to the US started to fall again (Figure 1).

Australian incomes per person – relative to the US – rose from about the time when our relative productivity growth headed downwards. Incomes have bounded away since the Great Crash of 2008 left the Australian economy little scathed and set the old developed economies of the North Atlantic onto a new trajectory of stagnation (Figure 2).

If the community's expectations of expenditure on the standard of living are rising more slowly than the economy's capacity to support expenditure, we are in the Salad Days of economic policy. These are the days when bad policy looks alright, and good policy looks stellar, a reforming Government can ask for the modest short-term sacrifice that is often necessary to generate large long-term gains. Losers from reform that is in the public interest will whinge, but they expect little sympathy. A wise government will work to ensure that the interests of the genuinely needy are protected

Figure 1 Labour Productivity and Gross National Income per Capita (Australia as percentage of the US)

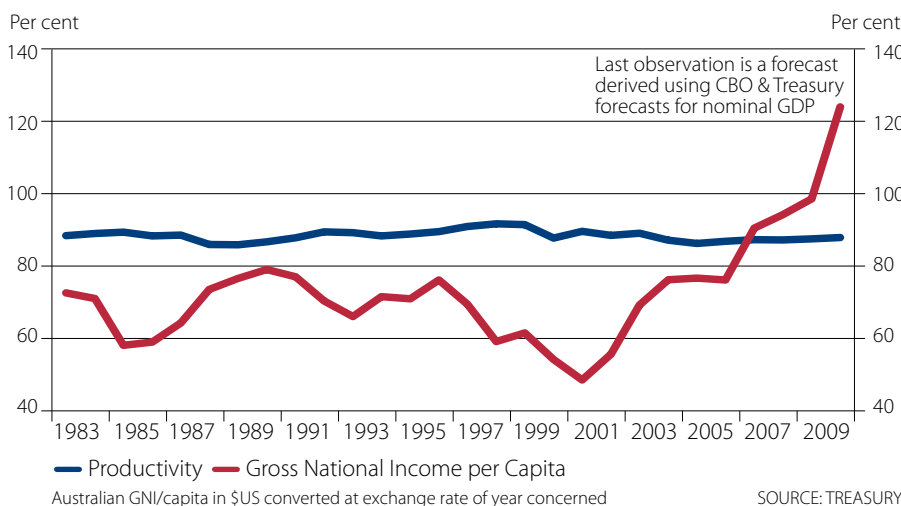
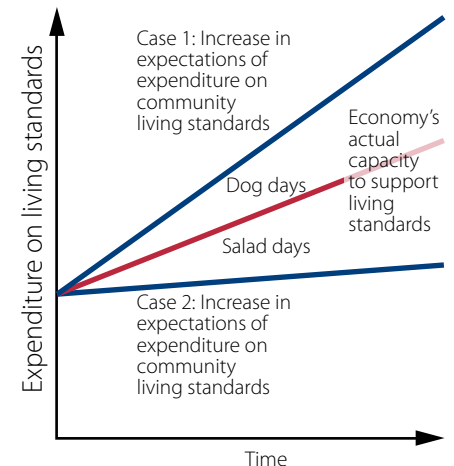


Figure 2 The State of Policy Bliss



from change that is in the public interest, and resources are available to put in place the necessary protections.

It is likely that the essential conditions for macro-economic stability – steady growth with sustainably low unemployment and inflation – are kept in place; that expenditure growth stays within the growth of the productive capacity of the economy, give or take prudent variations in levels of borrowing.

The Dog Days come when the community's expectations of rising living standards run ahead of the economy's capacity to support increased expenditure. The post-1983 reforms extending to the end of the century, after a lag, were a major factor in lifting productivity growth to historically high levels. Even more importantly, the acceleration came from multi-factor productivity growth. This is the basis of sustainable increases in living standards. Unlike capital deepening, it does not have to be paid for by sacrificing current consumption (nothing wrong with that, but 21st century Australians don't like to do it much), or by servicing capital inflow (the way we have funded much of the increase in 21st century investment).

How, then, were we able to sustain growth in employment and living standards through the first decade of the 21st century? For a few years into the century, after the end of the productivity boom, growth came mainly from a housing and consumption boom, financed by the banks, who themselves

funded the growth in lending by borrowing on offshore wholesale capital markets to an extent that has no parallel in history – our own or that of any other developed country.

It was imprudent and our banks would have come to profound grief when international capital markets froze in the Great Crash of 2008 and its aftermath were it not for the quick and massive intervention of the Australian Government.

Unlike the Productivity Boom, the Debt-Funded Housing Boom was not sustainable, and would have ended in Australian tears were it not for the timely arrival of the China-led resources boom. The resources boom put great pressure on the rest of the economy, especially the other traded goods and services sectors, services (education the biggest, followed by tourism), the rural sector and manufacturing, partly through the increase in the real exchange rate.

The expansion of the resources sector also and separately puts pressure on the rest of the economy by squeezing other sectors' access to capital. There are always some limits to capital inflow, even in the heady days of imprudent expansion before the Great Crash. These limits have been tightened by the Great Crash. Banks are somewhat constrained in expanding access to wholesale debt markets – the markets themselves are more cautious (and margins higher), and prudential limits on bank wholesale borrow-



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ing abroad are being applied more firmly.

There is less risk in equity capital inflow, but since the Great Crash there has been less direct investment abroad from the US and Western Europe, and while Asian sources of investment have become much more important, led by China, Australians have shown some ambivalence in remaining open to them.

There is strong momentum in Chinese and other developing country growth and it is likely to continue for a considerable while. However, it is likely that, despite this continued strong growth, the terms of trade will fall by a large amount with expansion of supply in Australia and elsewhere.

Investment growth will level out and then decline. We will then again need large contributions from investment and exports from other traded goods and services industries, but they will have been seriously weakened by the large, temporary decline in their competitiveness.

So after a decade or so of Salad Days, and getting on to a decade of the great Australian Complacency, we are likely to face Dog Days for at least a while – not necessarily starting tomorrow, as terms of trade and growth in resources investment growth could even increase for a bit longer – but sometime early enough for our response to the onset of Dog Days to shape our prospects to 2030.

Productivity growth stagnation is a hard starting point. Our heavily indebted private sector will carry a large burden if there is any upward tendency in global interest rates.

We are living in a world in which the global balance of economic and strategic weight has been changed fundamentally by the economic success of the large developing countries and by the stagnation in the North Atlantic countries after the Great Crash. We are still working out how to make the new international system work. There will be demands for increased real defence expenditure in this world (as in the current expectation of a three per cent per annum increase). There will be a choice of guns or butter; or guns or infrastructure. The latter choice is really a choice between guns now and security later, as a failure to restore sustainable growth would weaken us strategically at later times.

The world's tardiness in dealing with human-induced climate change – to which Australia has contributed a great deal, despite our economy facing larger damage from unmitigated climate change than that of any other developed country – is already affecting productivity growth, and this effect will increase with each passing decade, and of course increase much more beyond the 2030 horizon.

Sooner or later, Australia and the world will have to come to grips with effective climate change mitigation. This will inevitably involve some short-term cost to productivity, to be recouped many times in reduced productivity losses later on.

There are risks of things going badly wrong in the Dog Days; of slipping into policies that entrench slow growth

in employment and incomes.

The years to 2030 could be great decades for Australia, in an Asian region entering the harvest period of its economic development, with a self-confident Australia drawing strength from its two decades of prosperity and from the growth in familiarity with our Asian environment enriched during this time by the immense growth of our exports of education services and the high education and skill content of a large immigration program.

But it can only be great if we quickly renew the focus on productivity growth. That means coming to grips with a huge backlog in investment in infrastructure, education and training. It means remaining open to international immigration and capital, and investing in the capacity to make that all work.

It requires looking at hard issues like tax reform and climate change with an eye to the national rather than the private interest. That, above all, requires us to restore the political culture of the reform era. It requires us to turn our backs on the political culture of the Great Australian Complacency, where we indulge sectional resistance to change that is in the national interest.

I don't think that we will get it right without a major national focus on reducing short-term benefits for long-term ends. That will require some sharing of restraint for a while. There was not much sign of that just now – although the two per cent limit on real public expenditure growth was tough by historical standards, if falling short of what may turn out to be required.

We can take comfort from the fact that Australia has done what is required before. We did it better than other countries as we found our way out of the depths of the Great Depression. We did it in the 80s, as we reversed a long history of miserable relative productivity performance. I am afraid that Australians will have to do it again. It will be much easier if we can get back into a culture of productivity-raising reform before circumstance forces our hand. ◀

PROFESSOR ROSS GARNAUT AO is Vice-Chancellor's Fellow and Professorial Fellow in Economics (University of Melbourne) and Distinguished Professor of ANU. He is Chairman of the PNG Sustainable Development Program Ltd and its nominee Director on the Board of Ok Tedi Mining Ltd. Professor Garnaut is a member of the board of several international research institutions and the author of numerous books, monographs and articles in scholarly journals on international economics, public finance and economic development. In 2008, he led the Garnaut Climate Change Review, which examines the impact of climate change on the Australian economy and provides potential medium to long-term policies to ameliorate these.

The full text of Professor Garnaut's speech is available at www.rossgarnaut.com.au

Australia remains a price-taker for its commodities – railing iron ore in the Pilbara.

Productivity the key for our economy to 2030

When this commodity price cycle changes Australia has to marshal its water resources and become a quality exporter of food to the rest of the world.

PHOTO:ISTOCKPHOTO



By David Murray

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I've been asked to talk about the economy so I want to paint a picture of where we are at the moment, in the world, in Australia and the prognosis for 2030. The reason that this is important, picking up off Ross Garnaut's theme, is that the only way of making sustainable productivity improvement in Australia – looking both at where we are now and the prognosis for 2030 – is by the application of science and engineering through design.

Looking at Australia, it is evident the global financial crisis is not over – and I identify five phases.

In **Phase 1** we suffered a liquidity crisis because governments around the world and their regulators and supervisors allowed a build-up of leverage in both the private sector and the public sector in Europe and the United States to a level which was dangerous. The public sector has got an awful lot to answer for in that build up. For example, Alan Greenspan used to say repeatedly, unchallenged by other economists, that the central bank's role excluded looking at asset prices. Bank regulators allowed not just a build up of debt but a steady expansion of the equity multiplier in banks at the worst possible time. The history of Fannie and Freddie in the US will make great reading when it finally comes out, including the fact that they were contributors to political campaigns. The easing

of standards for access to housing finance in the US will also make good reading. They have an awful lot to account for in why this crisis happened.

In **Phase 2**, the first and correct response – which was well done – was to move the indebtedness from the private sector to the public sector and to add a dose of stimulus. That was needed in many countries in the world but was not needed in Australia. This put huge pressure on government finances which, in many cases, were already stressed.

Phase 3, where I think we are in now, highlights pressure for fiscal consolidation in those governments followed by some debt restructuring. Some countries won't make it. Fiscal consolidation, of course, is really tough and the best example probably at the moment to look at is Greece – for the sheer pain – but Britain, for sheer determination. Britain is determined to get its house in order as best it can.

In **Phase 4** we will get policy choices between fiscal discipline and inflation. Will the US inflate its way out? Many macro hedge fund managers believe that the US will inflate its way out. Also there are some investors prepared right now to pay the US Treasury for inflation-linked bonds.

Phase 5 is a 10 or 20-year work-out period.

So that sets up the starting point. In global finances, the banks have to de-leverage. They have higher capital ratios to

meet. They still have bad debts being worked out on their books. There is a very low demand for credit in the rest of the world and their debt maturities are very substantial and relatively short. Real estate prices are still high, fiscal deficits are high and access to finance will remain difficult.

We have the terms of trade cyclically high and a strong fiscal position going into the crisis, which is why the taxpayer did not incur any losses on the banks. Our growth and unemployment numbers are relatively strong. Unfortunately, government debt, both the State and Commonwealth level, is now rising.

The number that is little discussed is Australia's net foreign liabilities – which are approximately 60 per cent of GDP. That is a high number and it is the vulnerability in the Australian economy that the IMF keeps pointing to. The Economist magazine repeatedly over the years has pointed to a combination of high house prices and high net foreign liabilities. That, combined with the current account deficit, presents a risk and dependency on conditions in the rest of the world.

Trade is roughly balanced at the moment but current account deficit is of the order of \$50 billion a year. Sixty per cent net foreign liabilities is about \$700 billion and the servicing cost on that is about that gap between the trade balance and the current account – a negative three per cent of GDP – which means we've got to find three per cent every year before we start.

National profile

Australia has five per cent of the world's land mass and 0.3 per cent of the global population. That land mass is both large and has immense natural resources. With the small population goes the small domestic market, so developing new things is more difficult.

We are a price taker for commodities. All commodity sellers are ultimately price takers and we are capital-dependent on the rest of the world. We are inflation-prone because a small number of people can't possibly develop the level of resource we have when terms of trade are strong without quickly hitting capacity constraints. This causes the Reserve Bank to pull the handbrake on fairly soon in any growth cycle and – as a consequence, with that capital dependency and the nature of our economy – Australia traditionally maintains higher real interest rates than the rest of the developed world.

However we have an open economy, we have a record of stability backed by rule of law and a strong institutional

framework. On the other hand, we have a high welfare dependency. The issue is handling volatile revenue from commodities while meeting high fixed costs.

The only way to deal with that is to have a higher level of savings, a higher level of reserves.

Opportunities and threats

To me, the issue for the world is not so much climate change, but water and food shortage and the demand for energy caused by population growth. We have a shorter-term opportunity with the remainder of this commodity price cycle and we have opportunities to integrate more with Asia to be part of that region and a contributor to that region.

But what will we have in place when this commodity price cycle changes? In my view Australia has to marshal its water resources and become a quality exporter of food to the rest of the world to have something else to do other than exporting mineral commodities.

The threats are the alternative commodity-providing nations that China and others are promoting around the world. We have an ageing population and a structural deficit, our capital supply is constrained and the contingency program, security, climate and other things detract from productivity. The degree of importance we attach to them can be debated but they detract from productivity. Just as fighting a war detracts from productivity, so the security issue has got to be dealt with, but it is costly.

The prognosis to 2030, given that most of that time will be spent in the workout period of the financial crisis, is that we have a very weak starting point in national savings and there will be a long workout period with these constraints on global financing.

We will only get better living standards from what we put into productivity improvement. Looked at another way, our wish list for infrastructure, contingency items and health care can only be financed from incremental domestic saving in turn sourced from fiscal constraint and productivity improvement. Everything we do from here has to be self-financed and that creates quite significant challenges for us – particularly because that it is not what people think is going on. This will require a far more mature approach to things than we see today in the US and in Europe, where the consequences of debt are being papered over. Our opportunity now is to get hold of this issue while those countries are not – and raise our productivity.

► [MORE ON PAGE 20](#)

Letters to the Editor

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Food manufacturing vital for food security

Securing a food supply much as it is today will rest on a balance of government policies and market mechanisms.



By Geoffrey Annison

geoffrey.annison@afgc.org.au

The threats to food security, particularly at the global level, have been highlighted in the news media many times in the past 12 months. A global population of nine billion people by the year 2050 is predicted.

This is a clear threat to global food security as food demand may outstrip supply. It will be a challenge to feed such an increased population.

An additional factor is the 'nutrition transition' effect. More and more people, as they move into the middle classes, are moving from grain-based diets to meat-based diets.

The diversion of food crops, and particularly grain, from food production into animal feed and into biofuels represent additional threats, as do land degradation, water scarcity, and climate change. Labour shortage is an issue, particularly in some parts of the world and in Australia, particularly for farming systems.

Other challenges, in Australia and overseas, include human, animal and plant disease pandemics which can affect food production and distribution systems. Food security may also be threatened by input shortages, such as, of fertilisers and energy. Geopolitical disruption, war and trade wars and market distortions from speculation in volatile markets – resulting from a fine balance that might exist between the supply of food and food demand – are also issues which need consideration.

It has been estimated that in the 50 years between the year 2000 and 2050 more calories must be produced to meet demand, than were produced in the previous 5000 years. This is against a backdrop of large regions of the planet now, including in Australia, experiencing water scarcity, compounded by the effects of peak oil and peak phosphate (a critical fertiliser) supply predicted in the near future.

Assumptions

In discussing food security for Australians it is appropriate to make some assumptions which are important when public policy options are considered. FAO analyses show that there is sufficient productive capacity around the world to produce enough food for nine billion people. It

will require improved productivities across the production, manufacture and distribution system arising from new technology development and adoption. It will also require appropriate geopolitical management.

A main assumption is that the world can produce sufficient food with the right approaches in developing new technologies. The next assumption is that the range of foods, at least for Australians, will be as available and as affordable (more or less) as at present – that is most Australians will have diets based on meat, dairy, cereals, fruits, vegetables and fish, as is the case now. In short foods will be readily available, affordable, nutritious, convenient and tasty – as they are now.

The key question is how Australia will secure a food supply much as it is today when the challenges facing production systems are substantial and the growth in demand is predicted to be great. The answer is by a balance of government policies and market mechanisms.

Why should Australian governments address food security? The answer is simple. Because food is fundamental to the health and wellbeing of all Australians and it is a fundamental duty of government to look after the health and wellbeing of the community – and food security can no longer be taken for granted.

Food security can also be provided by market mechanisms, but this begs the question – if the issue is so critical, why should market mechanisms also be used to deliver food security? Again, the answer is simple – because markets allow the efficient allocation of resources if they are allowed to operate. Food security will require the very efficient allocation of resources because demand and supply is going to be so finely balanced over the next 20 to 50 years.

The challenge is that more needs to be done with less. So in terms of market mechanisms and resource allocation, to meet its food security demands, Australia will need:

- free flow of capital for investment;
- free flow of goods along the supply chain, no tariffs or subsidies;
- free flow of information to allow market signals, in-

“Food security exists when all people at all times have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences” – UN Food and Agriculture Organization (FAO)

cluding stock availability of products around the world and in Australia to limit speculation; and

- appropriate costing of externalities, including carbon and water costs.

Australia's food security

Australia is a net exporter of protein and calories but makes a relatively small contribution to global food security as a supplier – supporting, in terms of our production volumes, between 60 and 80 million people.

The excess production of agricultural products in Australia results in approximately 90 per cent of the content of food products manufactured in Australia being grown in Australia. Notwithstanding this, the food manufacturing industry relies heavily on specialised food additives and ingredients and processing aids – and a large part of these are imported. Food security in Australia is – and will be in 2030 – heavily dependent upon the import of specific ingredients.

Food manufacturing in Australia relies on global trade. If the ports suddenly stopped operating, a substantial portion of food manufacturing would cease almost immediately. Because Australia has a diverse manufacturing industry and skilled workforce, manufacturing would resume but many products would disappear from supermarkets shelves – for example, all products containing chocolate.

Food and health

Australia has a demonstrably safe food supply. World rankings of food safety were reported last year, which considered levels of food borne pathogens, use of risk

management plans and traceability and recall programs. Australia was ranked No.2 in the world.

Although our food is safe, the rising levels of diet-related chronic, preventable diseases in Australia might be interpreted as indicating it is not nutritious. This is a concern for government, with the levels of obesity and diseases such as diabetes, heart disease and hypertension threatening unsustainable costs to the health budgets in future.

But the food industry is faced with a paradox – there has never been a wider choice of nutritious foods on the market in Australia than there is now – and many are low in fat, reduced salt, high in fibre, etc. And there has never been a greater understanding of the link between foods, nutrition, diet and health. Nevertheless many consumers are still unable to select the diets they need to maintain or to achieve optimal health outcomes. This reflects the paradigm that these health problems are not simply diet-related, but are lifestyle related with many factors playing a role.

Re-engineering the food supply is one approach being developed. No longer is food and nutrition considered simply in terms of providing required nutrients, but rather the new maxim involves the concepts of nutrient balancing, nutrient bundling, nutrient fortification and incorporation of bioactives (such as antioxidants and omega-3s) in foods.

These foods will better assist consumers to make dietary choices providing more than simple sustenance but also enhanced wellbeing, health and fitness. Evidence is gathering that some foods will enhance performance across a range of measures and lower risks of disease. This will require refining of healthy eating messages from variety and balance through to specific dietary guidelines for at-risk population subgroups. The combination of new foods and appropriate marketing will strengthen the ability of the food industry to be part of the preventive health agenda.

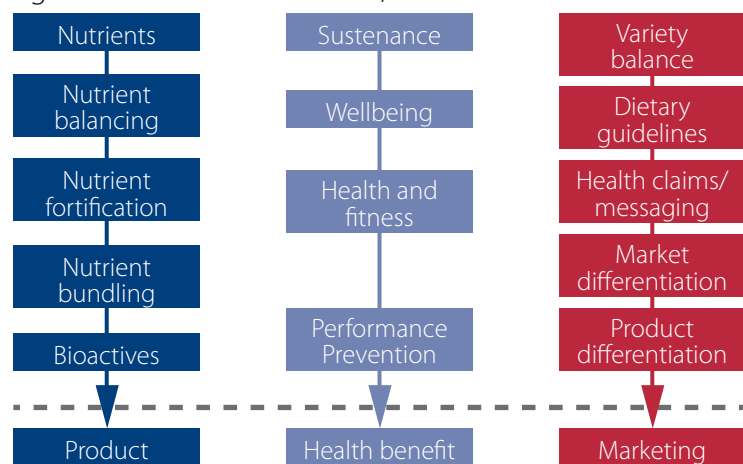
Productivity

Food manufacturing is Australia's largest manufacturing industry (about 21 per cent of the manufacturing sector), employs some 200,000 people, with \$16 billion of exports of processed foods and beverages in 2009-10. But the industry is under pressure from rising input costs, exchange rates, retail sector concentration and business uncertainty – policy and regulatory responses to issues like climate change, water scarcity and preventative health may reduce the attractiveness of the industry for business investment, so they must be well-crafted.

Food security in Australia will be assured by maintaining global trade and a competitive food-manufacturing sector in Australia. A competitive food-manufacturing sector can only be maintained through continuous improvements in productivity.

Australia's long-term productivity growth is decreasing.

Figure 1 Towards better food, better health



SOURCE: AUSTRALIAN FOOD AND GROCERY COUNCIL

Productivity growth in the manufacturing sector, particularly the food manufacturing sector, should be a focus of government policy due to its substantial size and contribution to the economy. Manufacturing still offers great opportunities for increased productivity growth through technological advances, but this requires support for innovation.

Climate change poses the greatest threat not only to agriculture but national productivity if firms are not able to make adaptations to a low-carbon, higher-energy-cost world in their production processes. The changes required to adapt to climate change will require capital investment, which itself will require industry to be profitable, which in turn will require improvements in productivity growth.

Government policies in areas such as climate change should not put Australia's economy or trade-exposed industries at a competitive disadvantage by moving further and faster than other countries.

Overall therefore, food security will be delivered by profitable industries, maintaining their competitiveness through innovation and employing a skilled work force.

Government has a role in shaping the business environment in way that is supportive of industry – the economic argument is that Government should share the risks due to the externalities, both positive and negative, which exist. It also emphasises why government and industry must be working together to create the right policy framework when addressing complex issues such as food security.

Policy challenges

The AFGC has been developing policy positions to ensure the food manufacturing sector is well-placed to play a role in providing food security in Australia. The challenges include:

- the carbon economy and the need to mitigate climate change effects and adapt to them;
- the water economy and the need to reduce use and recycle water;
- securing supply and the need to protect production, manufacture and distribution systems; and
- securing quality and the need to provide safe and nutritious foods.

In addressing these issues comprehensively the food manufacturing sector can make a sustainable contribution to the health and wealth of Australia. In doing so the food industry will continue to provide consumer and customer value propositions allowing consumers to choose foods based on how they will contribute to their health and lifestyles with minimal environmental impact. Industry will provide the sustainable business practices adding value to agricultural products.

Australia has the potential to be a preferred supplier to the world and, therefore, preferred site of manufacture. This, in turn, will enhance Australia's own food security by

The Australian Food and Grocery Council

The Australian Food and Grocery Council (AFGC) is the leading national organisation representing Australia's food, drink and grocery manufacturing industry. The AFGC comprises more than 150 companies, subsidiaries and associates, which constitute about 80 per cent of the gross dollar value of the processed food, beverage and grocery product sectors. With an annual turnover of \$100 billion, Australia's food and grocery manufacturing industry makes a substantial contribution to the Australian economy and is vital to the nation's future prosperity.

Manufacture of food, beverages and non-food groceries in the fast-moving consumer goods sector is Australia's largest and most important manufacturing industry. Representing 28 per cent of total manufacturing turnover, the sector is comparable in size to the Australian mining sector and is more than four times larger than the automotive sector.

The growing and sustainable industry is made up of 38,000 businesses and accounts for \$49 billion of the nation's international trade. The industry's total sales and service income in 2007-08 was \$100 billion. The industry spends about \$3.8 billion a year on capital investment and more than \$500 million a year on R&D. The combined activities added nearly \$27 billion to the economy.

The food and grocery manufacturing sector employs more than 315,000 people, representing about three per cent of all employed people in Australia, paying around \$14 billion a year in salaries and wages.

Many food manufacturing plants are located outside the metropolitan regions. The industry makes a large contribution to rural and regional Australia economies, with almost half of the total persons employed being in rural and regional Australia.

being and integral part of world trade in food.

The AFGC has advocated for a national food and grocery agenda reflecting the need for government to play a leading role in setting the policy framework required for a growing and profitable food industry. This will lead to a robust Australian food and grocery manufacturing industry with clean, green, healthy and safe products with informed and empowered consumers selecting the foods they need for healthy active lifestyles – providing not only enough food but meeting the health and cultural needs of the Australian population into the future.

It is imperative that Australia maintains control of its food supply through support of a resilient supply chain, and a robust domestic manufacturing capability in Australia. ◀

DR GEOFFREY ANNISON is Deputy Chief Executive of the AFGC, which he joined in 2007. He has wide experience in food regulation and innovation, having held senior technical and management roles in the industry in Australia and overseas, in academia, and in public policy. His career has spanned the FMCG sector with Goodman Fielder and the AFGC, the rural sector with organisations such as Australian Pork Ltd and AWB Ltd and research providers such as Massey University in New Zealand and CSIRO, providing him with extensive knowledge of industry issues, particularly the technical challenges in food science, nutrition and health.



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John Shine

Prime Minister's Prize for Science

As a PhD student at the Australian National University, John Shine discovered the importance of a brief sequence of genetic code. At its core are five letters—GGAGG—which tell ribosomes, the protein factories in all living things, to start making a protein. Today's gene sequencers would take a fraction of a second to do the

same job. But John's discovery and his subsequent gene cloning work at the University of California helped kick-start a biotechnology revolution.

Since 1990 John has led the Garvan Institute of Medical Research guiding its growth in staff, budget and stature.

Next year, when he stands down from his leadership role, he will focus fully on research and, with his team, expand their investigation of neural stem cells as potential therapies for neurodegenerative disorders.



Katherine Trinajstić

Malcolm McIntosh Prize for
Physical Scientist of the Year

Three hundred and eighty million years ago, in what is now the Kimberley Ranges, our early ancestors were developing teeth, jaws, limbs, and even a womb.

It was also when many of our oil and gas reserves were laid down. Kate Trinajstić has made this period her own through her discovery that the finest Gogo fish fossils are more than perfectly preserved bones—their muscles and internal organs have also been fossilised. Today she is using synchrotron light and CT scanning to virtually dissect these ancient fossils and discover how fish developed teeth, jaws and a womb.

Her work is crucial not just to our understanding of how life on Earth has evolved and responded to extinction events, she is also helping in the search for new oil and gas reserves.



Benjamin Kile

The Science Minister's Prize for
Life Scientist of the Year

Benjamin Kile is unravelling the secrets of blood in a series of discoveries at the Walter and Eliza Hall Institute for Medical Research in Melbourne.

He has discovered why platelets—the blood cells responsible for clotting—have a short shelf life at the blood bank.

He has also discovered a gene that's critical for the production of blood stem cells in our bone marrow. It turned out that the gene was already well known to science—but as a cancer gene.

These discoveries are just the beginning for this young scientist. Now he is using them to try and extend the life of blood bank products, and to get to the heart of some big questions in cancer. What causes good cells to go bad? How does cancer start?



Managing our water demand in a fickle environment

The great sustainability challenge is to manage the nexus between water and energy. You can't generate electricity without water or pump or treat water without electricity.



By Ross Young

ross.young@wsaa.asn.au

In 2008-09, behind only mining, the urban water industry was the biggest investor in the Australian economy in capital works. This investment has been driven by our drying climate, climate change and our need to adapt very quickly so that our cities don't run out of water.

The steady rise in temperatures over the past century has accelerated the rate of evaporation. The raw material on which our product depends is surface run-off, which has declined dramatically in the past decade.

The Australian map of mean decile temperature for 2009 showed that temperatures over most of the country were above average or the highest on average – another indicator that the country is getting warmer.

Rainfall is more erratic – and the quintessence of managing water resources in Australia is not that we are the driest inhabited continent but that we have the most variable rainfall of all the continents on Earth. That is why managing our water resource in Australia is particularly intriguing.

The national rainfall map for 2009 shows how the lowest rainfall neatly correlates with where the majority of the Australian population lives – on our south-east coast.

Australia has the most fickle and variable rainfall of all the continents. Average rainfall is a meaningless measure. How do you plan a water system when you have such variable inflows? Water inflows into our reservoirs are the X factor in planning for water – and the variability means you never know where you are going to end up.

Climate change has meant that our yields have collapsed, up to 70 per cent in some instances, and there's a marked reduction in runoff due to rainfall patterns changing. In Perth the rainfall has only declined about 20 per cent, but inflows are down by between 70 and 80 per cent.

Population growth is going to continue across Australia and most of the growth will either be in the big large capital cities or the major regional centres. The urban water industry has to accept responsibility to assist stressed rivers.

Water restrictions are not the vision for the urban water industry. Water restrictions cost a lot, they are inconvenient, they are inefficient and – if you have them all the time – when you come across another very dry period you have no other lever to pull. The urban water industry sees water restrictions for emergency cases and not as an ongoing water conservation measure.

The great sustainability challenge is to manage the nexus between water and energy. You can't generate electricity without water and you can't pump and treat water without electricity.

Desalination has been a focus with six desalination plants across five states – completed or under construction – planned to have a total capacity of 525,000 megalitres (ML), with the ability to grow to 715,000 ML. Sydney's Kurnell desalination plant will supply up to 15 per cent of Sydney's water supply by 2015.

Sydney's annual consumption in 2009 was around 400 gegalitres, so the total planned desalination capacity for Australia is about a year and a quarter's worth of water for Sydney – or about 1.9 years at 750 gegalitres.

Desalination hasn't been the industry's only response – a common misconception. The volume of **recycled water** has shown steady growth over the last decade. One point to emphasise is that none of this water has been used for indirect potable reuse – it's all used for irrigation, commercial and industry use, third pipes and golf courses and the like.

Climate change impacts are often characterised just as a reduction in inflows, but every aspect of the urban water in-

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dustry including its assets are impacted by climate change.

For example nobody ever envisaged, when we implemented the very successful demand management programs, what would happen to the **wastewater** system and wastewater flows – which have declined by 50 per cent in some areas because of people using lower volume shower roses and water efficient washing machines. People are diverting their grey water back onto the backyard. There is also less ground water infiltration into the sewers because the groundwater table has dropped, and also there is certainly less stormwater infiltration because it didn't rain.

This combination meant that some of our sewers in parts of Australia were struggling to act and operate properly because they rely on a certain amount of water going through them in order to take the waste away. And it's also meant that the concentration that arrives at the waste water treatment plant has increased dramatically because the loads are exactly the same but the volume of water has decreased.

Australia has the largest **dam capacity** per capita of population in the world. Per capita we store five to six times the water compared to the average European country. London stores only five months of water. If we had a five-month buffer in Warragamba Dam, Australia's largest, Sydney would experience regular water restrictions. Australia needs large dams so we can manage for the variability and fickleness of our rainfall.

There has been an amazing reduction in **household consumption** over the past decade – one of the great social revolutions in urban Australia. The public's response to

water conservation has been really quite amazing. I think this is why climate change has been more of a lightning rod issue in Australia than anywhere else. Too often overseas climate change is characterised in terms of ice melt and sea level rise that impact the future, whereas water restrictions were a tangible manifestation that the climate had changed – and why people had resonance with it.

Australia also leads the world in leakage management. Around the rest of the world the leakage rates can be 30, 40 or 50 per cent. In fact, in the UK they justify their leakage programs not to save water but to reduce their carbon footprint. By the time you pump the water out of the Thames, and put it through a treatment plant, and pump it into your distribution system, you are looking at a quite carbon-rich product.

There has been a lot of public debate about **population growth** in Australia and whether water availability would be a fetter on growth. WSAA's recent report, *Implications of population growth on urban water resources*, estimates (using ABS figures) that by 2056 we will probably need somewhere around 1300 or 1400 gigalitres of water, about three or four times what Sydney uses now. We think that that's quite an achievable figure over that period of time provided we start planning now and adopt new technology and we continue with water saving programs.

Water prices are in the process of doubling around Australia – some prices have already doubled – and some sections of the community are feeling angst. I think that most people are happy to pay a little bit more to have a

◀ FROM PAGE 12

Productivity

The issue for us is that we need to be able to demonstrate that Australians can get an incremental unit of output – that other people can't – out of any piece of equipment we buy from the rest of the world. It is still possible to contribute to productivity relative to others, even if you are using their capital.

Also, we must not overlook the issue of managerial capacity. It is possible to increase productivity by allowing foreign firms to establish manufacturing operations in Australia. If they are good at what they do they will employ people who will then be productive in what they do. So it doesn't matter where the capital comes from if it's affordable. There are many ways of improving productivity. Managerial know-how is generally a soft point for Aus-

tralia and the employment of labour and the skill with which people are deployed in the work force and managed has, in particular, been a fairly soft point.

The productivity agenda is very, very wide and can be pursued to great effect if we put our minds to it.

It will not help if governments legislate on the back of nightly news and the size of some statutes can reach 500 pages. You cannot get productivity improvement when the law is unclear and where the rules are unclear. The important people we employ in the public sector to advise governments can play a large role in the way they provide fearless advice and move forward with shorter and sounder forms of regulation.

In the productivity context, when Aus-

tralia thinks about things it would like to have, it has to ask the question "which ones will be internally self-financing", because they will be the only ones that we will be able to afford. ◀

MR DAVID MURRAY AO joined the Commonwealth Bank of Australia in 1966 and was appointed CEO in June 1992, retiring from this position in 2005. In his 13 years as CEO the bank was transformed from a partly privatised, government-owned bank to an integrated financial services company. Since then he has been Chair of the Future Fund, established to invest budget surpluses to meet the long-term pension liabilities of government employees and take the pressure off the budget from the ageing population. He is inaugural Chair of the International Forum of Sovereign Wealth Funds.

security of supply of their water, and water still is one of the cheapest household outgoings.

The **Murray–Darling Basin** is a key issue for Australia, but it's important to remember that back in 2004 there was very strong support from the urban people, from agricultural people and environmentalists about the National Water Initiative, which envisaged two very important outcomes. One would be that, rather than licences, farmers would be given secure property rights that would enable them to trade with other irrigators and also allow them to trade with the cities – a one-off significant transfer of wealth from the public to the private which would set up a market where water could move to a higher value use. The second, which seems to be forgotten, was the recognition that something needed to be done about the over-allocation of rivers and reducing rainfall.

ABS figures show the gross value of irrigated agriculture in the Basin in 2001, a relatively good year, was \$5.1 billion. Yet during the really bad drought year of 2005-06 it actually increased to 5.5 billion and was 5.1 billion again in 2008. This demonstrates the value of water trading and that those who received water to use in low-value production saw a way out of their financial trouble by selling their water to others who were producing a more value-added product.

ABARES modelling showed that a 3000-gigalitre cut to water allocations would result in about an \$800 million a year reduction in agriculture, assuming farmers took no offsetting measures, and ABARES estimates net job losses

at between 800 and 1200. Nobody wants to lose a job but, compared to the job cuts in other sectors of the economy, these are relatively small numbers.

Water use is the key issue. In both in New South Wales and, in particular, Victoria, flood irrigating pasture is still the largest use of water. There are few other uses of water that are less productive in terms of economic output per megalitre of water. Too often in the cities you hear rice and cotton maligned for the water they use but both of these crops produce many dollars per megalitre consumed.

The irrigation entities don't fully recover all their costs of supplying the water to the irrigators, which means that taxpayers have to front up every decade with dollars to actually reinvest to support irrigation.

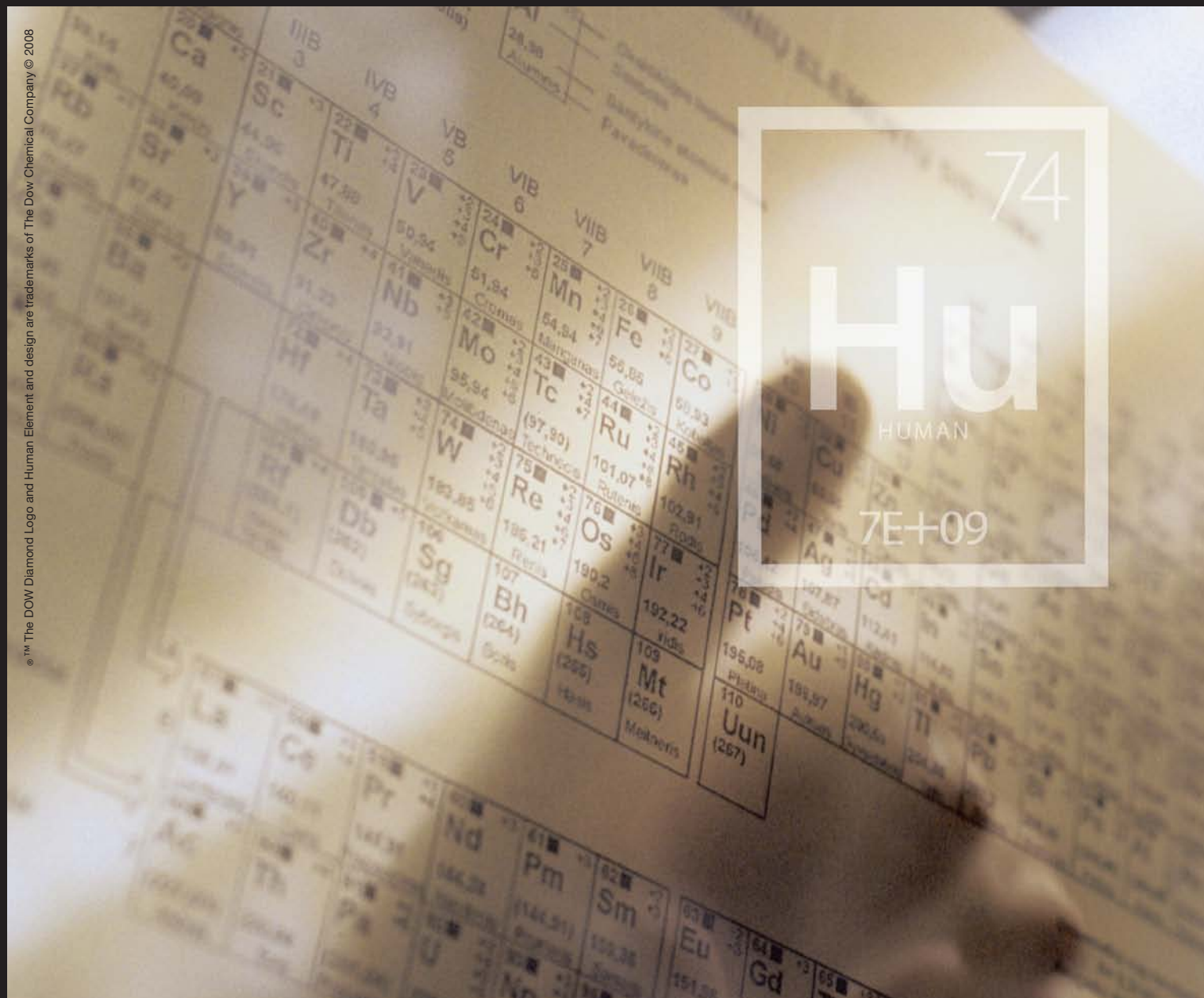
If we were able to push a lot of this low-value production onto high-value production, I don't think we would be having too much of a debate about whether the water was being used properly or not. ◀

ROSS YOUNG is Executive Director of the Water Services

Association of Australia (WSAA), the peak body for the urban water industry, whose members provide water services to 16 million Australians. He has extensive experience in urban water management at a senior level and represents the Australian urban water industry on water policy at the national level. He is Chair of the Global Water Research Coalition Board and a Board Member of WaterAid Australia. He has a Diploma of Horticultural Science, a Bachelor of Applied Science, an MBA and a Graduate Diploma in Natural Resources Law from the University of Melbourne.



The Melbourne grand prix track around the city's Albert Park Lake before the 2009 race during the Black Saturday summer – parched without irrigation.



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Carbon price at the heart of our energy transmission future

When there is a carbon price there will be more investment in the energy sector but there is low confidence on likely dates and policy uncertainty is delaying investment.



By John Howarth

john.howarth@aemo.com.au

Australia has two distinct energy distribution networks for gas and electricity that have grown over time and are very different – and include a number of future uncertainties and challenges for the Australian Energy Market Operator (AEMO) in its role as manager of the Australian energy market.

The foundations of the **gas network** were the Moomba and Gippsland oil and gas fields. In Victoria there was a network which supplied largely the Melbourne area. The Moomba-Adelaide and Moomba-Sydney pipelines supplied Adelaide and Sydney. This situation existed until the early 1990s, together with a small network in Queensland.

Considerable resilience was subsequently added to the network with additional pipelines from Port Campbell to Adelaide, Longford to Sydney and Longford to Tasmania – with the result that the pipeline system was starting to look like a meshed network.

The recent AEMO Gas Statement of Opportunities (GSOO) shows that supply from the traditional gas fields, Longford and Moomba, is dwindling. A major change is the amount of ‘non-conventional gas’ or ‘coal seam gas’ that has been found and brought to production in both Queensland and NSW, which is far greater than the supplies of gas available 40 years ago.

The **electricity network** looks very different. Every state has a basic supply source and transmission between that source and the major load centres. In Victoria there is a strong backbone across the base of the power system, with some of the cheapest supplies from brown coal generation. In South Australia there is some coal generation in the north but a lot of gas generation around Adelaide fed from the Moomba-to-Adelaide gas pipeline. In Sydney, generation is from the coal fields to the north and west of Sydney, coupled with a regional network. In the past 20 years interconnection has been installed between NSW and Queensland and Victoria to SA and to Tasmania, but the interconnected network is fairly young.

AEMO operates the wholesale electricity market in the national electricity market (NEM), the wholesale gas

market in Victoria and retail markets throughout participating states. It also operates new short-term gas-trading market developed in Sydney and Adelaide.

AEMO has the role of National Transmission Planner and it also handles long-term gas and electricity forecasting as part of its GSOO and Electricity Statement of Opportunities (ESOO) documents. These documents analyse the supply/demand balance in both gas and electricity for the next 20 years. We look at developing those markets and we also provide general information on the Gas Bulletin Board, which provides daily information about flows and capabilities of pipelines.

In Victoria we are also the transmission network service provider (TNSP) for the state and we make decisions to augment the network in Victoria, together with the role of managing emergencies – which is quite different state by state.

The maximum demand of the Australian electricity system is about 35 gigawatts – slightly greater than the demand of the US State of Texas – but we service five states, excluding Western Australia.

The average price of the wholesale energy component of your electricity bill is shown in Table 1. For residential customers this represents about one-quarter to one-sixth of the bill; for a large industrial user it is a much higher proportion.

We operate the world’s largest interconnected power system: more than 5000 kilometres, from Port Douglas in North Queensland to Port Lincoln in SA. There is about \$10 billion worth of electricity traded through the electricity market per annum.

The average demand is about 63 per cent of the maximum demand. In the ‘peakiest’ demand states – SA and Victoria – approximately 20 per cent of demand occurs less than one per cent of the time. There is not a lot of usage of the plant that is supplying the top 20 per cent of demand.

Table 1 Average annual price (\$/megawatt hour) for financial year 2009-10

NSW	Queensland	South Australia	Tasmania	Victoria
44.19	33.30	55.31	29.37	36.28

The gas market in Victoria by comparison to other states, in terms of demand, is quite high because it is basically a colder state and it has grown up enjoying the warmth of Longford gas. It uses about 200 petajoules (PJ) a year.

In all Australian states since the mid-1980s there has been a growth of air-conditioning load which has expanded to change all of Australia, except for Tasmania, from a winter peaking demand to summer peaking.

The renewable energy certificate scheme (RECS) that was introduced a few years ago has brought one big change in terms of the generation plant mix to the power system – the number of wind farms connected to the system. There is now about 2000 megawatts of wind connected to the grid across the NEM. The maximum output at any one time has been up to 1250 megawatts. SA is at present preferred by the developers for wind farms because of the quality of resource and other local issues. Tasmania also has one of the best wind resources.

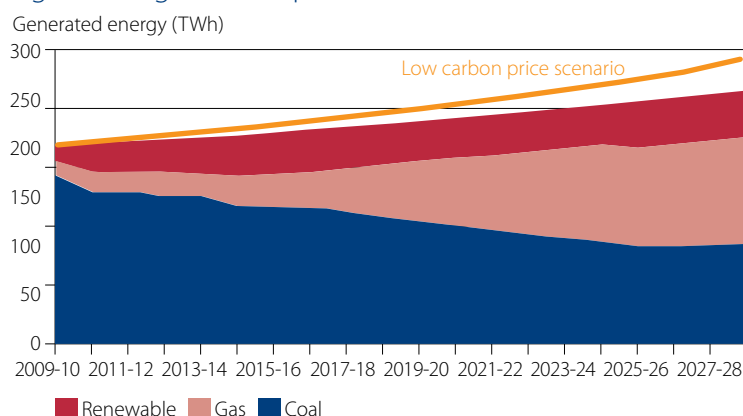
The future

Where are we going to go in the next 20 years as we seek to flatten the load curve and get more from existing infrastructure?

- Electric vehicles – there is approximately the complete demand of the electricity grid in transport energy. There is a big question mark about how you could achieve the shift

The Australian Energy Market Operator (AEMO) is a fairly new organisation, established to operate the electricity and gas markets for the majority of Australians. It has taken over the role of the six companies that on 1 July 2009 became AEMO. They were NEMMCO, the previous electricity market operator; VENCorp, the organisation that ran the gas market in Victoria; ESPIC, the Electricity Supply Industry Planning Council in South Australia; GMC, the Gas Market Company running the gas retail market in NSW; REMCo, the Retail Energy Market Company running the gas retail market in SA; and GRMO the Gas Retail Market Operator which was the Queensland retail market operator. AEMO is overseen by an independent skills-based board. It is 60 per cent owned by the Australian Government and 40 per cent by market participants, with about 40 different member companies. Our mission is to plan, develop and operate markets that are responsive to energy needs and support long-term energy investment in Australia.

Figure 1 High carbon price scenario



of all that demand to the electricity network, but some of it could take the opportunity of using off-peak power.

- Smart meters – what will happen in terms of how they impact customer's bills and what they do for the network?
- Energy efficiency – we are going to see a price rise over the next few years if we get a price on carbon. But the questions are what sort of price rise, what is that going to mean for energy efficiency and what is that going to mean for demand reduction? Although we have a huge resource of nonconventional gas in coal seam gas, the forecasts show a rapid increase in the amount of gas for generation. The only way we are going to reduce the carbon intensity of the stationary energy system is to replace coal with gas in the short term. Some reduction is possible with wind and other renewables but to get from the present 80 per cent intensity factor down to 55 or 60 per cent (as shown by the Garnaut Review of 2008) we really need to use gas to supply a significant amount of electricity in this country. This issue of intermittent energy from some of the renewable energy sources actually makes the job of running an electricity market more difficult. It also makes it more difficult running a conventional generator in terms of having to ramp it up and down more often to meet the volatile demand from customers and the intermittency of wind.
- Energy storage – the Snowy Mountains Scheme is the main storage reservoir where we have pumped storage and Queensland has the Wivenhoe Dam, which is a pumped-storage scheme. These constitute our water-based, large-scale energy-storage facilities. There is a question about whether there are other technologies that can be brought to bear to achieve viability of large-scale energy storage.

Carbon price

Future modelling under a high carbon price scenario covers the growth in demand over the next 20 years and incorporates the continued use of coal, although a high carbon price scenario does drive down the use of coal in the eastern states and most of that is replaced by gas. The rest of it is driven largely by the RECS Scheme and that is a market wedge that builds up in the next few years and then stays constant over the following 20 years. The difference between this and a low carbon scenario is obvious. Because the price is lower you get more growth in energy over that time so there is a fair bit of energy efficiency and reduction in overall demand between the two different scenarios.

The high carbon price scenario is reliant on a couple of technological breakthroughs. Geothermal generation is introduced in about 2024 but it is anticipated it will only become commercial towards the end of the 2020s. Carbon

Growth means transport challenges for Australia

We can make people more comfortable with adopting public transport if we provide better information to them.



By David Singleton

david.singleton@arup.com

It is clear that population growth along the east coast of Australia is going to generate significant transport challenges in the future.

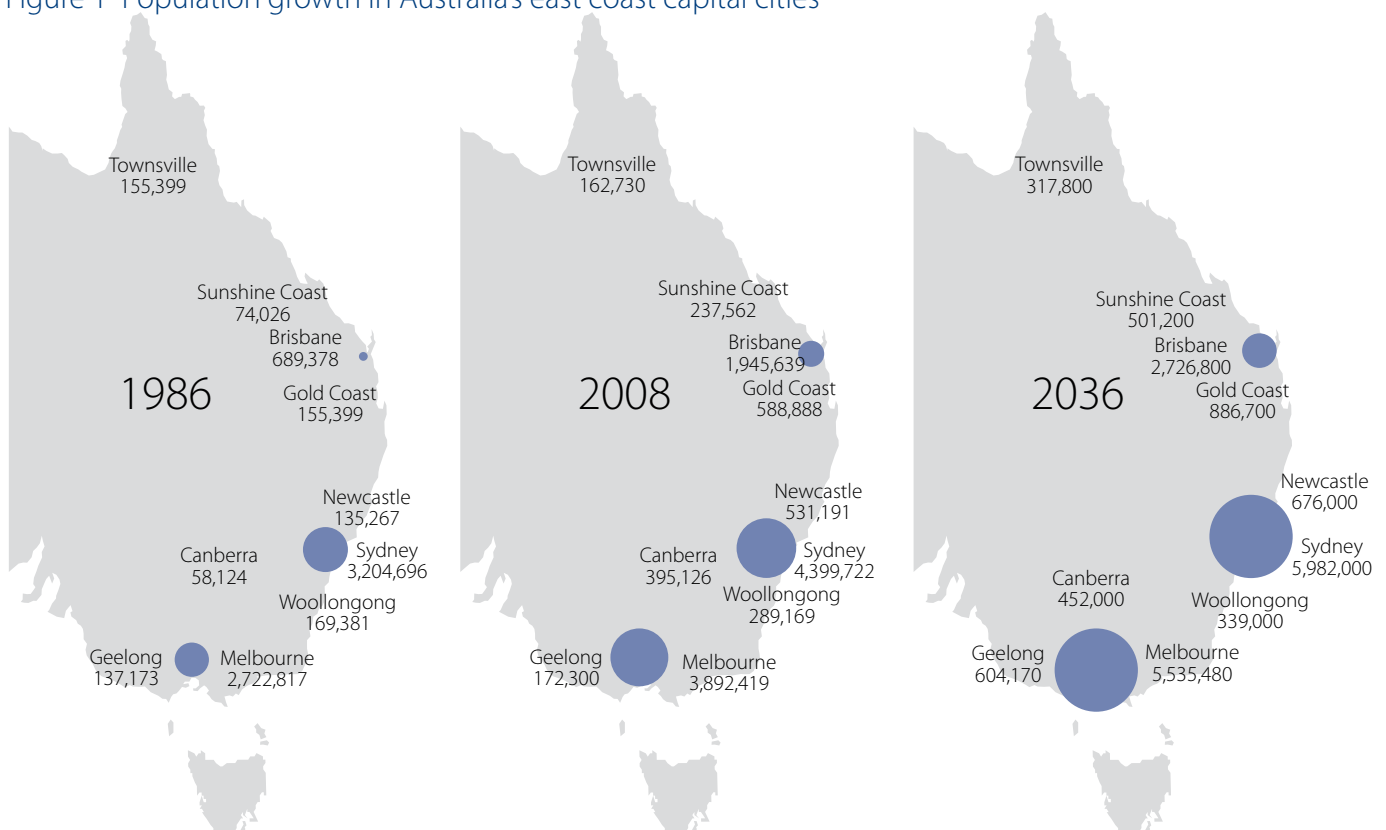
Transport demand and the related infrastructure is not in itself a dictator of the shape of Australia. Transport is a derived demand, but our sustained economic growth depends on maintaining efficient transport networks.

Efficient transport network performance is necessary if the country is to support increases in employment and to maintain or indeed improve productivity. Efficient transport systems provide support to our export activities but there is some evidence that capacity blockages in the transport system are once again constraining our export activities post the Global Financial Crisis.

Australia's transport infrastructure will face increasing demand from several sources. Population growth by 2030 will exacerbate existing network deficiencies and new or upgraded transport links will be necessary. Growth in housing and employment will require new urban development and new and improved transport networks will be required to service those. Finally, intercity passenger and freight movements will increase broadly in line with population growth – therefore air, rail and road interstate links will be overloaded.

The Grattan Institute (*Cities: Who Decides?*, Grattan Institute 2010) reviewed a number of international cities in terms of how successful they were in planning for their future and concluded that the way a city is administered is not really the issue.

Figure 1 Population growth in Australia's east coast capital cities



While it might have been thought that having a single authority would be a benefit, this was not the driver of successful planning for the future. The major contribution to successful planning was the extent to which the public and the community had been involved in the planning process. The extent to which there had been a consistent strategic direction across a number of political cycles was also found to be a factor.

Urban mobility

By comparison to other world cities, Melbourne (76 per cent) and Sydney (69 per cent) have high private car use. This is a result of their urban form, relative inadequacy of public transport and entrenched behaviours.

Solving Australia's urban transport challenge will require a major shift in travel to public transport modes and achieving this will require that special measures be taken.

Transit-oriented development is an approach to urban form evident in various countries. There are a number of successful examples in the US – Portland, Oregon, and the San Francisco Bay Area – and Hong Kong and Singapore in Asia.

In Australia we talked 15 years ago about densification around public transport nodes. The Melbourne District Cen-

tre concept was really an approach to transit-oriented development. More recently, the Melbourne Plan proposed intensifying development along tram routes to try to garner some of the advantages of placing more people close to transport.

Intelligent transport infrastructure provides the possibility that people can be more comfortable with the idea of a public transport solution if we provide better information to them. For example, you learn via your mobile phone that your train has been cancelled and, rather than taking the car out of the garage or seeking a lift, you are provided with information about an alternative public transport solution.

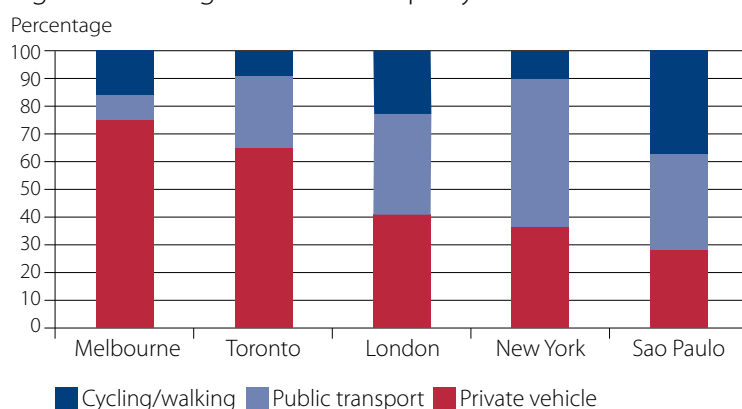
This type of information is going to be increasingly available to us as public transport users and should provide opportunities to encourage transit use. This is going to be critically important as much of our future urban population is likely to be housed on the fringe of the existing city areas, as this may well be the only place where families can afford to buy a home. If these suburbs are poorly served by public transport, families are likely to have to buy either a first or a second car; once they have done that they are unlikely to switch to public transport.

Bicycle transport is going to become a significant transport solution but it will have to be a lot safer than it is now. This is predominantly about how all road users behave.

Pedestrian travel will also become a significant contributor to modal share if people are living closer to where they work or to a public transport route and if we become fitter and are prepared to walk further.

Electric vehicle use will become more significant. Doing something about the emissions from ground transport is essential in a 20-year carbon management scenario and there is no doubt that electric vehicles are going to become a part of how we travel in the cities in the western world. There are already some significant trials of electric vehicles going on around the world.

Figure 2 Average number of trips by travel mode



◀ FROM PAGE 24

Carbon price

sequestration anticipates the proportion of coal growing again at the end of this period to 2030.

The demand side is getting peakier from the air-conditioning load. The supply side is getting less predictable with the current form of renewable, that is, wind and solar. To get the most out of the capital in our networks and generation there is a need to flatten the load curve and to be able to respond to changes in supply side conditions like wind. Storage of energy and shifting the use of energy are therefore focuses for the future.

The current predictions of commercialisation of new generation technologies such as geothermal and geosequestration are highly uncertain. While there is a lot of activity there is little confidence about when they will be brought to a commercial proposition.

Obviously when there is a carbon price there will be more investment in this area but there is low confidence on likely dates at present. Policy uncertainty at present is delaying investment in all these areas and is a potential issue for three or four years in the future in terms of our supply position. ◀

JOHN HOWARTH is Executive General Manager, AEMO, and heads the Transmission Services department, which provides long-term energy forecasts, procures augmentations for new connections and economic expansion in Victoria and provides advisory services to the SA Government. For more than 25 years he has provided solutions in infrastructure planning, energy market design, asset management and control system design. He has been responsible for energy transmission infrastructure planning and developing and implementing a new gas market in Victoria.

Intercity freight

There are already significant intercity freight transport movements between the three east coast pairs of Sydney–Melbourne, Sydney–Brisbane and Melbourne–Brisbane and we know that this freight task is going to grow. Most of that freight presently moves by road, although work is being undertaken investigating an inland freight rail line between Brisbane and Melbourne, which could potentially take a proportion of that road traffic.

Intercity passenger travel

There are significant intercity passenger movements, mainly by air. As a result our airports are significantly overloaded.

The Federal Government has commissioned a feasibility study into high-speed rail and we await those results with interest. It is doubtful whether the country can afford high-speed rail but higher-speed rail must become a more significant transport mode between our capital cities and in the regional development of the states to accommodate the populations that will wish to live there. Regional rail links do not need to be high speed rail but the services must be fast and efficient; rail investments in this context could be feasible.

Looking to 2030

Australia's population growth by 2030 will place a significant strain on existing infrastructure and the built environment. The majority of this population growth will occur in cities, placing further pressure on infrastructure and the resulting urban congestion represents a significant quality of life and productivity issue.

Recent estimates of national infrastructure shortfall places the deficit at between \$450 and \$770 billion and a major component of this is transport infrastructure.

Our standard of living, export performance and productivity are dependent upon access to efficient transport systems. There is a need for transparent investment allocation to sound transport projects that achieve an integrated strategic transport plan for Australia. ◀

DAVID SINGLETON FTSE is Chair, Global Infrastructure, Arup. He has experience in leading the growth and development of the global business of Arup in 40 countries. His career has spanned executive leadership as CEO and Chair of Arup Australasia (1996–04) to his present role as Chair, Global Infrastructure (from 2004). He was a founding member of the Arup Group Board (2001) and has been responsible for the strategic leadership and growth of the global organisation for 10 years. He is a Member of Living with Environmental Change Strategy Board, UK and a Member, Advisory Board, University of Cambridge Program for Sustainability Leadership.

LETTER

TRUTH IN DIAMETRIC OPPOSITES

How two diametrically opposite concepts of reality can sometimes both be true...

The concept of corpuscular theory of light, formulated by Sir Isaac Newton, states that light consists of very small discrete particles, which he called "corpuscles". According to Newton, these minute particles possess kinetic energy and travel in a straight line with a finite velocity through space. This theory also states that light requires no material substance (such as "ether") for its propagation.

This concept was completely different to the wave theory of light, put forward by Christian Huygens, the notion which received little scientific recognition at the time of its conception, due to Newton's great esteem.

In classical physics a particle and a wave have very little in common. In physical sciences a particle is usually described as a very small object, confined to a restricted area, which can possess such properties as volume and mass. By contrast, in science and also in mathematics, wave is depicted as a disturbance which travels through space-time continuum in such a way that this process is usually associated with the transfer of energy.

However, in quantum physics the perception of the wave-particle duality implies that material objects, and particularly sub-atomic particles, exhibit both wave and particle properties. Indeed, the fundamental notion of quantum physics addresses the inability of classical concepts such as "particle" and "wave" to meaningfully describe the behaviour of elementary particles.

A Nobel Prize Laureate in physics (in 1954), Max Born, explains this as follows: "In quantum theory we are only in the initial stage of the developing this concept, and hence I do not have at my disposal words of the language which would enable me to tell you about reality, with which we are dealing."

I wonder, if we take the chaos and the catastrophe theories in consideration, is it possible that some of the opposing views of the causes of climate change will both be true?

– PROFESSOR ALEK SAMARIN, FTSE

LOW-CARBON ENERGY RESTS ON ELECTRICITY

The financial viability of low-carbon electricity-generating technologies to offset reducing greenhouse gas emission targets will require electricity prices to rise substantially over time and imply a price on carbon that escalates as targets are tightened.

This was a key finding of an Academy report launched in December by the Minister for Energy, Martin Ferguson.

The report – *Low-Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia* – led to a wave of publicity across Australia in all media forms. It coincided with a Government debate on whether nuclear energy should become part of Australia's energy options, although the ATSE report mentioned nuclear energy as only one of the options available to Australia.

The report says with increasing prices for electricity and carbon emissions, a portfolio of low-carbon technologies can economically be deployed over time. No single technology has pre-eminence and different circumstances will determine the optimum choice low-carbon energy generation for a specific place at a particular time.

The report's findings rest in part on a new method of calculating which of the suite of low-carbon energy sources might prove most attractive in the future. It explores the usefulness of a financial tool, Net Present Option Valuation (NPOV), in supporting investment decision-making. NPOV complements the more traditional calculation of future Levelised Costs of Electricity (LCOE). It is more amenable to incorporating uncertainties and variations in future technology costs and carbon prices and to understanding their impacts.

Both the LCOE and NPOV results support the need for higher electricity prices and an escalating carbon tax to achieve future financial viability for low-carbon generating technologies.

NPOV indicates that an investment of some \$10 billion in the period between now and 2030 to 2040 is justified in support of

Martin Ferguson (right) and Peter Laver before the Minister launched the report.



alternative technologies through further expenditure on RD&D, infrastructure, development of regulatory regimes and the like, the report says – noting further work is required to validate this estimate.

ATSE suggests that further work be conducted to demonstrate the validity of the NPOV model developed in this study and to extend its application to generation sites and hubs, as well as to technology-specific studies.

The report shows that both the LCOE and NPOV methods indicate that only a few of the low-carbon technologies have a significant net present option value in 2020 – including wind, low-cost geothermal and combined cycle gas turbine.

By 2030, the NPOVs increase – gas-fired technologies including carbon capture have the highest values. Wind and nuclear also have moderately high NPOVs in 2030. Solar and coal-fired technologies, including those with carbon capture, have low NPOVs.

By 2040, all the technologies, with the exception of coal firing without carbon capture, have significant NPOVs. The highest NPOVs are associated with combined cycle gas plus carbon capture; wind; low-cost geothermal; solar thermal with central receiver; and nuclear.

Coal-based carbon capture, solar photovoltaic and regionally higher-cost geothermal technologies have moderate NPOVs, but NPOVs close to zero in 2040. Sensitivity analysis shows that with further

technology development, the latter values could become positive for these technologies. Combined cycle gas turbine has a high net present option value due to gas price uncertainty in 2040, but its net present value is negative for investment then due to the high CO₂ price imposed.

The Report launch was followed by a technical seminar on the topics covered in the report, with presentations by Dr Burgess and:

- Professor John Kaldi, Chief Scientist CO2CRC (Carbon Capture and Storage);
- Dr Bruce Godfrey, Chair of the Australian Solar Institute Research Advisory Committee (Solar); and
- Dr Cameron Huddleston-Holmes, Geothermal Stream Leader, CSIRO (Geothermal).

The Low-Carbon Energy project was funded by the Australian Research Council's Linkage Learned Academies Special Projects (LASP) scheme. It was supported by TRUenergy, the Energy Supply Association of Australia (ESAA) and the Victorian Government Department of Primary Industries. The Principal Author was Dr John Burgess FTSE, former head of research for BHP and later BHP's Vice President – Safety, Environment and Technology.

ATSE Vice President Mr Peter Laver introduced Mr Ferguson and Professor Mary O'Kane, a Director and Vice President since 1 January 2011, thanked him.

In the first 24 hours following the release

AND CARBON PRICES

of the report ATSE noted 251 downloads of the report to date and 231 hits on the media release posted to the ATSE site. In the first week the report was downloaded 540 times.

Mr Ferguson said the ATSE report came at an important time for Australia's energy sector and he welcomed this contribution to the current debate.

"ATSE's report brings an investor's perspective to the analysis of technology choices we will face out to 2040," he said.

"The report helps us understand the implications of policy and technology uncertainty on investor choices and the associated risks. The simple reality is that the market share of clean energy technologies will increase as their costs come down.

"We also need the right market frameworks and targeted support from Government to encourage R&D, demonstration and commercial deployment of promising technologies.

"ATSE's report calls for focused research, development and demonstration programs to accelerate the commercial deployment of new power generating technologies. Only a range of technologies will ensure our future energy security, and help us reduce greenhouse gas emissions."

Australia could not pin its hopes on one technology, Mr Ferguson said. "We need to test all technologies if we are to achieve the required investment outcomes.

"The right regulatory frameworks will

also play a key role in bringing about energy technology investment.

"The key reform we need now to ensure investment continues to be delivered in the energy sector – is a price on carbon. Until a price is put on carbon Australia's energy sector will continue to face uncertainty – and this uncertainty will hold back key investment decisions.

"We must be mindful that reducing emissions will not come without cost. However, it is also important to note that factors affecting current electricity prices are largely being driven by the need for increased investment in electricity network assets.

"Significant capital investment is required to replace ageing network infrastructure to meet rising demand and to ensure a reliable electricity supply for customers," he said.

"The challenge for all governments is to get the balance right in reducing emissions in a manner that does not impose an unreasonable burden on the community or industry. As their costs decrease over time, new energy technologies may hold the key to making both possible.

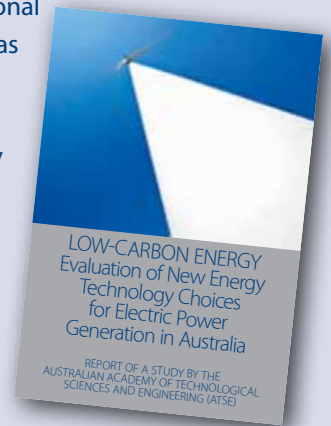
"Developing a broad suite of technologies is critical to the future of our energy sector.

"I thank the Academy for its contribution to the knowledge base, through this new report.

"Australia is fortunate to have so many energy options – both fossil and renewable, and some with potential we are only now beginning to realise. You are part of an exciting

future for energy technology in Australia," Mr Ferguson concluded.

The report, *Low-Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*, has since been introduced to audiences in Sydney and Brisbane at ATSE divisional events and was the topic of the inaugural Parliamentary Briefing in South Australia, organised by the ATSE SA Division.



New report on power cost comparisons

The Academy has completed a new report, *New Power Cost Comparisons*, for the Garnaut Climate Change Review, which deals with Levelised Cost of Electricity (LCOE) for a range of new power-generating technologies.

This report, commissioned by the Garnaut Review, was undertaken by Dr John Burgess and built on earlier work leading to the launch last December of the major report *Low-Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*.

The report notes that LCOE, which is used as a common cost measure for testing financial viability of power generation, is calculated for a range of emerging power generation technologies using a financial model developed for ATSE's *Low-Carbon Energy* report.

This methodology allows data originating from different sources, in particular from ATSE's *Low-Carbon Energy* report and from earlier reviews from Garnaut and the Treasury, to be compared on a common basis, and recent cost trends to be identified.



ATSE HOSTS GREEN GROWTH WORKSHOP

Leading Australian and Korean researchers, industry and business leaders and government officials met in Melbourne in March for a two-day workshop on green growth options and the impact of low-carbon energy in both countries.

The Australia Academy of Technological Sciences and Engineers (ATSE) – supported by the National Academy of Engineering of Korea (NAEK) – held the second international workshop Australia Korea Green Growth, which followed the first bilateral workshop held in Seoul in April 2010.

The 14-member Korean delegation was led by Professor Jong Kee Yeo, Executive Vice President and the ATSE President, Professor Robin Batterham AO FREng FAA FTSE, hosted the visit.

Its purpose was to inform Government, industry and the research community of the potential to pursue a coordinated Green Growth policy in Australia.

Australian and Korean speakers at the



Dr Joon-Hyun Lee and Professor Frank Larkins in deep discussion at the workshop.

workshop were drawn from universities, research centres and industry. High-level speakers were drawn from both countries and included Dr David Brockway FTSE, Director, Global Energy, CSIRO, and Professor Veena Sahajwalla FTSE, Director of Sustainable Materials Processing Program, UNSW.

The workshop was supported by the Australian Government and the Australia–Korea Foundation.

Speakers at the Plenary Session, chaired by ATSE Vice President Mr Peter Laver AM FTSE, which preceded the workshop were:

- Dr Terry Cutler FTSE, Chair of the Review of the National Innovation System – ‘The Imperatives Driving Collaboration’;
- Mr Martin Hoffman, Deputy Secretary DRET – ‘Australia – transitioning to a low carbon future’;

- Dr Joon-Hyun Lee, President, Korea Institute of Energy Technology Evaluation and Planning – ‘Current Status and Perspectives of Green Energy Technology Policy in Korea’; and
- Mr Michael Schwager, Head of Division, Industry and Small Business Policy, DIISR – ‘Green growth – Innovation driving the transition to sustainable development’.

ATSE Fellows and staff were heavily involved in the event and the site visits that preceded it. ATSE Fellows included session chairs Mr Martin Thomas AM FTSE, Dr John Wright FTSE, Dr Mike Sargent AM FTSE, Dr Graeme Pearman AM FAA FTSE, Dr John Sligar FTSE.

The Victorian Chief Scientist, Energy, Professor Frank Larkins AM FAA FTSE, hosted a dinner on behalf of the Victorian Government in conjunction with the workshop.

ATSE OPPOSES HUMAN GENE BILL

A Private Members’ Bill before the Australian Senate would have unintended negative consequences for the scientific research and the quality of medical products and care in Australia, ATSE has said.

In a submission to the Senate Inquiry into the Patent Amendment (Human Genes and Biological Materials) Bill, ATSE said the proposed amendment would not rectify the concerns of Senators expressed in the proposed Bill and would be likely to have the opposite effect.

The Bill in its current form would have unintended consequences arising from some of the proposed wording.

ATSE contended that there would likely be several serious negative consequences if the

Bill were passed, including:

- contravention of international agreements;
- inhibition of scientific research;
- loss of Australian competitive advantage;
- loss of investment;
- reduction in the quality of medical products and medical care available to the Australian community; and
- longer patent examination times and increased litigation.

ATSE recommended that the Senate reject the Bill and replace it with modifications to existing patent legislation that:

- establish the research use exemption for non-commercial research;
- tighten terminology so that Australian

patent laws and examination practices are consistent with and as rigorous as those of our trading partners; and

- do not define additional categories for exclusion, since these would lead to legal arguments over terminology, delays and increased patenting costs.

ATSE also recommended that measures be initiated at IP Australia to ensure rigorous patent examination practices that limit claims to those which are truly inventive, novel and useful.

ATSE said proposed changes to patent laws outlined in various reports (including the 2004 Law Reform Commission Report, the Advisory Council on Intellectual Property (ACIP) *Report, Patents and Experimental*

ATSE COMMITS TO PROMOTE WOMEN

The Academy has taken firm steps to promote women's roles in technological sciences and engineering – both within the Academy and nationally.

The Academy has approved a Gender Equity Policy which "recognises that more direct action is needed to address the gender imbalance both within the Academy membership and its

**Susan Pond, leading
ATSE's gender equity
initiative.**



activities as well as more broadly in promoting women in senior level in technological sciences and engineering in Australia".

In reaffirming its commitment to the importance of the full participation of women in technological sciences and engineering in Australia, ATSE's Gender Equity Policy says:

- Women constitute a wealth of talent and creativity. Research Institutes, academia, business and government need to adopt mechanisms that enable women in technological sciences and engineering to thrive and excel and be recognised so they can actively contribute to evidenced-based policy advice in addressing the key national challenges facing Australia's prosperity and wellbeing – now and into the future; and
- Maximising participation of women at all levels in technological sciences and engineering is a priority in terms of maximising productivity and innovation in Australia, as well as seeking social equity.

ATSE has committed to promoting women within its own organisation and to focus more broadly on career development of younger women, engagement with other organisations on gender equity issues

and promotion of women in technological sciences and engineering across Australia.

ATSE has appointed an Advisory Group from its Fellowship to advise its Board on gender equity issues and to work with Vice President, Membership and the ATSE Chief Executive Officer, Dr Margaret Hartley, to provide advice and direction on implementation of the Policy.

Its members are Professor Susan Pond AM FTSE, Director of ATSE and Commercialisation Australia (Chair); Professor Lyn Beazley AO FTSE, WA Chief Scientist; Professor Edwina Cornish FTSE, Deputy Vice Chancellor, Monash University; Dr Kathy Hirschfeld FTSE, Member of the Queensland University Senate; Professor Mary O'Kane FTSE, NSW Chief Scientist and Scientific Engineer; Dr Leanna Read FTSE, MD and CEO, TGR Biosciences; Professor Margaret Sheil FTSE, CEO Australian Research Council; and Professor Judith Whitworth, AC FTSE, Chair, WHO Global Advisory Committee of Health Research.

ATSE issued a media release on 7 March on its Gender Equity Policy to mark International Women's Day (8 March) and the conclusion of the 55th session of the UN Commission on the Status of Women (4 March).

Use, October 2005 and its subsequent discussion paper and the report of the Senate Community Affairs Committee, November 2010) would make the Australian patent system more consistent with those of our important trading partners.

ATSE strongly supported these proposed changes, provided they gave much greater clarity to all parties than currently existed, ATSE said.

Recommended measures included:

- research use exemption;
- higher thresholds for utility, novelty and invention, including requiring evidence of significant usefulness, revising descriptions of how "prior art" is defined and more closely defining "obviousness"; and

- requirement for full description of the invention such that similar work could be carried out by others to obtain the same outcome.

The world-renowned co-inventor of the cervical cancer vaccine, Professor Ian Frazer FAA FTSE, also opposed the proposed legislation. "The Bill if enacted would actually prevent much development of novel products of biomedical research," he said in a submission.

"It would remove much of the patent protection that currently can be granted to the inventor of a method of manufacture of a material that is "substantially identical" to something that exists in nature, but could not be manufactured without a novel

and inventive method, and which once manufactured would be of potential utility in industry or in health care.

"One consequences of the enactment of the Bill would be to provide yet one more incentive for Australia's biomedical research talent, and biotech industry to move overseas," said Professor Frazer, Australian of the Year in 2006 and winner of numerous national and international awards, including an ATSE Clunies Ross Award in 2007.

**The ATSE submissions is at
[www.atse.org.au/atse-in-action/
acting-nationally/policy-advice-a-
debate/submissions](http://www.atse.org.au/atse-in-action/acting-nationally/policy-advice-a-debate/submissions)**

STRONGER INTERNATIONAL LINKS IN GERONTOLOGY

ATSE has strengthened its international links in gerontechnology following a program of workshops and visits in Taiwan in October 2010.

The ATSE Report, *2010 Taiwan-Australia Bilateral Cooperation in Gerontechnology: Workshop and Visits*, details the October engagement in Taipei and is available on the ATSE website.

The program was supported by the National Science Council of Taiwan and the Department of Innovation, Industry, Science and Research (DIISR), organised by National Yang-Ming University and the ATSE. The workshops were organised by Professor Greg Tegart AM FTSE (Australia) and Professor Sai-Wei Yang, Head of the Department of Biomedical Engineering at Yang Ming University, Taipei (Taiwan).

Since 1992 there has been an active linkage between Australian and Taiwanese scientists and technologists under the agreement between the Academy of Science, ATSE and the National Science Council (NSC) in Taiwan. In response to a request from NSC in mid-2010 to broaden the scope to include gerontechnology in these exchanges, ATSE organised a delegation of 11 Australians led by Professor Tegart to Taiwan from 24 to 29 October, 2010.

Gerontechnology is the combination of medical aspects of ageing (gerontology) with technology to assist daily living. Gerontechnology matches technological environments to the health, housing, mobility, communications, leisure and work of older people and aims to promote human health and wellbeing. It draws together a range of disciplines from engineering, materials, nanotechnology, biotechnology, information technology, biomechanics and cognitive science and links them with social issues, ethics and design.

The exchange followed ATSE's launch in July 2010 of a major report on technology and ageing, *Smart Technology for Healthy Longevity*.

The interest in gerontechnology in Taiwan reflects the Taipei Government's identification of health care as one of the six emerging industries in the country, along with biotechnology, green energy, intensive agriculture, tourism and cultural creativity. This concentration on health care is also driven by the rapid demographic changes taking place in Taiwan, leading it to have an elderly population of more than 20 per cent by 2020 compared to the current 10 per cent – already high by world standards.

A two-day workshop was held on 25 and 26 October at Yang Ming University involving a matching number of Australian and Taiwanese researchers followed by two days of visits to

hospitals and institutions around Taipei. The workshop program was structured to exchange information and experiences on the challenges of ageing in both countries and the framework for application of technology, followed by studies on biomedical engineering for the aged, biomaterials applications for the aged, and ICT applications for the aged.

It emerged that while there are significant differences between the political, educational and research systems between the two countries, there are a number of clear messages for Australia which reinforce the recommendations in ATSE's *Smart Technology for Healthy Longevity* report.

First, the changing demographic change in both countries will lead to an increase in the numbers of long-lived persons with



Greg Tegart addresses the conference.

SMART TECHNOLOGIES FOR AGEING-IN-PLACE ARE

ATSE has urged the Productivity Commission to explicitly encourage an increased national focus on the RD&D, commercialisation and wide-scale deployment of smart enabling technologies to enable older Australians to remain in their homes for as long as possible.

The Academy also urged the provision of cost-effective solutions to meet the needs of an ageing population and address the projected shortfall in the number of healthcare professionals.

ATSE made these points in its recent submission to the Productivity Commission Draft Report *Caring for Older Australians*.

The Academy response, *Ageing-in-*

place: Living well with enabling technologies, recognises that the Productivity Commission's proposed new funding mechanism has the potential to facilitate the uptake of technologies that can enable "ageing-in-place" – the maintenance of older individuals safely, securely and happily in their own homes.

But ATSE remains sceptical, the submission says, that the proposed new funding base is sufficient to enable widespread and rapid uptake of technology and to deliver the consequential government savings.

ATSE firmly believes that technology will be the key driver in ensuring a high quality of life and cost-effective care for older Australians.

The submission suggests that the Productivity Commission:

- sets out strategies for the Australian Government to facilitate the rapid, wide-scale deployment of technology for the ageing population, in order to capture the benefits of the proposed new funding model;
- commissions a study to quantify the potential savings which can be delivered through ageing-in-place, enabled by smart technologies;
- recommends to governments that ageing-in-place through the uptake of smart technologies is demonstrated through

increased health and disability problems. This change is occurring more rapidly in Taiwan than in Australia and will lead to a shortage of carers and the need for new models of care.

Technology can offer possible solutions to issues of safety and security, diagnosis and treatment, and assistive technologies.

Second, there is a need for a national strategy to ensure a coordinated approach to the development and application of technologies to deal with the challenges of an increasing aged population. Taiwan is further advanced in this direction than Australia.

Third, the implementation of such a national strategy needs to be underpinned by continuing research in priority areas and by translation of successful research into commercial products. Taiwan is well advanced along this path with strong national programs

Fourth, Australia needs to cooperate internationally to gain access to new concepts and equipment. Given that Australia and Taiwan are of similar population size, there are clear opportunities for collaboration with synergies between Australia's stronger clinical and research activities and Taiwan's ability to prototype and rapidly commercialise low-cost, high-volume products.

Fifth, there is a need to develop training in gerontechnology in Australia, either through postgraduate courses in gerontechnology. Taiwan has already established several of these and their operation needs to be examined.

NEEDED

large-scale trials and studies in order to better understand the potential of smart enabling technologies to improve quality of life and deliver financial savings in Australia: and

- alerts the Australian Government to the need for strong national coordination of research, development and demonstration of smart technologies for healthy longevity in Australia and the need to develop a trained workforce to ensure their successful application.

ATSE SURVEYS FELLOWS ON NBN ISSUE

A recent survey of more than 100 ATSE Fellows has shown there is a broad range of views ranging from strong support to strong opposition for the establishment of the proposed National Broadband Network.

Those favouring the proposal said the NBN benefits mainly related to the availability of quality high-definition video and the ability to transfer massive amounts of data quickly.

Those opposing it questioned a major Government investment in an NBN – principally for technical, financial or policy reasons.

The survey, conducted informally, sought to establish the views of Fellows on the opportunities and challenges an NBN would present to the nation.

Those surveyed who support the concept said the main applications would be:

- in telemedicine, where people could receive high-quality medical services in their own home, with rural and regional Australia particularly benefitting from specialist services otherwise difficult and expensive to access;
- in research, where researchers in a range of data-intensive fields could efficiently access resources from around the world;
- in education, by providing access to real-time laboratory and practical demonstrations to enhance the student experience and provide cost savings on equipment and people;
- in supply chain management and customer relations, by vastly improving video exchanges with speeds seen by business as necessary to enhance competitiveness to match those available internationally;
- in rural Australia, by providing better access to services and communications;
- for farmers, who anticipate better integration of meteorological, environment and market information;
- in smart grids, which hold the prospect of major efficiency benefits for electricity (and possibly water) distribution in which the massive amount of data transfer and management involved makes them reliant

on the capacity provided by an NBN; and

- in cloud computing, where continuous high-capacity broadband is seen to be essential if its full capability is to be realised.

Other applications identified included assisting disabled people to access services and work, improving biosecurity, monitoring buildings and structures for enhanced performance, providing better traffic management, enabling international collaboration on design and construction, improving disaster recovery and more efficiently delivering government services.

The supporters said real-time high-definition video would enhance leisure and entertainment experiences.

They noted the ever-accelerating use of the wireless spectrum mainly for mobile devices would before long create capacity problems and there would be a need to migrate band-width rich applications such as HD video to a fixed high-capacity network.

Many believe that the availability of the NBN will in itself generate innovative uses that are unable to be conceived at present, in the same way that less than a generation ago nobody would have imagined the applications that the Internet has generated.

On the other hand, many ATSE Fellows question the major Government investment in an NBN. Their reasons included:

- the cost is seen as unaffordable and, if funding was available, it could be applied to far more productive purposes;
- based on past experience they lack of confidence that construction of this type of infrastructure by a public authority would be within promised budget and timelines;
- the benefits from the proposed NBN have been wildly overestimated;
- the current ADSL2+ is seen as quite adequate and capable of further improvement – and the incremental advantages of the higher speeds of the NBN are very small;
- considerable scepticism about whether

The submission is on the ATSE website.

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FEWER TRANSMISSION TOWERS FOR BROADBAND?

The Broadcasting

Australia tower at Willis

Hill near Smithton,

Tasmania, site of CSIRO's

Ngara wireless access

field trial.

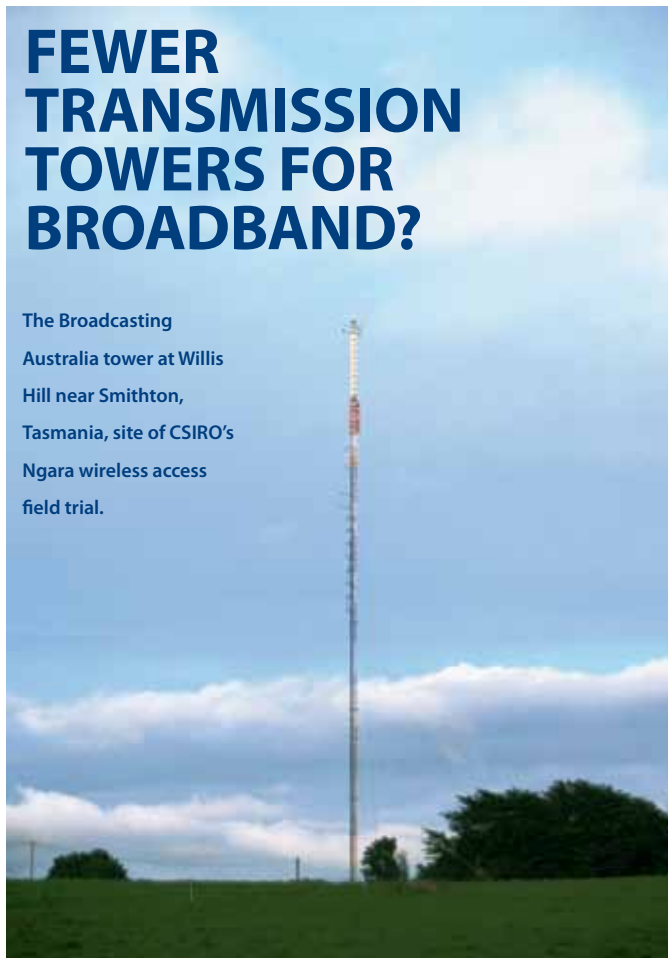


PHOTO: CSIRO

CSIRO is developing wireless broadband technology that could operate using barely a quarter of the number of transmission towers required by current systems – a potential boon for people living in rural and regional Australia.

“Analysis we’ve commissioned shows other wireless technologies, which typically operate at higher frequencies, would require four times as many towers,” CSIRO ICT Centre Director Dr Ian Oppermann said.

CSIRO’s first prototype Ngara access system currently gives six simultaneous users 12 megabits per second (Mbps) from the network to their home and 12 Mbps from their home to the network.

“We feel symmetry is important as people interact more using bandwidth-hungry applications such as video conferencing – they could

be working from home, participating in a lesson or visiting their doctor online,” Dr Oppermann said. “Current wireless technologies are not designed to allow uploads and downloads at the same rate and making them symmetrical would likely mean even more towers.”

CSIRO’s Ngara technology aims to bring wireless broadband access to people living beyond Australia’s planned fibre network using existing broadcasting infrastructure and UHF spectrum, such as that left behind when Australian TV goes 100 per cent digital.

At 20 bits per second per Hertz (20 b/s/Hz), Ngara is one of the most spectrally efficient in the world. The 12 Mbps, six simultaneous user system works in the space of one television channel, which is seven megahertz (MHz) wide. During recent field-testing from a Broadcast Australia tower in Tasmania, CSIRO’s low-power prototype system operated over distances up to 16 kilometres.

CSIRO, NICTA JOIN FORCES IN ACBI

The NSW Government has invested \$7.5 million in the Australian Centre for Broadband Innovation (ACBI) at the headquarters of CSIRO’s ICT Centre at Marsfield in Sydney. ACBI will establish a large-scale testbed network of fibre, wireless and satellite. From its beginnings in Sydney, ACBI will grow to have a national footprint and will work with industry to deliver breakthrough broadband applications.

“With ACBI’s broadband network we’ll take the broadband applications we’re developing out of the lab and bring them into the real world. We’ll test our applications with real people, over a real network, bridging real distances between real towns,” the Director of CSIRO’s ICT Centre, Dr Ian Oppermann, said.

“We are very pleased to have this funding support from the NSW Government to help research and trial new technologies for a high-speed broadband network,” said Dr Terry Percival, NICTA’s Neville Roach Research Laboratory Director. “We are also proud that Australia’s two leading Information Communications Technology (ICT) organisations, CSIRO and NICTA, are working together on this exciting new initiative and bringing industry on board.”

ACBI will focus research initially in four areas: smart infrastructure, digital media and health, education and government services.

◀ FROM PAGE 33

the main potential beneficiaries in regional and rural Australia will see much change – as these communities will be in the seven per cent of the population which will not be able to access the NBN and will have to put up with services little different to those currently available;

- concern about obsolescence – rapid technology change in the ICT field may

make the NBN obsolete before it is rolled out; and

- other alternatives to the NBN exist, including further improvements to ADSL2+ and new developments for wireless.

This group suggests the public interest may be better served by defining a requirement and letting the market satisfy it with whatever mix of technologies is deemed most appropriate.

Reaction to the need for a detailed cost/benefit study were mixed, ranging from it being an absolute necessity to a belief that it would be inappropriate for projects of this nature and – in any case – the debate would merely move to questioning the underpinning assumptions by anyone dissatisfied with the outcome.

The ATSE Board reviewed the survey at its February meeting.

Only carbon fools rush in



By Ziggy Switkowski

If the 100-year trend of global warming continues, then computer models predict a climate future with many undesirable features. They include much increased volatility with more severe and catastrophic weather events, extended droughts, intense bush fires, unreliable rainfall, severe floods, mighty hailstorms, devastated agriculture, rising sea levels, species destruction, melting icebergs, receding glaciers, bleached coral reefs and more.

Accepting, as I do, that the current warming substantially arises from global greenhouse gas emissions from the burning of fossil fuels, efforts to reduce production of carbon dioxide and other GHGs are appropriate.

Does this mean that our government's current attempt to price carbon is a good thing? Well, it depends.

Australia produces nearly 600 million tonnes of CO₂ (equivalent) annually contributing 1.4 per cent to the global load of around 45 billion tonnes. If we reduce our emissions by five per cent will the frequency or severity of our cyclones reduce? No.

If we reduce emissions by 40 per cent will the average three millimetre per year rise in coastal sea levels fall? No. If we shut down our energy systems completely (and our economy), will our coral reefs improve? Well, no.

So, which part of our environment is protected by our carbon reduction strategy? None.

Will any environmental indicator be measurably affected by reductions in Australia's GHG output? None that I know of.

Because global warming is driven by aggregate emissions, little Australia does can have a meaningful impact upon our climate unless supported by similar action around the world. That's just a statement of the relatively small size of our economy in a global context.

Of course, if other countries were to take a similar parochial approach, then by the end of this century the world might become an unfamiliar, climate unfriendly place and a difficult challenge for our grandchildren's children.

At the same time, action by Australia unaccompanied by

Finding energy alternatives –
injection well at the CO2CRC
Otway Project exploring carbon
capture and storage.



similar efforts by the major emitters (China, the US, European Union, Japan, Russia, India and Brazil make up 80 per cent of global output) can be only symbolic, especially while the big emitters are not yet acting in a coordinated way.

But worse still would be unilateral action that negatively impacts our economy for no apparent benefit – the unjustified geopolitical vanity of Kevin Rudd's original strategy.

Still, the introduction by Australia of a carbon price which then morphs into an emissions trading scheme will:

- add support for a unified global emissions reduction framework;
- prepare Australia for a future with mandatory carbon limits enforced by punitive international trade rules;
- raise funds which could be directed to more research and development of clean energy;
- stop investment in new coal fired power stations; and
- increase federal revenues, just as a tax would.

Some of these points need further elaboration. For example, Australia mines about 350 million tonnes of coal annually, with nearly 100 million tonnes used domestically

and the rest exported. Global demand is close to six billion tonnes, dwarfing our production volumes, and it's an interesting coincidence that our domestic use of coal lines up in proportion to our economic size and close to our emissions overall – around 1.6 per cent.

Limiting our coal industry makes little sense. We forgo an important profitable export earner (annual revenues around \$50 billion) while creating space for other suppliers to fill, which they will – to no measurable environmental benefit.

A better national priority would be to invent technologies that enable the burning of coal, and gas, cleanly and capture all associated GHG emissions.

Our total cost of transport fuels is now near \$50 billion annually. Without behaviour changes and subsidies, a \$20 carbon price will increase this petrol bill by \$1.7 billion or a little over three per cent. Given the volatility of petrol prices, this impost – phased in over a number of years – will have little measurable effect and few of us will abandon the internal combustion engine and its emissions.

The picture is different with electricity.

In 2011, the total cost of electricity to Australian households and business will exceed \$25 billion. In the absence of compelling alternative technologies and any changes to consumption patterns, and without compensation, a carbon price of \$20/tonne will increase costs by about \$5 billion or 20 per cent – presumably over a number of years.

But economist Warwick McKibbin makes a key point. The importance of carbon price is where we're heading, not the level we start with. It's the judgements of future costs that will shape choices we make today. Carbon prices must rise steeply in the future once transitional support falls away. So a low carbon price initially, complete with generous offsets, makes eminent political sense, but what future levels must be set to seriously drive the move towards cleaner alternatives? That figure is well above \$50/tonne.

If the demand for energy doubles by 2050, as currently forecast, and mix changes occur (mainly by adding new gas-fired capacity, plus renewables), and we succeed in reducing emissions by 60 per cent from a business-as-usual trajectory, then we will still be emitting around 400 million tonnes annually – a very aggressive target. At \$100/tonne – a level which I expect us to cross well before 2050 – this becomes an annuity stream of \$40 billion, probably well before 2050. Not too shabby when compared to the GST or mining super profits tax.

And if today's household expenditure on electricity and petrol is eight per cent of discretionary income, this becomes 16 per cent at mid-century through investment-driven energy inflation plus a carbon cost.

The proposed approach to pricing carbon anticipates a

transition period where households will be subsidised for increased energy costs and industry will be fairly compensated. In my view, this period of adjustment may last five years and be broadly revenue-neutral to the Federal Budget. The government hopes that at the end of this interval, community acceptance and international agreements will lock in an ETS. This is a reasonable view.

From about 2016, the net contribution to federal revenues could lift to \$6 billion and then rise at an average rate of \$1 billion each year until well past the middle of the century.

These revenues may well arrive beyond the term of the current Government which cannot be fairly accused of a tax grab. But which future government will walk away from such a river of gold?

The most relevant point is that pricing carbon is about rebalancing our economy by designing an evolutionary path along which we lessen our dependence upon fossil fuels but protect our competitiveness and productivity. This is the point emphasised recently by Rio Tinto's managing director in Australia, David Peever.

Pricing carbon in Australia is not an environmental strategy, notwithstanding the central role being played by the Greens. The key performance indicators must be financial and technological. Emission reductions are secondary until such time as a global accord harmonises international practice. My guess that this is five years away is very optimistic.

Is it imperative we start now? Not really. GHG emission reduction and an Australian ETS is an economic question not one of global warming mitigation, yet.

Is it less expensive to start now rather than later, as Sir Nicholas Stern suggests? I doubt it. This assumes that technology will not intervene and set us upon a new cleaner trajectory as tends to happen.

In 1910, all efforts were directed to managing and reducing the manure produced by the key mode of transportation – the horse – which quickly became obsolete once mass market automobiles appeared a few years later.

The 21st century clean energy alternative to coal and gas is surely just around the corner and all my scary numbers could turn out to be ill informed.

So, let's start on this journey but proceed carefully, keep our national interest foremost, and look to technology, here and abroad, to enable the transition. ◀

• *This article was first published online in Business Spectator*

DR ZIGGY SWITKOWSKI FTSE is Chancellor of RMIT University and the former chair of the Australian Nuclear Science and Technology Organisation (ANSTO). He was recently endorsed as the Chairman of Suncorp.



Biomass is pre-dried before pyrolysis.

PHOTO: CHRISTIAN PEARSON

PYROLYSIS COULD BOOST CHARCOAL PRODUCTION

A new biomass pyrolysis technology could expand charcoal production in Australia tenfold, and generate a range of valuable byproducts.

The new technology aims to help the iron and steel industry and other metal extraction industries compete in a carbon-constrained economy, according to the February edition of CSIRO's *Process* magazine.

"The easiest way to reduce greenhouse gas emissions is to replace the fossil carbon with renewable carbon that can be readily absorbed into metal extraction industries, using the same technologies and equipment they have now," says CSIRO's Dr Alex Deev.

The new process CSIRO is developing may be capable of producing charcoal volumes equivalent to 30 per cent or more of the annual industry coke consumption and will also capture valuable byproducts. BlueScope Steel and OneSteel are industry partners on the project.

CLIMATE CHANGE NEEDS "CONCRETE" ANSWERS

Understanding how climate change could impact the deterioration of the basic building block of much of Australia's infrastructure – concrete – is crucial to ensuring major assets such as roads, ports and buildings continue to perform up to expectations, according to a CSIRO report.

Concrete deterioration is caused by a range of physical, mechanical and/or chemical factors. One of the major threats to the longevity of concrete structures is carbonation, which occurs when atmospheric CO₂ penetrates into the structure to expose steel reinforcements to corrosion.

Corrosion caused by chloride penetration is another serious threat to concrete durability causing cracking, delamination, or spalling, especially in marine and coastal areas.

"In order to better understand how climate change might influence infrastructure maintenance and construction, we need to establish an accurate national database on the rate, and factors involved in, the deterioration of concrete infrastructure," said the report's lead author, CSIRO Climate Adaptation Flagship's Dr Xiaoming Wang.

"Failure to consider the effects of climate change may compromise the safety of concrete structures but, overcompensating in our efforts to adapt for climate change may unnecessarily increase costs.

"Both corrosion mechanisms are influenced by climate change but, the time it will take for climate change to exacerbate carbonation and chloride-induced corrosion of concrete structures will depend on their location and level of exposure to the elements," Dr Wang said.

"Scientists and engineers from CSIRO, in collaboration with a colleague from the University of Newcastle, have shown that increased atmospheric CO₂, in addition to a changing climate – including 'chronic' factors like increasing CO₂ concentrations, temperatures and humidity, and 'acute' factors like extreme weather events – will alter environmental exposure of most concrete infrastructure over their relatively long lifetime.

"This means that concrete structures will generally deteriorate faster with major implications for the safety, serviceability and durability of infrastructure, particularly in warmer inland and coastal areas," Dr Wang said.

PHOTO: XIAOMING WANG, CSIRO



Brisbane Riverside Freeway pylons.



ELECTRIC HOLDENS BEING DESIGNED

EV Engineering Ltd has announced it will design and engineer seven 'proof of concept' fully-electric versions of Australia's number-one selling passenger vehicle, the Holden Commodore, over 15 months.

The 'proof of concept' vehicles will be powered by renewable energy using standard electric vehicle plug-in and battery switching infrastructure. They will be used to investigate technical viability and attractiveness to customers so that consideration for mass production can be undertaken.

Consistent with the direction of the Automotive Australia 2020 roadmap, EV Engineering represents the first industry collaboration on large, powerful, zero-emission vehicles, bringing together major automotive component suppliers Air International, Bosch, Continental and Futuris, electric vehicle infrastructure and services provider Better Place, with the support of Holden and CSIRO.

Dr Calum Drummond FTSE, CSIRO Group Executive, Manufacturing, Materials and Minerals, said: "The global automotive industry is looking at a fundamental change – the transition from internal combustion engines to electric power trains. CSIRO is supportive of company initiatives in this 'green car' direction, including the EV Engineering Ltd project and its goal to engage key players in Australia's industry to take advantage of the evolving transition and the opportunity it promises."

The chairman of EV Engineering Ltd and former President and CEO of Mitsubishi Australia, Robert McEniry, announcing the project in Melbourne, said electric vehicles represented an exciting opportunity and important part of the future of the Australian car manufacturing industry.

Members of EV Engineering Ltd are backing the project with financial and in-kind contributions and substantial access to IP and engineering support. Funding of \$3.5 million for engineering costs will be provided by the Australian Government's Green Car Innovation Fund (GCIF).

UQ SIGNS TO DEVELOP GEOTHERMAL POWER

The University of Queensland's Geothermal Energy Centre of Excellence has signed an agreement with US turbine and power plant manufacturer Verdicorp to develop technology that is expected to significantly reduce the cost of geothermal electricity.

The agreement marks the start of a collaborative project to develop technologies that will help the geothermal sector reduce the cost of

At the electric Holden launch (from left) Evan Thornley (Better Place Australia), Gavin Smith (Bosch), Senator Kim Carr, Rob McEniry (EV Engineering), Bruce Griffiths (Futuris) and Ian McCleave (EV Engineering).

geothermal electricity below that of gas-fired electricity and is expected to make geothermal power cost-competitive. The target technologies also have the potential to increase geothermal productivity by 50 per cent for hot rock geothermal resources similar to those found in Cooper Basin, SA.

The collaborative project will develop key technologies including supercritical cycle equipment such as supercritical turbines; heat exchangers and air-cooled condensers for geothermal, solar thermal and waste heat power generation applications; and new cycle fluids and fluid mixtures suitable for supercritical cycles.

A high-pressure supercritical turbine and cycle testing facility will be built on the Pinjarra Hills campus of UQ later this year. The facility will include a portable test plant for testing and demonstrating the benefits of the new power plant technologies at remote geothermal sites.

BIOENERGY CROPS COMPLEMENTARY: RIRDC

With public debate on Australia's future energy needs gathering pace, three new RIRDC reports on potential bioenergy feedstocks add to the exchange of ideas on our nation's future energy supply.

"It is widely regarded that bioenergy could play a significant role in a low carbon energy future in Australia," said Dr Roslyn Prinsley, General Manager New Rural Industries at RIRDC. "These reports will help us understand which potential feedstocks are commercially viable and best suited to Australia's growing conditions.

"Importantly, the studies help to dispel the myth that the production of bioenergy feedstocks has to come at the expense of land destined to grow crops for human consumption. In fact, the feedstocks investigated in these reports – agave, giant reed and Australian native plants – were grown in marginal and degraded land areas where conventional crops would find it difficult to prosper and remain profitable."

Feasibility of Agave as a Feedstock for Biofuel Production in Australia concludes that it is feasible to grow agave in Australia to produce ethanol. Agave is an extremely water efficient plant and researchers found that Queensland's climate – very similar to areas in Mexico where agave is widely grown – and soils were best suited to agave's production in Australia.

Evaluating Biodiesel Potential of Australian Native and Naturalised Plant Species found 20 of the 200 plant species evaluated for their oil content could be used as biodiesel feedstocks, including the Beauty Leaf Tree. Biodiesel oil from the tree was tested for its engine performance, with the study uncovering favourable results.

Commercial Potential of Giant Reed for Pulp, Paper and Biofuel Production highlights the significant potential of giant reed in areas unsuitable for food crops due to salinity. Researchers found more than 45 tonnes of giant reed could be grown per hectare annually on marginal lands using saline winery wastewater for irrigation.

The reports are available at the RIRDC website (www.rirdc.gov.au).

BIOFUELS RESEARCH TO TURN WASTE INTO WEALTH

PHOTO: SHUTTERSTOCK

Wheat stubble – a waste plant material that may produce liquid fuels using enzyme biotechnology techniques.

CSIRO and Australian and UK universities aim to transform waste plant material into a sustainable, low-emission fuel for the world's cars, trucks and aircraft.

The new \$8.3 million CSIRO Energy Transformed Cluster on Biofuels in Canberra will develop new processes using enzyme biotechnology techniques to produce liquid fuels from waste plant feedstocks with the potential to provide 30 per cent of Australia's future transport needs.

Transport is the third largest producer of greenhouse gas emissions in Australia after the electricity industry and agriculture.

The three-year collaboration between CSIRO's Energy Transformed Flagship and the Australian National University (ANU), RMIT University, the University of Queensland and the University of Manchester in the UK, will deploy cutting-edge biological methods to produce liquid transport fuels and other valuable chemical products from the cellulose and lignin solids of waste plant material.

According to the Director of CSIRO's Energy Transformed Flagship, Dr Alex Wonhas, sustainable biofuels can significantly reduce emissions from transport, strengthen energy security and create new business opportunities.

"Second-generation biofuels that are produced from agricultural waste could potentially be a cost-competitive, low-carbon fuel that will keep our cars on the road and planes in the sky," Dr Wonhas said.

"The Cluster on Biofuels brings together a unique group of leading Australian and international scientists to develop new and competitive solutions for sustainable biofuel production which should position domestic companies for global success."

Cluster Leader, ANU's Professor Chris Easton, said the expertise and complementary skills in the Cluster would combine to develop new processes for generating biofuels in a sustainable way.

"We are confident this unique team of enzyme engineers, energy biotechnologists, microbial systems biologists and energy crop biotechnologists will engineer enzymes which can convert plant waste into alternative fuels, adding greater value to plant crops at the same time," Professor Easton said.

DOW TURNS TO THE EUCALYPT IN BRAZIL

Dow Chemical announced that its largest manufacturing facility in Brazil, the Aratu Complex, will add biomass to its portfolio of clean energy sources by the end of 2012, when Aratu will be more than 75 per cent sourced for power and steam through hydropower and eucalyptus-based co-generation.

Eucalyptus wood biomass will be used to produce steam for the site's chlor-alkali and chlorohydrin production processes. The plant is expected to reduce the site's carbon dioxide emissions by 180,000 metric tons annually, and conserve 200,000 cubic metres of natural gas daily.

Dow Chairman and CEO Dr Andrew Liveris FTSE, said the company was "focused on energy solutions that will unlock dramatic improvements in our energy profile as well as that of our customers and partners".

The Aratu site currently receives all of its electricity from hydropower and will be the first petrochemical user of biomass in Brazil through the supply agreement. The steam produced by the co-generation plant will be integral to the manufacture of materials for the automotive, building and industrial sectors.

STRONGER SOLAR TIES WITH GERMANY

Australia has signed a new Memorandum of Understanding (MoU) In Germany between the Australian Solar Institute (ASI) and the Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany's national research centre for aeronautics and space.

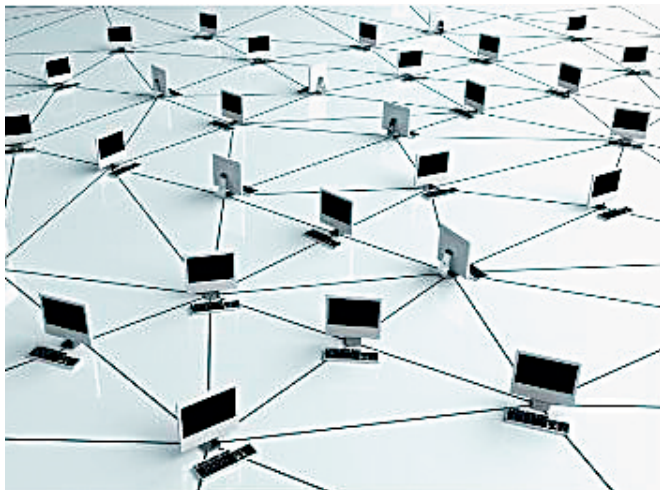
The agreement builds on the MoU the ASI already has in place with Germany's Fraunhofer Institute, which focuses on solar photovoltaic technologies.

The new MoU aims to foster cooperation in a number of areas, including:

- collaboration on concentrated solar power (CSP) development and deployment, including sharing views on future opportunities and challenges for CSP in a global context so as to help focus R&D on known research gaps and on overcoming barriers;
- provision of peer review expertise;
- joint R&D projects between DLR and Australian research bodies supported by the ASI; and
- support for solar skills development and education in Australia and Germany, for example through the provision of bilateral educational scholarships and exchange of research personnel.

The ASI and DLR have already agreed a number of priority activities for immediate commencement, including high temperature CSP modelling and high temperature receiver performance and analysis.

CSIRO will initially lead the scoping of Australia's involvement in these areas, with the ASI seeking to broaden Australia's involvement in the near future. The ASI will fund activities under the MoU from its existing international engagement budget. The ASI is part of the Government's \$5 billion Clean Energy Initiative.



NATIONAL UNIVERSITY RESEARCH NETWORK TAKES OFF

University of SA Vice Chancellor Professor Peter Høj FTSE has announced the first piece of infrastructure to be funded as part of the \$37 million National Research Network (NRN) project to extend and upgrade the data network between Australia's universities and research institutes.

The NRN project, part of the Australian Government's Super Science (Future Industries) initiative, will ensure the Australian Research and Education Network (AREN) has the capacity to support growth in Australian research and innovation.

AREN forms the backbone of all Australian research collaboration infrastructure and is essential for the transfer of large data sets between universities and research institutions in all capital cities and many regional centres, as well as isolated research facilities. It also facilitates collaboration between Australian and overseas researchers.

Professor Høj said AREN was vital in supporting national collaborative research. "The network ensures researchers from universities, government agencies and research institutions across Australia, regardless of their physical location, can share data," he said. "This is fundamental for a robust, collaborative and growth-oriented research community, so I'm delighted that UniSA has been chosen by the DIISR to deliver this crucial piece of national research infrastructure."

Since 2002 the Australian Government has committed up to \$125 million to building AREN.

COLLABORATION VALUE SIGNIFICANT – REPORT

A new report proves that services that foster collaboration between industry and the research sector produce quantifiable and significant benefits for the nation.

In a report produced by independent economic consultancy AEC Group, the Australian Institute for Commercialisation's (AIC) flagship TechFast program was studied for its impact on the overall Australian

economy. The AEC Group interviewed a sample of companies that had established collaborations with research organisations through the program, and determined the additional revenue earned and jobs created as a result of the collaboration, that would not have otherwise been made. AEC then modelled the broader economic benefits of the collaboration using its proprietary input-output economic model. Nearly 200 such collaborations have been established by the AIC since 2004.

The report found that such services (provided to business by the AIC) could be worth up to \$240 million a year to the economy in terms of additional turnover, exports, and hundreds of new jobs.

The AIC said the study showed the importance of having an efficient and affordable resource with deep knowledge of the innovation system that R&D-based businesses could consult when they simply did not know how to take the next step. "It's a truism but people and businesses don't know what they don't know," said Dr Rowan Gilmore FTSE, Chief Executive Officer of the AIC.

"This report quantifies the value that our activities add to the Australian economy, and proves that the country could reap many more rewards from its R&D activity if we address the culture of innovation and treat the commercial side more seriously."

Companies interviewed indicated that engagement with the AIC accelerated the entire innovative process by one or two years, just by connecting them with the right people and providing the mechanism to establish their innovation.

AUSTRALIA, OECD "ON SAME PAGE" WITH INNOVATION

Complex challenges like climate change, food security and the growing scarcity of water – and how governments deal with them – were discussed at a recent Canberra workshop the Australian Government co-hosted with the OECD. Delegates also examined how innovation contributed to productivity, prosperity and a nation's overall wellbeing.

Innovation Minister Senator Kim Carr told the workshop the OECD's Innovation Strategy was in strong alignment with Australia's 10-year innovation agenda – Powering Ideas: An Innovation Agenda for the 21st Century. "When it comes to innovation, Australia and the OECD are on the same page," Senator Carr said. "We both agree that an effective innovation system is critical to international competitiveness ... and that competitiveness is not just economic, but also involves wellbeing and environmental sustainability.

"I asked the OECD to come to Australia and give us advice on the mechanisms to access the best local and world knowledge, to build globally competitive industries and to create jobs for our prosperity and wellbeing.

"New methods of collaboration are required to get the best solutions to major policy challenges. Even at a local level, today's problems rarely sit within the responsibility of any one government agency or minister and require the collaborative efforts of every level of government, as well as action by private and community sectors."



The familiar face of a GPS device.

ARE WE OVER-RELIANT ON GPS ALREADY?

Society may already be dangerously over-reliant on satellite radio navigation systems like GPS, the Royal Academy of Engineering warns in a recent report. It says the range of applications using the technology is now so broad that, without adequate independent backup, signal failure or interference could potentially affect safety systems and other critical parts of the economy.

Global Navigation Space Systems: reliance and vulnerabilities looks into the increasing use of global navigation satellite systems (GNSS) to gain accurate data for positioning, navigation and timing (PNT). The US-operated Global Positioning System (GPS) is best known as the first major implementation of this technology but other GNSS systems are being planned and built, including the Russian GLONASS and Europe's Galileo.

The report focuses on our increasing reliance on GNSS and the current limited use of GNSS-independent backups for PNT data. The vulnerabilities of GNSS to interference, both man-made (such as jamming) and natural (such as solar flares) are also highlighted.

GNSS dependency is now widespread. As well as the ubiquitous satnav, the signals are used by data networks, financial systems, shipping and air transport, agriculture, railways and emergency services. The European Commission, in its recent mid-term review of the European satellite radio navigation programs, estimated that an €800 billion chunk of the European economy is already dependent on GNSS.

All GNSS applications are vulnerable to failure, disruption and interference and the report looks at a range of possible consequences of these, from the inconvenient (such as passenger information system failures) to possible loss of life (such as interruptions to emergency services communications). The severity of the errors may be so large as to give noticeably suspect results which can immediately be identified by the users, but the real threat lies in "dangerously misleading" results which may not seem obviously wrong – a ship directed off course by faulty data.

There is also a concern over the criminal use of jamming equipment to bypass GNSS systems – easily available technology can be used to block tracking of consignments of goods or to defraud systems that collect revenue using GNSS (such as toll-road charging).

Dr Martyn Thomas CBE FREng, Chairman of the Academy's GNSS working group, says: "GPS and other GNSS are so useful and so cheap to build into equipment that we have become almost blindly reliant on the data they give us.

"A significant failure of GPS could cause lots of services to fail at the same time, including many that are thought to be completely independent of each other. The use of non-GNSS back ups is important across all critical uses of GNSS."

It is an issue that many law enforcement agencies and governments don't want to discuss, according to Professor Andrew Dempster, from the UNSW School of surveying and Spatial Information Systems, who is a specialist in satellite navigation signal processing and receiver design.

Professor Dempster said the matter of interference with GPS was "a significant hazard for military, industrial and civilian transport and communication systems" because criminals had worked out that they could jam GPS. He also said that because GPS signals were weak, they could "easily be outpunched by poorly controlled signals from television towers, devices such as laptops and MP3 players, or even mobile satellite services".

The report looks at security awareness and recommends that critical services include GNSS vulnerabilities in their risk register and that these are reviewed regularly and mitigated effectively. It says the provision of a widely available PNT service as an alternative to GNSS is an essential part of the national infrastructure – a terrestrial radio navigation system called eLORAN is already in development for this purpose.

The Royal Academy of Engineering also suggests banning the import, advertisement and possession of jamming devices and creation of an R&D program focused on antenna and receiver improvements that would enhance the resilience of GNSS-dependent systems against natural and man-made threats.

The report is available at www.raeng.org.uk/gnss

CARBON FIBRE MAY TAKE DEAKIN INTO A NEW ERA

Deakin University's Associate Professor Bronwyn Fox says the recent Carbon Fibres – Future Directions conference held in Geelong, to coincide with the International Air Show at Avalon, was an overwhelming success and may lead to the establishment of a carbon composite community. Deakin and the Victorian Centre for Advanced Materials Manufacturing (VCAMM) hosted the conference with the support of the Victorian Government.

Professor Fox said that carbon composites were still in their early days, but diminishing petroleum resources, the need to create more environmentally friendly cars and aeroplanes, and to generate electricity in new sustainable ways was already increasing the demand for carbon composites. "The establishment last year of the Australian Future Fibre Research and Innovation Centre (AFFRIC) and the decision to build the Australian Carbon Fibre Research Centre in Geelong have provided us with an amazing opportunity to become a global leader in carbon composites," he said.

During the conference, Deakin also entered into agreement to work with the University of Manchester on research into carbon composites.



PHOTO: AUSTRALIAN CENTRE FOR FIELD ROBOTICS.

EXPANDING THEIR OCEAN VIEW

Tasmanian scientists will gain unprecedented access to data from high-tech equipment for monitoring coastal and ocean ecosystems through new technology provided through the Australian Integrated Marine Observing System (IMOS).

TasIMOS will combine joint research by CSIRO and the Institute of Marine and Antarctic Studies (IMAS) at the University of Tasmania to provide real time data from the Maria Island National Reference Station; monitor water properties and seabed habitats using several types of autonomous vehicles; detect a range of tagged marine animals using curtains of acoustic receivers; and validate satellite remote sensing of ocean conditions.

The datasets will help scientists underpin a whole-of-system approach to managing aquaculture and fisheries resources and biodiversity, including marine reserve management.

IMOS is supported by the Australian Government, through the National Collaborative Infrastructure Strategy and the Super Science Initiative. It is led by the University of Tasmania. The TasIMOS Node is co-led by CSIRO and the University of Tasmania through the Institute of Marine and Antarctic Studies.

NICTA TACKLES ONLINE VIDEO SEARCH

NICTA is collaborating with Microsoft Research Asia (MSRA) to develop technology to improve the performance of online video search engines.

Most search engines support keyword search for video-based content retrieval, a technique which often results in the retrieval of unrelated videos, too many videos, and videos where the related video action segments are buried somewhere in the footage but the displayed frame does not show this action. The retrieval quality is largely determined by textual information such as title, tag or description, rather than visual similarity.

Autonomous vehicles will form a vital part of the TasIMOS ocean monitoring system.

With new research funding from Microsoft Research Asia, NICTA will investigate a hierarchical approach to video search that will map action words from video titles and transcripts to action segments within the video. The NICTA team will develop algorithms and prototype software and test them using Microsoft's video metadata.

"We want to find the best way for computers to sort and recognise actions in videos," said Dr Jian Zhang, NICTA Project Leader.

"NICTA has technology that recognises and models video-based action, which we developed for automation of video surveillance systems. In this new project, we are exploring the application of this technology to online video search so that search engines can deliver more accurate, faster results."

"Through this new engagement with MSRA, NICTA continues to drive innovative Australian ICT onto the world stage," said NICTA CEO Professor Hugh Durrant-Whyte FRS FAA FTSE. "This research will address one of the most difficult technological challenges for search engine developers around the world."

HONEY BEES INSPIRE AEROBATICS

Australian scientists have developed a novel autopilot that guides aircraft through complex aerobatic manoeuvres by watching the horizon like a honey bee.

Allowing aircraft to quickly sense which way is "up" by imitating how honeybees see, engineers and researchers at The Vision Centre, Queensland Brain Institute and the School of Information Technology and Electrical Engineering at The University of Queensland have made it possible for planes to guide themselves through extreme manoeuvres, including the loop, the barrel roll and the Immelmann turn, with speed, deftness and precision.

"Current aircraft use gyroscopes to work out their orientation, but they are not always reliable, as the errors accumulate over long distances," says Vision Centre researcher Saul Thurrowgood.

"Our system, which takes 1000ths of a second to directly measure the position of the horizon, is much faster at calculating position, and more accurate. With exact information about the aircraft's surroundings delivered in negligible time, the plane can focus on other tasks.

"Imagine a plane that has eyes attached to each side at the front – the wide-angle camera lenses provide a view of 360 degrees."

The group first "trained" the system to recognise the sky and the ground by feeding hundreds of different landscape images to it and teaching it to compare the blue colour of the sky with red-green colours of the ground. Simple, low-resolution cameras similar to a bee's visual system were then attached to the aircraft, allowing the plane to take its own landscape pictures to identify the horizon while flying.

Mr Thurrowgood says that the system can potentially be adapted for all types of aircraft – including military, sporting and commercial planes.

A weighty account of research in universities

By Ian Rae

ianrae@bigpond.com

Professor Frank Larkins AM FTSE has written an important book about research in universities, titled *Australian Higher Education Research Policies and Performance 1987-2010*.

He was Deputy Vice-Chancellor (Research) at the University of Melbourne from 1990 to 2005 and so, along with many other Fellows, lived – some would say suffered – through the changes that he describes. “Almost constant transformation since the introduction of the Unified National System,” is Frank’s dispassionate take on it.

He begins with a chapter on university research before 1987, reminding us of bodies like the Commonwealth Tertiary Education Commission and the Australian Science and Technology Council – like many another, all swept away by two decades of relentless attempts by governments to effect more accountability by and productivity from university researchers.

It started earlier at CSIRO, so the professors should have seen it coming. Caught up in the Dawkins revolution mischievously titled the Unified National System (it’s anything but), they were unprepared for clawbacks that shifted money from block grants to competitive funding schemes, demanded quality assurance, and saw the development of various research indices.

There was almost always a review underway, headed by such luminaries as Professor Geoff Wilson AM FTSE (1988), Kwong Lee Dow (1989), Deryck Schreuder (1992), Don Mercer and Dr John Stocker AO FTSE (1998), Donald McGauchie (2003) and Denise Bradley (2008).

Scholarly analyses were published by academic researchers and government bodies such as DEST. Who remembers the Department of Education, Science and Training or the National Board of Employ-

ment, Education and Training (NBEET) or the various departmental permutations of these three portfolios? Read the book for a refresher course.

Successive chapters of Professor Larkins’ book deal with the higher education policies of Labor (1987–96) and Coalition (1996–07) administrations with a coda for Labor (2007–10) – research training and performance; competitive funding frameworks; collaboration, innovation and commercialization; costs, ethics, and staffing.

There are numerous graphs and tables. As an example of the detail they contain, the one on Cooperative Research Centres (CRCs) shows which ones were approved, along with their Commonwealth funding and the participants’ cash and in-kind contributions, in each of the 12 rounds up to 2009.

Further evidence of the concentration research and research funding is found in the accounts of Centres of Excellence and Special Research Centres. I see both the CRCs and the Linkage Grants awarded by the Australian Research Council as attempts to lure academics away from curiosity-led/basic/blue sky research – Professor Larkins offers an extensive typology – towards ‘useful’ research (although everybody avoids such a crass description).

Frank’s final chapter, ‘Reflections Past, Present and Future’, touches on some significant overarching issues and gives him scope for some personal opinions.

University enrolments have increased from 400,000 in 1987 to more than a million today, of which close to 300,000 are fee-paying students, mostly from overseas. The Higher Education Contribution Scheme (HECS), that once seemed so controversial, is covered earlier in the book as merely one among many changes wrought at the beginning of the study period.

The growth of research offices is noted, as is the growth in research-only staff, whose numbers have doubled since 1992.

Most are employed in the science, medicine and technology faculties. This observation provides the explanation for the increase in chemistry staff numbers even though undergraduate enrolments (the usual cash cow) have diminished.

Australian universities rank well in global research indices, no doubt in part due to research concentration, which, Professor Larkins says “will need to continue for Australia to remain competitive in international rankings,” coupled with better scholarships and academic salaries. An interesting aspect of the concentration is that Australian Technology Network universities, which had hoped to prosper in the unified system, attract only 8.4 per cent of the available research funding (up from seven per cent) while the Group of Eight (go to the back of the class if you can’t name them) increased theirs from 66.9 to 69.8 per cent.

The result of Frank’s labours is a weighty account of the world in which he lived as researcher and administrator for nearly two decades. Call it ‘Memories of a Grant-Hunting Man’ and you won’t be far wrong.

PROFESSOR IAN RAE FTSE is a former Technical Director of ATSE and Honorary Professorial Fellow, History and Philosophy of Science, University of Melbourne. He is member of the leadership group of ATSE’s Climate Change Forum and former President of the Royal Australian Chemical Institute.

Frank Larkins at the launch of his new book, *Australian Higher Education Research Policies and Performance 1987-2010* (Melbourne University Press, Carlton, 2011).





PHOTO: CSIRO

CSIRO scientists working at the highest level of biosecurity (level 4) at AAHL in Geelong.

Bat immunity key to virus control

CSIRO research into how bats can host some of the world's deadliest viruses without suffering any ill-effects themselves will lead to improved strategies for controlling the spread of bat-borne diseases.

"CSIRO is helping to safeguard the health of Australians and livestock through a comprehensive research program that examines how bats have adapted to co-exist with some of the most deadly viruses known," says Dr Linfa Wang FTSE, who leads a team of scientists at CSIRO's Australian Animal Health Laboratory (AAHL), in Geelong.

Dr Wang told more than 600 delegates at the 1st International One Health Congress in Melbourne in February that the aim was to better understand bat immunology and the bat virus-host interaction to identify strategies to control viruses such as Hendra virus spreading to other animals and people.

"In order to better control the spread of viruses, like Hendra, from bats to horses and then to people it is becoming increasingly important to learn what governs the

interactions between viruses and their hosts and, in particular, the phenomenon of 'host switching'," Dr Wang said. Host switching is where a virus spreads from an existing host to a 'new' host species.

"In some cases these host-switching events go unnoticed, as no disease develops in the new host. However, in other situations the virus adapts to the new species and causes severe disease and in some cases death."

Bats are known to be a source of viruses that have been involved in host-switching incidents, including Hendra, Ebola and SARS, and appear to have developed the ability to tolerate infection with these pathogens, which are fatal to other mammals.

"Bats appear to have some kind of 'viral radar' – a highly effective immune system that provides them with broad spectrum protection against viral attack. Our research will assist in developing faster, more sensitive surveillance tools that may radically change the risk management of zoonotic diseases in Australia and worldwide.

"That will mean we can move forward from just responding when an outbreak occurs, to putting pre-emergence surveillance and prevention strategies in place."

Dr Wang joined the Academy in 2010 and made a compelling presentation on bats as disease hosts at the New Fellows Seminar following the AGM last November.

Low Carbon Energy report goes to Brisbane

Queensland's new Chief Scientist, Dr Geoff Garrett AO FTSE, chaired the Queensland launch of ATSE's report, *Low Carbon Energy*, in February, following the national launch in Melbourne in December and the NSW launch in Sydney in January.

The audience of more than 90 people from industry and government heard Dr John Burgess FTSE explore the usefulness of financial investment tools for making choices about new power-generating technologies outlined in the ATSE report.

Mr Dennis Bird, General Manager, Strategic Economic Projects, Queensland Department of Employment, Economic Development and Innovation, gave an update on the status of Queensland's LNG industry, and Simon Bartlett FTSE, Chief Operating Officer of Powerlink, spoke about transmission developments to support the CSM LNG industry. Professor Paul Meredith from the University of Queensland's Global Change Institute (GCI) presented UQ's Renewable Energy Roadmap. The GCI supported the event with sponsorship.

Greg Tegart

Professor Greg Tegart AM FTSE presented on the topic Smart Technology for Healthy Longevity at a forum on Innovations in Health and Community Care at Old Parliament House, Canberra, in March.



Ezio Rizzardo among Top 100 chemists

CSIRO Fellow Dr Ezio Rizzardo FRS FAA FTSE has been ranked as one of the world's top 100 chemists in the past decade by US information and analysis company Thomson Reuters.

Published to mark the International Year of Chemistry, the list was compiled on the basis of the highest citation impact scores for chemistry papers (articles and reviews) published by individual chemists between 2000 and 2010. Under this criterion, Thompson Reuters ranked Dr Rizzardo at 18th.

The company said that as approximately a million chemists were recorded in the journal publications it indexed during the past decade, the Top 100 Chemists list represented the top hundredth of one per cent.

Dr Rizzardo, a Fellow since 1994, published 52 papers, had 91.2 citations per paper and was the only Australian to be ranked in the top 20.

"We at CSIRO are tremendously proud of Ezio's achievements," CSIRO Group Executive, Manufacturing, Materials and Minerals, Dr Calum Drummond FTSE said. "For him to be ranked 18th in the world in terms of citations over the past 10 years, out of hundreds of thousands of chemists is, a truly outstanding accomplishment."

Dr Rizzardo's research has focused on developing methods for controlling free radical polymerisation. His breakthrough Reversible Addition-Fragmentation chain Transfer (RAFT)

Ezio Rizzardo has been ranked 18 in a list of the world's top 100 chemists.

technology has led to the development of an entirely new area of science.

"RAFT is the ultimate polymer-building technology and allows for the development of new materials with controlled structure and architecture," Dr Drummond said. "The impact of this groundbreaking science will be felt in many aspects of our daily life and will grow exponentially over coming years."

CSIRO says RAFT is now one of the most studied areas in polymer science, with more than 10,000 journal publications appearing during the past decade.

"Commercially there are over 500 active patents using RAFT with new products being both commercialised and researched in a range of fields including: drug delivery; biocompatible materials with increased function; paints and coatings to meet stricter environmental guidelines; targeted personal care and cosmetics; synthetic rubbers for improved performance; and, additives to promote fuel efficiency."

Fellows will influence Strategic Roadmap

ATSE Fellows will play a strong role in the development of the 2011 Strategic Roadmap for Australian Research Infrastructure, with roles on five of the six Expert Working Groups established to provide specialist advice to government – and a very strong influence in the Frontier Technologies group.

During 2011, the Strategic Roadmap for Australian Research Infrastructure will be developed to inform future decisions on where Australia should make strategic infrastructure investments to further develop its research capacity and improve research outcomes over the next five to 10 years.

The 2011 Roadmap aims to consider new and emerging areas of research that may require different types of infrastructure in the future, and determine whether the current mix of capability areas continues to meet researchers' needs.

Eleven ATSE Fellows are participating according to DIISR, which recently announced the membership of the Expert Working Groups:

- Environmentally Sustainable Australia – Dr John Church FTSE, Principal Research Scientist, CSIRO; Dr Russell Reichelt FTSE, Chair and CEO, Great Barrier Reef Marine Park Authority;
- Promoting and Maintaining Good Health – Professor Simon Foote FTSE, Director, Menzies Research Institute, University of Tasmania;
- Frontier Technologies – Dr Calum Drummond FTSE, Group Executive, Manufacturing, Materials and Minerals, CSIRO (Chair); Professor Lorenzo Faraone FAA FTSE, Director, West Australian Centre for Semiconductor Optoelectronics and Microsystems, UWA; Professor Tanya Monro FTSE, Director, Institute for Photonics and Advanced Sensing, University of Adelaide; Professor John O'Callaghan FTSE, Emeritus Professor, ANU; Professor Mary O'Kane FTSE, NSW Chief Scientist and Scientific Engineer; Professor Judy Raper, Deputy Vice-Chancellor (Research), University of Wollongong;
- Safeguarding Australia – Professor Susan Pond AM FTSE, Board Member, Commercialisation Australia, and a Director of ATSE; and
- eResearch Infrastructure – Dr Joanne Daly PSM FTSE, Strategic Adviser – Science, Strategy and People, CSIRO.



Tanya Monro



Simon Foote



Mary O'Kane

Ian Frazer to head Queensland's TRI

The world-renowned co-inventor of the cervical cancer vaccine Professor Ian Frazer FAA FTSE has been appointed Chief Executive of the new \$345 million Translational Research Institute (TRI), due to open in Brisbane in 2012.



Ian Frazer working with students at the 2007 Extreme Science Experience

Professor Frazer has been a researcher and academic at the University of Queensland (UQ) since 1985 and Director of its Diamantina Institute since 1997. He was Australian of the Year in 2006 and has won numerous national and international awards, including an ATSE Clunies Ross Award in 2007. Alongside his new role, Professor Frazer will continue to lead the Diamantina Institute research group.

The TRI will be the largest institute of its type in the Southern Hemisphere – and one of only a handful worldwide that can research and trial treatments and manufacture breakthrough drugs in one location. It will accommodate up to 650 researchers from its four partners: UQ, Queensland University of

Technology, Mater Medical Research Institute and the Princess Alexandra Hospital.

Professor Frazer, whose new role begins in July, said he was honoured to accept the appointment and excited about future discoveries and advances in medical research that would be made at TRI, to be located in the inner suburb of Woolloongabba, where it will provide 32,000m² of research space over five floors.

"There are a number of pressing human health issues in the world such as diabetes, cervical and prostate cancer, melanoma and obesity, and I am proud to be leading TRI in researching and developing treatments for these diseases," he said.

"Importantly, patients, the Australian economy and our medical industry will all benefit from TRI's ability to manufacture and commercialise these treatments.

"Too often, Australia loses promising medical scientists to overseas institutions as we are not able currently to support the development of new medical treatments and their translation from research to clinical practice. The TRI will change all of this, resulting in the retention of our brightest minds and therefore better healthcare for all Australians.

"If the TRI and its manufacturing capabilities had been established at the time of the development of the cervical cancer vaccine, much more of the economic benefit from its \$5 billion-plus of worldwide sales would have returned to Australia."

TRI chairman Dr David Watson said Professor Frazer played a large role in the development of the TRI vision and was the best person to move it forward. "Appointing the right person was crucial, as the CEO will be the key driver of the vision to create an Australian-first home for medical research, clinical trials and treatment commercialisation," he said.

Adrienne Clarke now La Trobe Chancellor

Australian scientist and businesswoman Professor Adrienne Clarke AC FAA FTSE has been appointed Chancellor of La Trobe University.

A former chairman of CSIRO and Lieutenant-Governor of Victoria, Professor Clarke has been a director of public companies



Professor Adrienne Clarke

including Woolworths, Alcoa, WMC, AMRAD, Fisher & Paykel Healthcare, Hexima and AMP.

She is author of four major scientific books dealing with chemistry, cell biology and genetics, and has served on the Prime Minister's Science and Engineering Council and on the Victorian Business Round Table. She represents ATSE on the CAETS Noise Control Technology Committee.

Professor Clarke is Laureate Professor at the University of Melbourne. She is also on boards including the Australian Research Centre for Urban Ecology and the Australian Advisory Board of The Nature Conservancy, and has been a member of the La Trobe University Council since August 2010.

Professor Clarke said education – learning how to learn – was the most important investment Australia could make for its future.

"La Trobe University has a reputation for excellence in providing education for students from diverse backgrounds and in several fields of research," she said. "These are great foundations on which to build an even stronger university for the future. I am very honoured to have been given the opportunity to serve and to contribute to this future."

Professor Clarke's scientific work provides critical insight into the biochemistry and genetics of flowering plants, their reproduction and growth. It has led to industrial applications for next-generation controls of insect pests and fungal diseases of crops.

She is a Foreign Associate of the National Academy of Sciences (USA), a Foreign Member of the American Academy of Arts and Sciences and a Fellow of Janet Clarke Hall in Melbourne.

Professor Clarke took up her post in February, following the retirement of leading educationist Sylvia Walton.

Paul Greenfield new ANSTO Board Chair

Professor Paul Greenfield AO FTSE, Vice Chancellor of the University of Queensland, has been appointed to head the Australian Nuclear Science and Technology Organisation (ANSTO) Board. He succeeds Dr Ziggy Switkowski FTSE, who retired from the position at the end of 2010 after four years as Chair.

Announcing the appointment, Innovation Minister Senator Kim Carr said Professor Greenfield's experience on the board since 2007 and his skills in science and senior management made him an outstanding candidate for the position.

"ANSTO has a unique place in the Australian innovation system. Its research is helping to solve big questions in fields as diverse as health,

climate change, mining and engineering. And its research partnerships span the globe."

Professor Greenfield has extensive experience as a director and is, or has been, a director on a number of company boards. He has consulted and worked widely with industry on a range of projects spanning biochemical engineering, water and wastewater issues and environmental management, as well as economic evaluation of projects (particularly in the biotechnology and environmental fields).

His interests lie in biotechnology, environmental management and R&D management and commercialisation. He serves on the DSTO Advisory Board and is currently the Chair of the Group of Eight Universities.

Senator Carr also welcomed Mr John Ryan to the ANSTO board. Mr Ryan has previously been a Deputy Secretary in the Department of Resources Energy and Tourism, Commissioner for the Australian Energy Market Commission, head of the Canberra Office of the Allen



Consulting Group, head of the Science Industry Policy Division of the Department of Industry, Science and Technology, Deputy Director of the Bureau of Industry Economics and project director at the Industries Assistance Commission. Mr Ryan was recently appointed the inaugural Chair of the National Research Infrastructure Council.

"ANSTO thrived under the leadership of Dr Switkowski, who has been a steady hand and sage adviser," Senator Carr said. "The government is very grateful for his distinguished service over five years on the board, including almost four as chair."

WOMEN IN TSE

'Aussie' professor wins L'Oréal-UNESCO Award

Professor Jillian Banfield, Professor of Earth and Planetary Science, of Environmental Science, Policy and Management, and of Materials Science and Engineering, University of California, Berkeley, has been named the 2011 North American Laureate at the 13th Annual L'Oréal-UNESCO For Women in Science Awards, in Paris.

Originally from Australia, Professor Banfield received her bachelor's and master's degrees in geology from the Australian National University. She completed a PhD in Earth and Planetary Science at Johns Hopkins University in 1990. From 1990–01 she was a professor in the Geology, Geophysics and Materials Science Program at the University of Wisconsin–Madison. Since then, she has been a professor at the University of California, Berkeley, and an affiliate scientist at the Lawrence Berkeley National Laboratory.

Professor Banfield has been honored with numerous prestigious awards, including a MacArthur Fellowship (1999–04), The Dana Medal of the Mineralogical Society of America (2010) and a John Simon Guggenheim Foundation Fellowship (2000.) She was elected to the US National Academy of Sciences in 2006.

The other Laureates named were:

ASIA / PACIFIC

Professor Vivian Wing-Wah Yam, Professor of Chemistry and Energy, University of Hong Kong – for her work on light-emitting materials

and innovative ways of capturing solar energy.

AFRICA and ARAB STATES

Professor Faiza Al-Kharafi, Professor of Chemistry, Kuwait University – for her work on corrosion, a problem of fundamental importance to water treatment and the oil industry.

EUROPE

Professor Anne L'Huillier, Professor of Atomic Physics, Lund University, Sweden – for her work on the development of a camera for recording events in attoseconds (a billionth of a billionth of a second).

LATIN AMERICA

Professor Silvia Torres-Peimbert, Professor Emeritus, Institute of Astronomy, Mexico City University – for her work on the chemical composition of nebulae, which is fundamental to our understanding of the origin of the universe.

Gender barriers a reality

Gender still matters, according to a recent US survey on the ability of women to succeed and move ahead in scientific careers.

Almost all women surveyed (98 per cent) said they knew of someone who had left scientific research because of barriers including work/life balance, having and raising children and gender bias. In contrast, male scientists were more likely to leave for reasons including insufficient pay, access to grants/funding or job scarcity.

The survey of 1300 male and female scientists was commissioned by L'Oréal USA and performed by the American Academy for the Advancement of Science.



Laurie Faraone

Micro technology for macro good

Winthrop Professor Lorenzo Faraone FAA FTSE is Director of a new facility at the University of Western Australia that will enable the development of unique technologies to revolutionise daily life in fields as varied as health, agriculture, mining, automotive industries, communications, data storage and defence.

Professor Faraone's Microelectronics Research Group at UWA is a global leader delivering solutions, new knowledge and education in advanced microelectronics, optoelectronics, nanotechnology, photonics and microsystems technology.

He now heads the new WA node of the Australian National Fabrication Facility (ANFF), in UWA's School of Electric, Electronic and Computer Engineering, which aims to enable collaboration and facilitate the transfer of research into applications in industry. ANFF links 19 institutions nationally grouped into eight nodes, providing researchers and industry with state-of-the-art fabrication facilities.

UWA provides, via ANFF, access to state-of-the-art infrared technology and micro-electromechanical systems (MEMS) fabrication processes for industry and the broader Australian and international research communities.

Gilbert Tucker: distinguished atmospheric scientist

Dr Gilbert Tucker, whose distinguished career as an atmospheric scientist included responsibility for building the research capacity of the Bureau of Meteorology and CSIRO over more than three decades, has

died in Victoria, aged 80.

Dr Tucker, a Fellow from 1989 until his resignation in 2001 (nearly a decade after his retirement), reshaped the Australian meteorological research agenda and ensured that it was effectively integrated with the global effort. He was an early and active participant in the design of several of

the major global research initiatives, serving on a range of senior steering committees.

He led CSIRO's scientific support for the developing national response to the threat of human-induced climate change, and remained forceful in his view that the science must be rigorous and the uncertainties should not be underestimated. In 1981, long before 'greenhouse' and 'climate change' had become household terms, he wrote the Australian Academy of Science's influential monograph *The CO₂-Climate Connection: A Global Problem from an Australian Perspective*.

He was president of the International Association of Meteorology and Atmospheric Physics from 1987–91, and for several years after he retired from CSIRO in 1992 he served as a senior fellow at the Institute of Public Affairs in Melbourne.

Born in Wales, he graduated from the University College of Aberystwyth in 1950 and obtained a PhD from Imperial College, London, in 1954. Dr Tucker worked as a research scientist at the UK Meteorological Office from 1956–65 when he was appointed as head of research and development at the Australian Bureau of Meteorology in Melbourne.

CSIRO had established a meteorological physics section under Dr Bill Priestley in 1946 and a joint BoM-CSIRO Commonwealth Meteorology Research Centre was established in 1967, with Dr Tucker transferred from the BoM to CSIRO to serve as its officer-in-charge.

Under Dr Tucker's forthright and inspiring leadership from 1969–73, the centre blossomed as an independent research organisation bridging the research and the operational responsibilities of the BoM.

He was appointed chief of the CSIRO Division of Atmospheric Physics (later Atmospheric Research), in Melbourne in 1973 and built on the legacy of his predecessor, Dr Priestley, in leading world research programs in micrometeorology, cloud radiation, atmospheric chemistry, dynamic climatology, regional meteorology and climate change impact assessment.

Edited from an obituary first published in The Age, contributed by Dr Graeme Pearman AM FAA FTSE, who succeeded Gilbert Tucker as Chief of CSIRO Atmospheric Research (1992–02).

Grant Hosking was a leading engineer



Grant Hosking

The Academy notes with regret the recent death of Rhodes Scholar and prominent Adelaide engineer Norman

Grantham (Grant) Hosking

AO FTSE, who died recently, aged 86.

A Fellow since 1989, he is remembered by his colleagues in the Academy as a charming and gracious person with a quick wit and a keen sense of humour.

He graduated from Adelaide University in Civil Engineering in 1946, was South Australia's Rhodes Scholar in 1947 and graduated with an MA (Hons) in Engineering Science from Oxford University in 1950.

He then worked as a research engineer at the Massachusetts Institute of Technology (1950–51) and as a lecturer and senior lecturer in the University of Melbourne's Department of Civil Engineering (1952–56).

After working in private practice, he established his own firm in 1961 in Adelaide, which he led until his retirement in 1988 – Hosking, Oborn & Partners (later Hosking Oborn Freeman Fox) – and subsidiary water and wastewater engineering firm Montgomery Hosking Stone.

He was an Honorary Fellow and President (1978) of the Institution of Engineers, Australia, a Councillor of the Association of Consulting Engineers Australia (1966–69), Councillor of the Institute of Arbitrators Australia (1979–92) and Vice President of the Australian Council of Professions (1979–80).

Alban Lynch honoured by new building

Professor Alban Lynch AO FTSE, former Head, Department of Mining and Metallurgical Engineering, University of Queensland, has been honoured with the new Minerals Characterisation Research Building at the Julius Kruttschnitt Mineral Research Centre (JKMRC), University of Queensland, named the Alban Lynch building.

Officially opened in June 2010 by the Queensland Treasurer, the Hon Andrew Fraser, the facility was named in recognition of Professor Lynch's contribution to minerals research on a global scale. As the founding Director of the JKMRC, Professor Lynch operated on the basis of undertaking research at operating mine sites around the world and this set the standard for working in close collaboration with the minerals industry and for building research capacity.

The JKMRC is a recognised global leader in the development and application of innovative mineral characterisation methodologies and equipment, and this new facility provides the platform for this research to continue to expand and to create industry-transforming technologies.

Professor Lynch, a Fellow since 1979, was honoured with a Lifetime Achievement Award at the XXV International Mineral Processing Congress (IMPC) held in Brisbane in September 2010. He is also co-author of a book, *History of Flotation* (AusIMM, 348pp), launched at the XXV IMPC.

Raise the best higher, says President

More funding for science research should go to universities already in the top 25 per cent globally in an effort to lift them even higher, says ATSE President and former Chief Scientist Professor Robin Batterham AO FREng FAA FTSE.

"We should concentrate more of our research funding on those that are performing at the higher levels," *The Australian's* Higher Education section reported him as saying.



Alban Lynch being congratulated by Queensland Treasurer Andrew Fraser at the opening.

Professor Batterham's analysis of a decade of citations for the Group of Eight Universities, plus the University of Newcastle and CSIRO, is published in *Australian Universities Review*.

He concludes that "the relatively large number of institutions publishing in particular fields and ranking well below world average performance raises interesting questions".

"Uncomfortable as the question is, should our limited research funds be used this way or are we better bringing those near the top (say, the top 25 per cent) up to the top 10 per cent?"

The Australian said Professor Batterham analysed the Thomson ISI Essential Science Indicators for the decade to 2009, which showed none of the Go8 universities were in the world top 10 for 20 fields of research, although many were in the top 10 per cent of institutions.

All but the University of Adelaide were in the top 10 per cent in at least one field, with the University of Sydney and the University of Queensland in the top pack in four fields each.

Clinical medicine and plant and animal science were particular strengths: six universities made it into the top 10 per cent in those fields. CSIRO was in the top 10 for plant and animal science, environment and ecology and agricultural sciences.

"Excellence in research has many advantages. In particular, it facilitates more international collaboration, and hence more impact and innovation," Professor Batterham told *The Australian*. "So I ask: why should we fund research that is less than excellent? The proposition is hard to sustain so we are left with the uncomfortable position of concentrating research funds at the excellent end of the spectrum."

He also noted that his analysis left out smaller institutions such as medical research institutes.

Bob Hillman served WA for 44 years

Former ATSE Councillor and WA Division Chair Bob Hillman AO FTSE, who spent nearly 45 years in the public sector in Western Australia, has died in Perth aged 90.

A Fellow since 1987, Robert Merry Hillman was a former Chair of the Water Authority of WA. He served on ATSE's Council (1992–95) and as WA Division Chair (1991–94).



Bob Hillman

He graduated in engineering from UWA in 1942 and served with the Royal Australian Engineers in New Guinea, New Britain and Bougainville (1942–46) before joining

the WA Public Works Department after demobilisation.

In 1964 he was appointed Chief Engineer, Metropolitan Water Board, and was Director of Engineering for the Public Works Department 1972–84. He served as Chair of the Water Authority of WA (1984–90) and WA Water Resources Council (1977–84).

At various times he served as Member of the Metropolitan Planning Authority, the State Planning Authority, the Conservation and Environment Council of WA and the WA State Committee of CSIRO. He was an Honorary Fellow of the Institution of Engineers, Australia, and a Member of the Australian Water and Wastewater Association.

He was a strong contributor to Murdoch University, serving on the Planning Board and the Senate and as Pro-Chancellor (1977–81) and maintaining a strong interest in the university until last year.

Suresh Bhargava leads RMIT chemistry link with India

RMIT University has opened a joint Research Centre with the Indian Institute of Chemical Technology (IICT) in Hyderabad, India, marking the International Year of Chemistry.

Professor Suresh Bhargava FTSE, Head of Advanced Materials and Industrial Chemistry at RMIT, who joined the Academy in 2010, leads the RMIT group.

The Centre will focus on environmental and industrial research and is RMIT's first collaborative research footprint in India. RMIT is committed to contribute more than \$400,000 dollars for the joint Centre and has already contributed \$150,000 toward the establishment of the facility and student scholarships.

IICT is a leading Institute in India, with expertise in several branches of chemistry, especially in organic synthesis, including natural products, medicinal chemistry, catalysis and physical photochemistry.

Researchers at RMIT and IICT are already working together on projects including in relation to nano-engineered materials, methods for the removal of mercury from industrial air effluents and environmentally sustainable industrial process design.

The new joint facility will allow researchers to work on projects including catalysis for green chemistry, advanced materials and renewable energy, processes for water quality monitoring and waste water treatment, control of greenhouse gas emissions and air pollution, and bio-nanotechnology.

Professor Bhargava said the initial collaboration between RMIT and IICT started

almost three years ago and had been very successful.

"The two research groups have jointly published some 15 papers and have independently filed innovative patents in frontier areas of R&D," Professor Bhargava said.

"Our research will benefit the poorer people in India and will provide cost-effective, indigenous solutions and technologies for water purification and air pollution control. For example, one technology is to use nanocomposite clays to make pots that purify groundwater and make it safe to drink.

"Through the excellent scientific quality of the groups involved, this joint venture is expected to produce research publications and innovative patents that will have a valuable impact on global issues."

ATSE launches its SA Parliamentary Briefings

ATSE launched its program of Parliamentary Briefings to the South Australian Parliament in March, following the lead of Victoria and NSW, where the program is now established.

The topic for the first briefing was Low Carbon Energy, with a presentation by Dr John Burgess FTSE, lead author of the major ATSE report launched last December by Energy Minister Martin Ferguson.

Dr Burgess has since made presentations organised by the NSW and Queensland Divisions in Sydney (January) and Brisbane (February).

The briefing was organised with the Friends of the SA Parliament Research Library,

with the support of the Head Librarian, Dr Coral Stanley, and opened by the Speaker, Lyn Breuer. It was chaired by Professor Mike Miller AO FTSE, SA Division Chair.

More than 30 packed the Speaker's Dining Room, including 17 Parliamentarians – among them the SA Minister for Energy, Michael O'Brien – and the balance of the audience were parliamentary and members' staff.

Professor Miller said Dr Burgess's presentation evoked considerable interest and lively discussion and noted the audience found it helpful and looked forward to future briefings.

New book from Lindsay Falvey

Professor Lindsay Falvey FTSE is the author of a new book *Small Farmers, Secure Food: Survival Food Security: the World's Kitchen and the Critical Role of Small Farmers*, which deals with issues of food security in disadvantaged countries and the huge contribution made by small farmers in those countries.

Professor Falvey, Professor of Agriculture at the University of Melbourne and a Fellow since 1997, is critical of international institutional approaches.

The 225-page paperback book calls for an objective approach to national food security and social equity. Professor Falvey had dedicated the book to the late Professor Derek Tribe AO OBE FTSE, whom he describes as a "mentor and influential international agricultural scientist of a valued generation".

Published by Thaksin University Press in Thailand in association with the Institute for International Development in Australia, the book is available from either publisher. The book can be downloaded at www.iid.org/publications/SmallFarmers2010.pdf

Limited numbers of the book are available free of charge to ATSE Fellows by contacting Professor Falvey (lindsay.falvey@gmail.com).



RMIT University
Vice-Chancellor and
President, Professor
Margaret Gardner,
with Professor Suresh
Bhargava.



2011

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UQ PAVES THE WAY FOR NEXT-GENERATION ELECTRONICS

Researchers at The University of Queensland have discovered how to create a whole new array of plastics with metallic or even superconducting properties.

UQ's Professor Paul Meredith and his colleagues, Associate Professor Ben Powell and Dr Andrew Stephenson, have used ion beam techniques to produce strong, flexible and conductive plastic film. Ion beam techniques are widely used in the microelectronics industry, however adapting this process to plastic films has not been successfully achieved until now.

The team, in collaboration with Associate Professor Adam Micolich from UNSW, has been able to use an ion beam to tune the properties of plastic film so that it conducts electricity like the metals used in electrical wires.

As well as being inexpensive, flexible and easy to produce, these new materials are vastly more tolerant of exposure to oxygen compared to standard semiconducting polymers. Together, these advantages

may give the new material a bright future in the ongoing development of plastic electronics applications.

The Federal Government's 2010 Excellence in Research for Australia (ERA) survey confirmed The University of Queensland as one of the nation's top two universities, measured on a combination of research quality and breadth. ERA reported that research at UQ is above world standard in more broad fields than at any other Australian university: this reflects UQ's leading global role in many areas of discovery. UQ's outstanding critical mass offers researchers significant interdisciplinary capability.

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*UQ has been named in the top 50 universities in the world in the 2010 QS World University Rankings.