

# FOCUS



INTERNATIONAL EDITION

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## AUSTRALIA / KOREA

**WORKING TOGETHER ON GREEN GROWTH**

Contributors look at 50 years of friendship and  
a sustainable-energy Green Growth future

# “How we can feed ourselves sustainably in a low carbon economy?”



Wanzhuang Eco City © Vyonyx/Arup/Client SIIC

Climate change, water shortages, rising crude oil prices and an expanding population are beginning to question the resilience of our current farming and food supply systems.

In the near future localised food production – integrated into the city’s infrastructures – might well be a key factor in securing access to affordable and healthy food for new and existing communities.

Arup understands the need for localised integrated food production in a Slim City – the resource and carbon efficient cities of the future.

Our multi-disciplinary teams are assisting clients to set the bar for sustainable development, and are committed to help implement initiatives that strive to make a difference to society.

We assist local and state governments in identifying what food sustainability means and how it transfers into policies and projects.

Our model for planning sustainable cities has been developed and used to inform Arup planning projects worldwide - including masterplanned communities in Queensland and Victoria (Australia), Zuidas (The Netherlands), Chaiten and Noviciado (Chile), Baku City Development (Azerbaijan), Ebbsfleet and Northstowe (UK), Destiny (US), Wanzhuang and the Changxindian Community (China) and the design for the Low2No development in Helsinki (Finland).

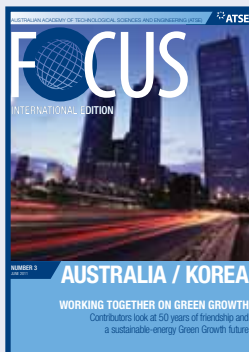


## Australia pursues Green Growth with Korea

■ Green Growth initiatives in Korea have attracted Australian attention and have led the Australian Academy of Technological Sciences and Engineers (ATSE) and the National Academy of Engineering of Korea (NAEK) to hold international Green Growth workshops workshops in Seoul (2010) and Melbourne.

The purpose of the recent Australia Korea Green Growth workshop in Melbourne was to inform Government, industry and the research community of the potential to pursue a coordinated Green Growth policy in Australia.

This edition of *ATSE Focus* concentrates on the emerging relationship and interdependence between Australia and Korea, highlighting particularly the bilateral Green Growth endeavours. A number of the international workshop presenters have authored articles, as well as leading figures in the Australia-Korea relationship.



Front cover: South Korea – a rapid-growth economy with a strong focus on sustainability.  
Photo: iStockphoto



Australian, Korean, Canadian and US scientists lower monitoring tools down CRC-2 well prior to injection of CO<sub>2</sub> at Australia's CO<sub>2</sub>CRC Otway Project (page 20).

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# FOCUS

*ATSE Focus International* is produced to highlight Australia's relationship with the international community in the areas of science and technology and the Academy's role in engaging with partner countries. It will be produced from time to time to reflect a key aspect or development in the science and technology relationship between Australia and another nation.

Its purpose is to stimulate interest, discussion and development of research and research application opportunities for the benefit of both nations, and the world. Articles are contributed by ATSE Fellows with particular expertise in topic areas and by key figures in the relationship.

Please address comments, suggested topics and article for publication to [editor@atse.org.au](mailto:editor@atse.org.au).

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# Australia is Korea's "important ally"

It is crucial for Korea to engage in international collaboration with countries leading in these areas, especially countries such as Australia.



By Jong-Kee Yeo

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Australia and Korea have enjoyed a good friendship for decades. The year 2011 is the 'Australia-Korea Year of Friendship', which celebrates the 50 years of diplomatic relationship between the two countries.

Australia has been an important political, strategic and economic ally of Korea. Among many aspects of collaboration between two countries, renewable energy and 'green growth' are hot topics in both countries and a continuous collaboration would be mutually beneficial.

Nowadays, climate change and renewable energy are important issues in every nation – and Korea is no exception. In fact, Korea is considered as being more vulnerable to the effects of climate change and more dependent on fossil fuel than most other countries. For example, the average surface temperature in Korea rose by 1.75°C between 1912 and 2008, greater than the world average.

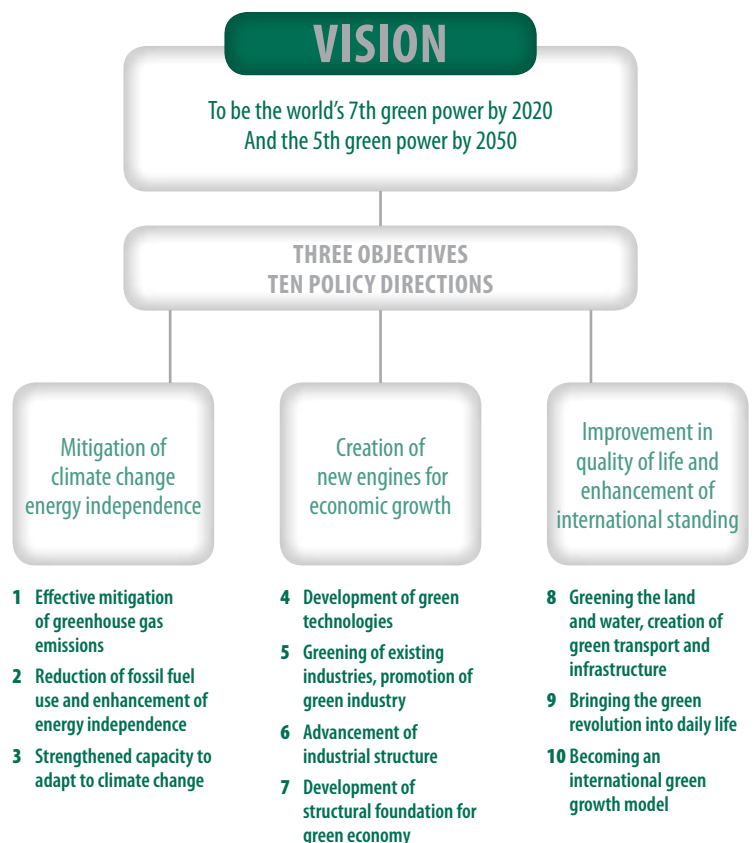
Therefore, the Korean government has taken strong initiatives to resolve these issues through the Framework Act on Low Carbon and Green Growth, promulgated in January 2010. It has been designed to mitigate climate change, accomplish energy independence, create new engines for economic growth, and improve quality of life (see diagram, right).

To achieve this vision and objectives, we must develop technologies related to new and renewable energy sources. For example, our government's goal is to secure a 13 per cent share in the world market of the following nine technologies by the year 2030: solar energy, wind power, LEDs, electronics and IT, hydrogen fuel cells, green fuel, IGCC (integrated gasification combined cycle), and CCS (carbon capture and storage).

For the next five-year plan, the Korean Government estimates that an investment of about US\$300 million will

be required in each of the nine technologies listed above. Of this projected amount, the Government will contribute 60 per cent and industry is expected to contribute the remaining 40 per cent. Moreover, the Korean Government has voluntarily announced a 30 per cent reduction in greenhouse gas emissions by 2020.

To realise this ambitious goal, it is crucial for Korea to



source: [www.greengrowth.go.kr](http://www.greengrowth.go.kr)

## Contributions are welcome

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

Networking at people-to-people, academia-to-industry, and institute-to-institute levels will greatly increase collaboration and opportunities in the future.

engage in international collaboration with countries leading in these areas, especially countries such as Australia.

Through the Australia–Korea Green Growth International Workshops, jointly organised by Australian Academy of Technological Sciences and Engineering (ATSE) and the National Academy of Engineering of Korea (NAEK) in Seoul on 27 to 29 April 2010 and in Melbourne on 17 to 18 March 2011, we have learned that the two countries share the same approach for achieving economic development with minimal environmental effect.

We also found that Australia has already accumulated considerable knowledge in the related technologies. These workshops have enabled us to share common interests on climate change and clean energy. They have also served to bring into contact representative scientists and engineers working in energy-related areas across industry, academia, and research institutes.

NAEK greatly values its intimate partnership with ATSE to jointly promote international networking and collaborative opportunities and enhance national competitiveness, economic well being, and environmental sustain-

ability. The ongoing technological innovation and bilateral cooperation will be beneficial for both countries.

Networking at people-to-people, academia-to-industry, and institute-to-institute levels will greatly increase collaboration and opportunities in the future. I believe that our collaborative efforts along with the upcoming Free Trade Agreement between Australia and Korea will serve to open avenues for greater collaborations in many different technological areas. ◀

**DR JONG-KEE YEO** is Executive Vice President, National Academy of Engineering of Korea (NAEK) and Executive Advisor of LG Chem. He served as President and CTO of LG Chem from 2000 to May 2006. Dr Yeo is a graduate of Seoul National University, with a BS and an MS in chemical engineering. He received his PhD (in polymer science and rheology) from Lehigh University, USA. He has received The Order of Science and Technology from the Korean Government, the Korean Ministry of Science and Technology's Technology Award and the NAEK Award from NAEK and the Technology Management Award from Korea Industrial Technology Association.

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CONTENT MATTERS



# Common values and strategic interests underpin our links

Regular high-level visits between the two countries demonstrate the strength and importance of the bilateral relationship.



By Sam Gerovich

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It would be rare to find an Australian home today that did not contain products from Korea. The investment relationship is also growing and diversifying, binding our economies closer together.

This year marks a significant milestone – the 50th anniversary of diplomatic relations – for Australia and the Republic of Korea and is designated the Year of Friendship.

Over the past half-century, Australia and Korea have become firm friends and close partners. We share common values and strategic interests, and our economies complement each other, driving mutual prosperity. Korea is Australia's fourth largest trading partner. Australian minerals, energy and services contribute to the development of Korea's high-tech export sector and highly-educated workforce.

Similarly, Australia is an important market for Korean passenger vehicles, electronic goods and household appliances. It would be rare to find an Australian home today that did not contain products from Korea. The investment relationship is also growing and diversifying, binding our economies closer together.

Frequent high-level engagement between Canberra and Seoul demonstrates the importance of the bilateral relationship. Recently, reciprocal visits by leaders have accelerated, and focused on wide-ranging topics from regional security, trade liberalisation to climate change.

The visit to Korea in April by Prime Minister Julia Gillard was symbolic of the importance the two governments attach to the bilateral relationship. Prime Minister Gillard was the first Australian Prime Minister to celebrate ANZAC Day – our national day to honour the sacrifice of our soldiers in war – on Korean soil. Australians may not always be aware of the role Korea and Australia have played in each other's history, but we have always supported one another when it counted.

During Prime Minister Gillard's visit, the two governments reaffirmed their strong commitment to conclude Free Trade Agreement (FTA) negotiations this year. The conclusion of a comprehensive FTA, which will strength-

en economic cooperation and provide a significant boost to both economies, is the next logical step in the bilateral trade and economic relationship.

Our complementary relationship also incorporates the battle against climate change. During her visit, the Prime Minister announced that Australia would contribute \$10 million to the Korea-led Global Green Growth Institute (GGGI), to support the development of green growth strategies and policies in developing countries.

Australia joining the GGGI followed discussions initiated by President Lee Myung-bak during his visit to Australia in March 2009. He made the case that Australia and Korea, as middle powers, should lead global efforts to fight global warming. Our partnership within the GGGI represents an exciting opportunity to take this vision forward, and adds to the cooperation we already enjoy in the Global Carbon Capture and Storage Institute (GCCSI), where Korea was one of the founding members.

Prime Minister Julia Gillard and Korean President Lee Myung-bak at the Leaders' Summit in Seoul in April 2011.



# Decontaminating – for a safer, cleaner and greener world.

Over the past century, there has been widespread contamination of soil, air and water by urban waste disposal, industrial activities, mining and minerals processing and agriculture. The environmental, economic and social consequences of this are enormous. Environmental management of land and groundwater contamination alone is estimated to cost in excess of A\$1 trillion per year globally.

UniSA's Centre for Environmental Risk Assessment and Remediation (CERAR) is at the forefront of environmental remediation research. Established in 2003, the Centre aims to minimise risk to human and ecosystem health through rigorous risk assessment and the development of cost effective and sustainable remediation technologies for air, soil and water contamination. The Centre is also home to, and a major partner with, the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE).

CERAR's varied research and training work engages in many international collaborative projects, particularly across the Asia-Pacific region. These have led to cutting-edge technology developments and research training in the area of environmental risk assessment, management and remediation.

A current collaboration in Korea led by the Professor Nanthi Bolan and his team is making important developments in green technologies. Working with the Hub University of Industrial Collaboration (HUNIC) based at the Gyeongnam National University of Science and Technology (GNTECH) in Korea, the collaboration has resulted in an important exchange of information, staff and students. As a result, training and capacity building has been significantly advanced around green approaches to contaminant containment and remediation.<sup>1</sup>

This highlights just one example of how CERAR and its many international collaborators are continuing their vital work in minimising risk to human and ecosystem health by delivering superior research solutions.<sup>2</sup> These are directly helping Australia and our region maintain a healthy environment central to our health, safety and sustainable prosperity.

For more information about research at UniSA visit [unisa.edu.au/research](http://unisa.edu.au/research)

<sup>1</sup>Nanthi Bolan, Jin Hee Park, Brett Robinson, Ravi Naidu and Keun Young Huh. 2011. Phytostabilization: a green approach to contaminant containment. *Advances in Agronomy* 112, 146-203.

<sup>2</sup>Recent Excellence in Research for Australian (ERA) rankings confirmed UniSA's outstanding performance above world standard in Environmental Science research.

*HUNIC students from Korea undertaking research training at UniSA's Centre for Environmental Risk Assessment and Remediation.*



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## Collaboration potential

Australia and Korea have well-established scientific networks and research collaborations, based on the complementary nature of our respective scientific research and industry sectors: Australia has advanced university-based science, and Korea has strong market-oriented research and development, and expertise in patenting. These links are predicated on Australia's strong export of educational services to Korea. At the end of 2010, there were approximately 35,000 Korean students enrolled in Australian education institutions.

Australia and Korea have a bilateral Agreement on Scientific and Technological Cooperation and a range of other formal agreements between government and scientific bodies. Under these agreements and institutional links, Australian researchers have been working closely with their Korean counterparts. Australian researchers are increasingly collaborating with Korean colleagues and joint scientific publications have risen steadily in recent years to 421 in 2010, ranking Korea as our 18th partner for collaborative science and technology research.

While visiting Australia in 2009, President Lee visited the School of Photovoltaic and Renewable Energy Engineering at the University of New South Wales (UNSW), one of the world's leading research centres for solar and other new energies. He recognised that Australia was a world leader in carbon capture and sequestration and renewable energy technologies. He emphasised that Korea could help

commercialise Australian research and technology.

I would like to commend the work of the Academy of Technological Sciences and Engineering (ATSE), the Australian Academy of Science (AAS) and the Australia–Korea Foundation for building strong linkages between Australian and Korean science authorities, research institutes and academics. Many of these important programs and initiatives, which form the foundation for future collaboration, are showcased in this publication, including Green Growth Workshops, the Korea–Australia–New Zealand (KANZ) Broadband Summits and the Early Career Researchers Exchange Program.

Australia and Korea face a number of common challenges, including climate change, energy security, environment protection, ageing populations and growing health-care obligations, and both governments recognise that science and innovation will be a key pillar of economic growth and social development in the coming decade and beyond. ◀

**HIS EXCELLENCY MR SAM GEROVICH is the Australian Ambassador to the Republic of Korea (since 2009) and was formerly a First Assistant Secretary in the Australian Department of Foreign Affairs and Trade (2006–08). He graduated from the University of Sydney and joined Foreign Affairs in 1972 and served in progressively more senior roles representing Australia in Hong Kong, Beijing, Tokyo, Taipei and Shanghai (Consul-General, 2002–06). He speaks Chinese, Japanese and Russian.**

## Korea–University of Wollongong collaboration will revolutionise medical bionics

■ A significant research collaboration between Australia and Korea was formed recently enabling the development of revolutionary bio-printing technology used to develop groundbreaking medical bionic devices.

The ARC Centre of Excellence for Electromaterials Science (ACES) hosted the President of the Korean Institute of Machinery and Materials (KIMM) at the University of Wollongong (UoW) to sign an agreement that will enable ACES to forge ahead with its work in medical bionics.

"Fabrication of devices based on next-generation materials using old-generation fabrication methods is not realistic," said ACES Executive Research Director Professor Gordon Wallace FAA FTSE. "We must confront the reality that we need to develop new machinery to tackle these complex tasks."

Combining world-class expertise in the fields of materials and machinery, the collaboration will initially focus on building new bio-printing technologies. This will feed directly into the ACES bionics program, specifically in the areas of nerve and muscle repair as well as

detection and control of epilepsy.

"To bring practical solutions to the community in the quickest timeframe possible, we must combine with partners wherever they are able to bring all the skills to the table," Professor Wallace said.



**Dr Sang-Chun Lee, President of the Korea Institute of Machinery and Materials, and Professor Gordon Wallace, Executive Research Director of ACES, after the signing.**

# Time to promote more bilateral collaboration

In comparison to the level of bilateral cooperation that has been achieved so far in other fields, the two countries' collaboration in the science and technology area is less significant.



By Kim Woo-sang

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**2**011 marks a special year in relations between Korea and Australia: this year we celebrate the 50th anniversary of the establishment of bilateral diplomatic ties. Over the past five decades, both countries have cultivated an extensive partnership featuring strong commercial ties, strategic security cooperation and broad people-to-people links.

The partnership has been accelerated not only by the necessity of the private sector, but also by the strong commitments of two governments with shared strategic and economic interests.

Korea has become Australia's fourth-largest merchandised trade partner after China, Japan and the US. Bilateral economic and trade relations will be further enhanced if the on-going FTA negotiations are concluded, hopefully, within the year.

In comparison to the level of bilateral cooperation which has been achieved so far in other fields, the two countries' collaboration in the science and technology area is less significant. According to the Australian Research Council, the total number of Korean research institute collaborations with ARC-funded programs was 161 cases up to 2008, or 1.2 per cent compared to China at 506 cases (3.7 per cent), Japan at 674 cases (5.0 per cent) and the US at 3197 cases (23.5 per cent).

I believe that the time is now for promoting bilateral collaboration in science and technology to complement our strong bilateral ties in other areas. The scope of cooperation should be extended from the individual research project to wider studies based on broad national policy.

In this regard, the ongoing cooperation between the

Australian Academy of Technological Sciences and Engineering (ATSE) and the National Academy of Engineering of Korea (NAEK) is encouraging. In 2010 and 2011 respectively, the ATSE and the NAEK held two workshops on green growth aiming to identify opportunities for co-operation in areas such as renewable energy, smart grid and carbon capture and sequestration.

Likewise, there are notable efforts between the Korea Energy and Mineral Resources Engineering Program (KEM-REP) and the University of Western Australia and Curtin University, whose 2010 MoU generates exchanges which strengthen the relationship between the two countries, leading to high quality knowledge exchange. I am hopeful that initiatives like these will boost investment in and commercialisation of Australian and Korean innovations.

From a Korean perspective, Green Growth policy has been given the highest priority in the national economy and science arenas. On 15 August 2008, President Lee Myung-bak announced that "Low Carbon and Green Growth" was Korea's new national vision for the next 60 years. The Korean strategy in green growth seeks to promote the development of core green technologies that will provide future engines of growth to the Korean economy. To this end, the Korean Government has poured around a \$1.2 billion budget in 2010 into national R&D projects. These funds, together with industry investment, will be expanded to \$2.2 billion in 2011.

While both countries are undertaking collaboration in these areas, there is much greater potential for Australia-Korea bilateral cooperation in green growth and climate change. Korea has participated in the activities of the Global Carbon Capture and Storage Institute from its foundation, and the good news to come out of Prime Minister Julia Gillard's visit to Korea in April this year is the Australian government's plan to contribute \$10 million to the Global Green Growth Institute established by the Korean Government in 2010.

But neither country needs to confine its collaborative

From a Korean perspective, Green Growth policy has been given the highest priority in the national economy and science arenas. On 15 August 2008, President Lee Myung-bak announced that "Low Carbon and Green Growth" was Korea's new national vision for the next 60 years.

# Transitioning to a low-carbon future

Australia has a natural interest in working closely with Korea to advance opportunities to reduce greenhouse gas emissions from fossil fuel.



By Martin Hoffman

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**T**his year, Australia and Korea celebrate 50 years of friendship. There are many facets to this friendship, but given my responsibilities in the Department of Resources, Energy and Tourism one common feature that I find of particular interest is the fact that, over this period, both countries have witnessed major changes in energy demand and usage.

For instance, Australia's population has grown from nine million people to more than 22 million. Australian households of today use, on average, close to four times the energy they did in the 1950s. Korea's population and energy demand has experienced similar trends arising from decades of technological change and economic prosperity.

Both countries are heavily dependent on fossil fuels for electricity, although in Australia we rely more on coal rather than petroleum products. Korea is one of Australia's most important and enduring trading partners for energy resources. For example, Australia is Korea's number one supplier of coal and a major supplier of oil and uranium. In future, liquefied natural gas could become a significant commodity in the trade and investment relationship. In total, Korea accounts for almost 15 per cent of our energy exports.

Australia therefore has a natural interest in working closely with Korea to advance opportunities to reduce greenhouse gas emissions from fossil fuel. From the Australian Government's perspective, this must be in combination with policies which ensure we can take advantage of other emerging energy technologies which will allow us to move away from our reliance on fossil fuels, without compromising energy security and reliability.

The role of innovation in energy technology is critical to the pursuit of a low-carbon society. This is why the Australian Government established our \$5 billion Clean Energy Initiative, which supports the research, development and demonstration of emerging renewable and low-emissions fossil fuel technologies. For example, the Clean Energy Initiative will drive advances in large-scale solar power, geothermal, ocean energy and carbon capture and storage (CCS).

Australia is Korea's number one supplier of coal and a major supplier of oil and uranium. In future, LNG could become a significant commodity in the trade and investment relationship.

Importantly, this direct government funding will work alongside our legislated Renewable Energy Target of 20 per cent by 2020. The Renewable Energy Target has generated billions of dollars in private investment in mature technologies like wind and solar photovoltaic, and will continue to drive strong investment in renewable energy over the coming decade.

The third enabling factor in accelerating the move to a low-carbon economy for Australia will be implementing a price on carbon, which is currently under development by the Government.

Like Australia, Korea is also making significant investments in the development of emerging energy technologies, including lower emissions power generation, CCS, energy efficiency, renewable energy and nuclear power.

Given our strong trading links in coal and petroleum products, it is particularly pleasing to see our growing relationship in the area of CCS, including technology research and development. For example, the Korean Institute of Geology, Mining, and Materials is working closely with various Australian research organisations, including the Australian Cooperative Research Centre for Greenhouse Gas Technologies and CSIRO to advance CCS. Multinational cooperation is also a feature of our relationship, including Korea's strong participation at both government and industry level in the Global CCS Institute established by Australia, and our common membership of other forums.

International collaboration is critical to accelerating the commercial deployment of emerging energy technologies. Australia welcomes the recent launch of the Global Green Growth Institute (GGGI) by Korea, which will establish a network through which countries can draw from the shared

► [MORE ON PAGE 22](#)



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# Green growth and innovation

Green growth is being examined by a range of countries and international organisations as an economic framework for sustainable growth.



By Michael Schwager

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**G**reen growth is about managing key risks to the economy, such as climate change and resource bottlenecks, in ways that simultaneously promote current growth and job creation.

Australia's Department of Innovation, Industry, Science and Research (DIISR) is supporting this process by encouraging a transformation in Australian industries and businesses through its national innovation system. It aims to drive knowledge creation, cutting-edge science and research, international competitiveness and enhance sustainability and productivity.

## Green growth has begun ...

Green growth will gradually transform production (through increased resource efficiency) and alter consumption (by establishing and expanding markets for green products and services). There are a variety of opportunities inherent in this transition.

First, consumers are reducing their environmental footprint, avoiding brands with poor environmental reputations and are often willing to pay a price premium for green products, all of which are opening up new markets for business.

Second, financial markets are increasingly promoting green outcomes, both directly (through the rise of socially responsible investment [SRI] funds, which target companies with good environmental and economic performance) and indirectly, as the broader financial community increasingly includes environmental risk factors in financial decisions. As an indicator of the scale of investment opportunities in this space, in 2010 SRI funds managed an estimated \$3.07 trillion in assets in the US, representing approximately 12 per cent of the total marketplace investment.

Third, green growth is being examined by a range of countries and international organisations as an economic framework for sustainable growth. The United Nations Environment Programme is looking at the potential of

the Green Economy, with a particular focus on promoting development. The US has announced that its priorities as host of Asia-Pacific Economic Cooperation (APEC) in 2011 will include green growth. Further, the Organisation for Economic Co-operation and Development (OECD) has developed a Green Growth Strategy Report, which was released at the OECD Ministerial Council Meeting on 25 and 26 May 2011.

The OECD identifies three key elements to green growth policies:

- improving resource management and boosting productivity;
- encouraging economic activity to take place where it is of the best advantage to society over the long term; and
- enabling new ways for business and the community to achieve these goals. Innovation was identified as being at the core of this process.

## ... but more innovation will be critical

As resource use continues to grow in the future, there will be a point at which outcomes that are simultaneously economically, environmentally and socially beneficial will be limited by the continued depletion of natural capital. Innovation will be the key to doing more with less, enabling continued growth beyond present limits.

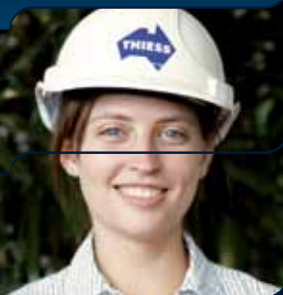
Innovation for green growth involves two quite different processes, each with different barriers to overcome.

The first process focuses on research and development. 'Radical



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innovations' (anything from new green building materials to fusion energy) have huge potential to drive green growth.

The Australian Government provides funding directly to public research organisations, such as CSIRO, and also promotes research and development in business through the Research and Development Tax Credit.

However, more can be done to capitalise on Australia's research strengths. Businesses face a variety of challenges at demonstration and commercialisation phases, ranging from a lack of experience and skills, to an immature venture capital market. Greater collaboration, improved skill development and the promotion of an innovation culture that supports research and development across the economy, particularly in small to medium enterprises, will be critical to achieve green growth.

The second process recognises that innovation is not just about new technology. It is also about greening the economy by increasing resource efficiency and implementing new production processes, distribution systems, business models, and communication strategies.

Unfortunately, many small businesses do not have the time, skills or resources to adequately respond to these opportunities. Often, green growth potential remains unrecognised or unexplored, due to lack of information or skills, or is perceived as being too peripheral to the bottom line. In other cases, cleaning up business operations may require significant investment or retooling.

Australian Government programs, such as Enterprise Connect's Clean Business Innovation Centre and Supplier Advocates, are contributing to overcoming these failures and easing restrictions on businesses' access to finance.

Green growth is about capturing opportunities from new technologies and innovative ways of doing business. The Australian Government has an important role in catalysing and supporting this transformation to secure a more prosperous and sustainable future for all Australians. ◀

MICHAEL SCHWAGER is currently Head of the Industry and Small Business Policy Division in the Australian Government's Department of Innovation, Industry, Science and Research (DIISR). The Division provides advice on a wide range of policy issues affecting the competitiveness and growth of Australian businesses; and has specific responsibilities for policies relating to small business, regulation reform, independent contractors and the service economy. His previous roles in the Australian Public Service included responsibility for pharmaceutical and biotechnology industry development, foreign investment attraction, international energy trade policy, agricultural trade policy and a stint managing corporate functions. He completed his Bachelor of Economics at the University of Sydney.



# Green Growth under the spotlight



Professor Robin Batterham and Professor Jong Kee Yeo at the workshop.

■ Green growth options and the impact of low-carbon energy in both countries were front of mind when leading Australian and Korean researchers, industry and business leaders and government officials met in Melbourne recently.

With the backing of the National Academy of Engineering of Korea (NAEK), ATSE held the second international workshop – Australia Korea Green Growth – which followed the first bilateral workshop, held in Seoul in April 2010.

ATSE President Professor Robin Batterham AO FREng FAA FTSE said that global understanding was emerging of the importance of integrated and innovative policies in resource management (including energy, water, food, health and environmental security) – both within and transcending national borders – not only to address the challenges of climate change but also to provide a positive stimulus for new jobs in new industries with a strong and sustainable economy.

“Such an integrated, multidisciplinary approach is being termed in a number of arenas as ‘Green Growth’,” Professor Batterham said. “The Green Growth initiatives being actively pursued by the Republic of Korea have important policy implications in Australia.

“Korea has already implemented a comprehensive strategic

This edition of *Focus* concentrates on the emerging relationship and interdependence between Australia and Korea, highlighting particularly the bilateral Green Growth endeavours. A number of the international workshop presenters have authored articles, as well as leading figures in the Australia-Korea relationship.

approach to Green Growth and the country sees it as the best solution for promoting a sustainable climate and environment while building and maintaining internationally competitive industries.”

## SPEAKERS AT THE PLENARY SESSION:

- 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.

## Letters to the Editor

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

### AUSTRALIAN SPEAKERS AT THE WORKSHOP

Australian speakers at the workshop were drawn from universities, CSIRO, Cooperative Research Centres and industry and included Dr David Brockway FTSE, Director, Global Energy, CSIRO, and Professor Veena Sahajwalla FTSE, Director, Centre for Sustainable Materials Research & Technology, UNSW. Others were Professor Richard Corkish, Head of School of Photovoltaic & Renewable Energy Engineering, UNSW; Dr Michael Goldsworthy, CEO, SilexSolar; Dr Gerry Wilson, Theme Leader, CSIRO Future Manufacturing Flagship; Ms Sylvia Tulloch, Managing Director, Dyesol; Dr David Harris, Theme Leader, Energy Technology, CSIRO; Mr Peter Coombes, Manager Sustainability, Delta Energy; Professor Rachel Webster, Melbourne Energy Institute, Melbourne University; Dr Graeme Beardsmore, Technical Director, Hot Dry Rocks Pty Ltd; Ms Anna Skarbek, Executive Director, ClimateWorks Australia; Mr Alan Pears, Co-director of Sustainable Solutions; Adjunct Professor at RMIT Centre for Design; Dr David Cornforth, Research Scientist, CSIRO Energy Technology; Professor David Hill, Chair, University of Sydney Centre for Intelligent Electricity Networks; and Dr Mark Bonnar, Investment Director, Cleantech Ventures.

### KOREAN WORKSHOP PARTICIPANTS

Korean participants included Professor Jong Kee Yeo, Executive Vice President, National Academy of Engineering of Korea (NAEK); Dr Sangwook Park, Principal Research Engineer, Solar Research Institute, Solar Business Division, LG Electronics; Dr Kyungkon Kim, Solar Cells Center, Korean Institute of Science & Technology (KIST); Professor Myongsook Oh, Department of Chemical Engineering, Hongik University; Dr Dae Gee Huh, Korea Institute of Geoscience and Mineral Resources; Dr Chong Kul Ryu, Chief Researcher, Green Growth Laboratory, KEPCO Research Institute; Dr Yoonho Song, Geothermal Resources Department, Korea Institute of Geoscience and Mineral Resources; Dr Seok Hun Kang, Senior Researcher, Korea Institute of Energy Research; Mr. Soon Yeol Jeong, Senior Manager, Korea Electric Power Corporations; and Mr Taehyong Park, Group Leader, Business Strategy & Marketing Group, Fuel Cell Division, POSCO Power.

The workshop, supported by the Australian Government and the Australia–Korea Foundation, aimed to inform Government, industry and the research community of the potential to pursue a coordinated Green Growth policy in Australia.

## ATSE welcomes Ian Chubb as new Chief Scientist

■ In a media release responding to the appointment of Professor Ian Chubb as Chief Scientist, ATSE said his long and distinguished record in science and academia would help him serve the nation well in the role.

Professor Robin Batterham AO FREng FAA FTSE, ATSE President and former Chief Scientist, said Professor Chubb – the 2011 ACT Australian of the Year – had provided three decades of service to tertiary education and university governance in Australia and internationally and had made an exceptional contribution to the Australian National University in the decade he served as its Vice Chancellor.

A neuroscientist by training, Professor Chubb understood science, believed a robust higher education system was crucial to the economic and social success of the nation and had been a powerful commentator on education policy, Professor Batterham said.

“ATSE and the Australian Council of Learned Academies (ACoLA) look forward to working with Professor Chubb in his new role to ensure that Government investment in technology and science is maintained and our established skills and commercial results in many areas of pure and applied research are enhanced,” Professor Batterham said.

“We look forward to him bringing his broad suite of skills to bear for the benefit of the entire spectrum of research – from fundamental inquiry to RD&D at the commercial stage.”

Liaison with the Minister’s office resulted in the ATSE media release being posted as a link on the Minister’s website.



Ian Chubb

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## Time to promote more bilateral collaboration

activities to green growth and climate change. On the contrary, the scope and areas for cooperation should be expanded. Agri-food, manufacturing technology, chemical research, telecommunication, information technology and other fields can be taken into account.

Indeed, the Agreement between the Government of Australia and the Government of the Republic of Korea on Scientific and Technical Cooperation, signed in 1999, provides an existing mechanism for bilateral collaboration. Based on this Agreement, both countries need to work together to develop our innovative ideas into meaningful and sizeable collaborative programs in the areas of science and technology. ◀

**HIS EXCELLENCY PROFESSOR KIM WOO-SANG** was appointed the Korean Ambassador to Australia in May 2008. Previously he was director of the Institution of East and West Studies at Yonsei University, member of the Advisory Committee of National Security Council, and a key adviser to President-elect Lee Myung-Bak on foreign policy and security. He received his PhD in Political Science in 1988 from the University of Rochester. For 20 years he has researched and taught international politics at a number of institutions including Hoover Institution at Stanford, Texas A&M and Yonsei University in Seoul. He still holds a professorial position at Yonsei.

# Australian CCS lessons have world value

Considerable research is needed to optimise CCS technologies for coal-fired power generation, but all the elements are known and proven.



By David Brockway

david.brockway@csiro.au

**T**he term carbon capture and sequestration or carbon capture and storage (CCS) is often misunderstood or at best misapplied to only part of the complete CCS process. For power production from fossil fuels, CSS can be considered to include three key elements. The first comprises a number of energy conversion processes involving coal combustion and/or gasification through to power production. The second includes separation and capture of the carbon dioxide (CO<sub>2</sub>) emissions, usually drying and compression of the gas and its transmission or transportation to a sequestration site. The third comprises essentially permanent sequestration or storage of the CO<sub>2</sub>.

In the case of geosequestration, storage is achieved in a porous rock with an impermeable cap rock at a depth of at least 800 metres, such that the CO<sub>2</sub> remains as a supercritical fluid while it undergoes further chemical and/or physical reactions with its surroundings over many years.

While there remains considerable research to optimise CCS technologies for coal-fired power generation, all the elements are known and proven, albeit often at a smaller scale and without full integration. The principal challenge facing large-scale adoption of CCS technologies is to achieve demonstration of a number of integrated technologies and apply the learnings from these to improve the technologies and significantly reduce their cost. To this end the G20 announced the objective to achieve 20 commercial-scale CCS demonstrations by 2020.

The Australian Government accepted the challenge to play its part supporting several such demonstration plants. Recognising that these plants would be high-cost, first-of-a-kind and competing in the Australian electricity market, several years ago the Commonwealth announced the CCS Flagship program, originally funded with \$2 billion and reduced to \$1.68 billion in the recent Federal Budget.

The black coal industry also committed significant funding (\$1 billion) to CCS demonstrations as have some State governments, notably Victoria – with its Energy Technology Innovation Strategy (ETIS) program.

The key objective of the CCS Flagship program is to facilitate at least one and preferably several commercial-scale CCS plants in Australia. The CCS Flagship funding was intended to provide the additional resources, over and above that provided by industry and State Governments, to ensure commercial viability of the projects.

Following a short listing process, four projects were selected to prepare full business cases from which the Commonwealth would select one or more for funding support. These four are the ZeroGen, Wandoan, CarbonNet and Collie Hub projects. The two Queensland projects (ZeroGen and Wandoan) are for standalone IGCC-CCS projects and the latter two are for projects with a hub collecting CO<sub>2</sub> from a number of sources from which the gas will be sequestered.

Example of sources include the HRL Dual Gas IDGCC plant and/or the TRUenergy IGCC plant in Victoria (CarbonNet) and the Perdaman coal to urea plant in WA (Collie Hub) (see [www.atse.org.au/resource-centre/func-startdown/373](http://www.atse.org.au/resource-centre/func-startdown/373)).

Separate from but complementary to the CCS Flagship projects, a number of other CC demonstration plants are planned such as post-combustion capture (PCC) plants at existing power stations in Victoria, NSW and possibly Queensland.

One project that has progressed well past the planning stage and is now in construction is the Callide oxyfiring demonstration. This project is based around repowering the 30MW Callide A power station in Queensland to operate as an oxyfiring pulverised fuel boiler plant (see [www.atse.org.au/resource-centre/func-startdown/373](http://www.atse.org.au/resource-centre/func-startdown/373)).

In light of recent experiences and events, some modification to the original CCS Flagship program has been announced. Recent experiences and events include:

- the need, cost and risk to delineate a 'bankable' sequestration site has become clearer following the experience of ZeroGen. (ZeroGen was arguably the leading CCS project in Australia; certainly the most developed. In attempting to delineate a bankable





UQ's new "Sustainable Building" to be built in 2011 will house the Global Change Institute and be an example of modern green technology in action.

# DISCOVERY FOR THE NEXT CENTURY

**As UQ embarks on its second century, it is imperative that our work continues to meet the needs of a diverse and dynamic world.**

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- The Queensland Alliance for Agriculture and Food Innovation is a partnership with the Queensland Department of Employment, Economic Development and Innovation, and together we will maximise the calibre of research in agriculture and related areas, including food security.

- UQ leads the nationwide Terrestrial Ecosystem Research Network that will radically improve the accuracy of assessment of the effects of climate and land use changes on ecosystems.
- A research consortium, led by UQ, brings together some of the biggest names in global aviation to secure a green fuel initiative that could slash greenhouse gas emissions by turning sugar into jet fuel.

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

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

sequestration site, the company is believed to have committed about \$90 million to exploration in the Dennison Trough only to find that it was unsuitable due to low permeability and porosity in the basin);

- there are a number of other challenges around a first-of-a-kind CCS project including permitting, technology integration and a schedule determined by external considerations;
- there has been an unforeseen, rapid and significant escalation of capital cost for plant and equipment over recent years;
- the global financial crisis has significantly impacted on the capacity of the Federal Budget to provide funding for the CCS program at level and in the timeframe originally envisaged; and
- it has become apparent that the Commonwealth funds alone may be insufficient to ensure commercial viability of full-scale coal-fired generation plants incorporating CCS in the Australian electricity market, considering that the market is one of the most competitive in the world (under current policy settings, new generation plant incorporating CCS will find it hard to compete commercially with existing plant with largely written down capital and no CCS.)

Possibly, in light of these experiences and events, the most recent Federal Budget announced changes to the CCS Flagship program including savings of \$250.9 million, with \$60.9 million to be redirected to the establishment of 'National CO<sub>2</sub> Infrastructure Plan'. Clearly funding for the plan is intended to contribute to addressing the issue of delineating 'bankable' sequestration sites. The budget also announced 'rephasing' of \$420 million to 2015-16 and beyond.

It is critically important that a significant number of CCS demonstration projects are undertaken world-wide. The recent experiences in Australia appear to hold important lessons for other countries embarking on a CCS demonstration program. ◀

**DR DAVID BROCKWAY FTSE is Director Global Energy for CSIRO. In this role he is responsible for developing major national and international collaborations between CSIRO, other research organisations, industry and governments. Until recently he was Chief of CSIRO's Division of Energy Technology, which undertakes R&D on fossil fuels, renewables, energy storage, intelligent energy management, distributed generation and energy scenario modelling. For the previous decade he was CEO of the CRC for Clean Power from Lignite and its predecessor, the CRC for New Technologies for Power Generation from Low-Rank Coal. This was preceded by 13 years with the SEC Victoria.**

## Research collaboration in the spotlight

■ Four experts with international experience in the linking of research organisations and industry were among the speakers at a May seminar in Sydney that put the spotlight on the strengthening collaboration between research organisations and industry in Australia.

The issue is a key to national innovation as the effectiveness of research collaborations between research organisations and industry reflects to a large extent the success of a nation's innovation system, which in turn influences the nation's economic prosperity. Deeper collaboration between industry and academia and research organisations is encouraged by governments to increase national competitiveness and wealth creation.

Professor Philip Ternouth, Visiting Professor, University of Salford, and Associate Director for R&D and Knowledge Transfer at the UK Council for Industry and Higher Education, addressed the situation in Britain. Professor Liangchi Zhang FTSE, Scientia Professor and Australian

Professorial Fellow, University of NSW (UNSW), addressed the Asian experience.

The European experiences was addressed by Dr Anders Hallgren, Director, Sydnovate (formerly from Sweden) and Dr Klaus Lips, Deputy Director, Institute Silicon Photovoltaics, Helmholtz-Zentrum Berlin für Materialien und Energie (Germany).

They spoke at a two-day workshop, *Strengthening Links Between Industry and Public Sector Research Organisations*, held at the NSW Trade and Investment Centre, Sydney, organised by the Academy, funded by Federal Government through ISL-SAP and hosted for the NSW Government by Professor Mary O'Kane FTSE, NSW Chief Scientist.

ATSE Fellows speaking at the event included Professor Robin Batterham AO FREng FAA FTSE, ATSE President; Professor Paul Greenfield AO FTSE, Vice-Chancellor, University of Queensland; Dr Jim Patrick FTSE, Chief Scientist, Cochlear Ltd; Professor Hugh

Durrant-Whyte FAA FRS FTSE, CEO, NICTA; Dr Alan Finkel AM FTSE, Chancellor, Monash University; and Dr Rowan Gilmore FTSE, CEO, Australian Institute of Commercialisation.

Other speakers included Mr Ken Pettifer, Division Head of Innovation, Department of Innovation, Industry, Science and Research; Dr Katherine Woodthorpe, CEO Australian Private Equity & Venture Capital Association Ltd; Professor Les Field FAA, Deputy Vice-Chancellor (Research), UNSW; Dr Wayne Stange, CEO, AMIRA International; Dr Greg Smith, Executive Director, SciVentures; and Dr Alastair Hick, Director Commercialisation, Monash University.

Dr Terry Cutler FTSE, Principal, Cutler & Co, was the speaker at the workshop dinner and session chairs included Emeritus Professor Lesley Parker AM FTSE, Dr Bob Frater AO FTSE, Dr John Bell FTSE, Mr Peter Tyree FTSE and Professor Judy Raper FTSE. Professor Ron Johnston FTSE and Mr David Hinds FTSE were session leaders.

# Leading the way on carbon capture and storage

Australia has the potential to be a significant player in CCS and has been a pioneer in taking this technology forward.



By John Kaldi and Dae-Gee Huh

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**I**ncreasing concentrations of greenhouse gases in the atmosphere, including carbon dioxide (CO<sub>2</sub>) emitted by burning fossil fuels, are linked to climate change and are a major national and international concern.

Australia and Korea have a greater reliance on fossil fuels for their energy supply and industry than many other developed countries. Australia is one of the world's largest energy exporters and Korea one of the world's largest energy importers. Consequently, international efforts to limit CO<sub>2</sub> emissions worldwide will impact on both countries' economies.

Australia has the potential to be a significant player in the emerging new field of carbon capture and storage (CCS) – a technology that could potentially mitigate more than half of Australia's CO<sub>2</sub> emissions – mostly from the coal-fired power stations that supply 80 per cent of Australia's electricity.

Australia, through the efforts of the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC), has been a pioneer in taking this technology forward since 1999. CO2CRC is a joint venture linking participants from Australian and international industry, universities and other research bodies (including in New Zealand, the US and Canada, as well as Korea).

Australian State and Federal governments have placed CCS firmly on the agenda, introducing legislation to cover CO<sub>2</sub> storage in 2008 (Federal offshore and Victorian on-shore storage bills) and establishing the Australian-based Global CCS Institute.

A Korea Institute of Geoscience and Mineral Resources (KIGAM) scientist adjusting fittings for downhole assembly before lowering into CRC-2 well at Australia's CO2CRC Otway Project.





CCS involves removing CO<sub>2</sub> from the waste gases of major stationary sources, such as power plants, oil and gas production facilities, petroleum refineries and cement plants, and storing it rather than releasing it to the atmosphere.

The CO<sub>2</sub> is separated, captured and compressed before being transported via pipeline and injected as a super-critical liquid into suitable geological formations at least 800 metres below ground. At this depth the subsurface pressure keeps the CO<sub>2</sub> in its dense form.

The rocks required for injection must have adequate porosity in which CO<sub>2</sub> can be stored, as well as suitable permeability to allow the CO<sub>2</sub> to be injected into the reservoir, and an impermeable cap rock seal above to ensure that the injected fluid stays in the target reservoir. Depleted oil and gas reservoirs are a good example of the type of formations required for storage but there are a range of options for storing CO<sub>2</sub> for thousands if not millions of years.

Studies are underway to better characterise Australia and Korea's storage potential but it is believed that Australian geology is capable of storing hundreds of years' worth of the country's CO<sub>2</sub> emissions at current rates. Korea has, at present, far less identified storage capacity.

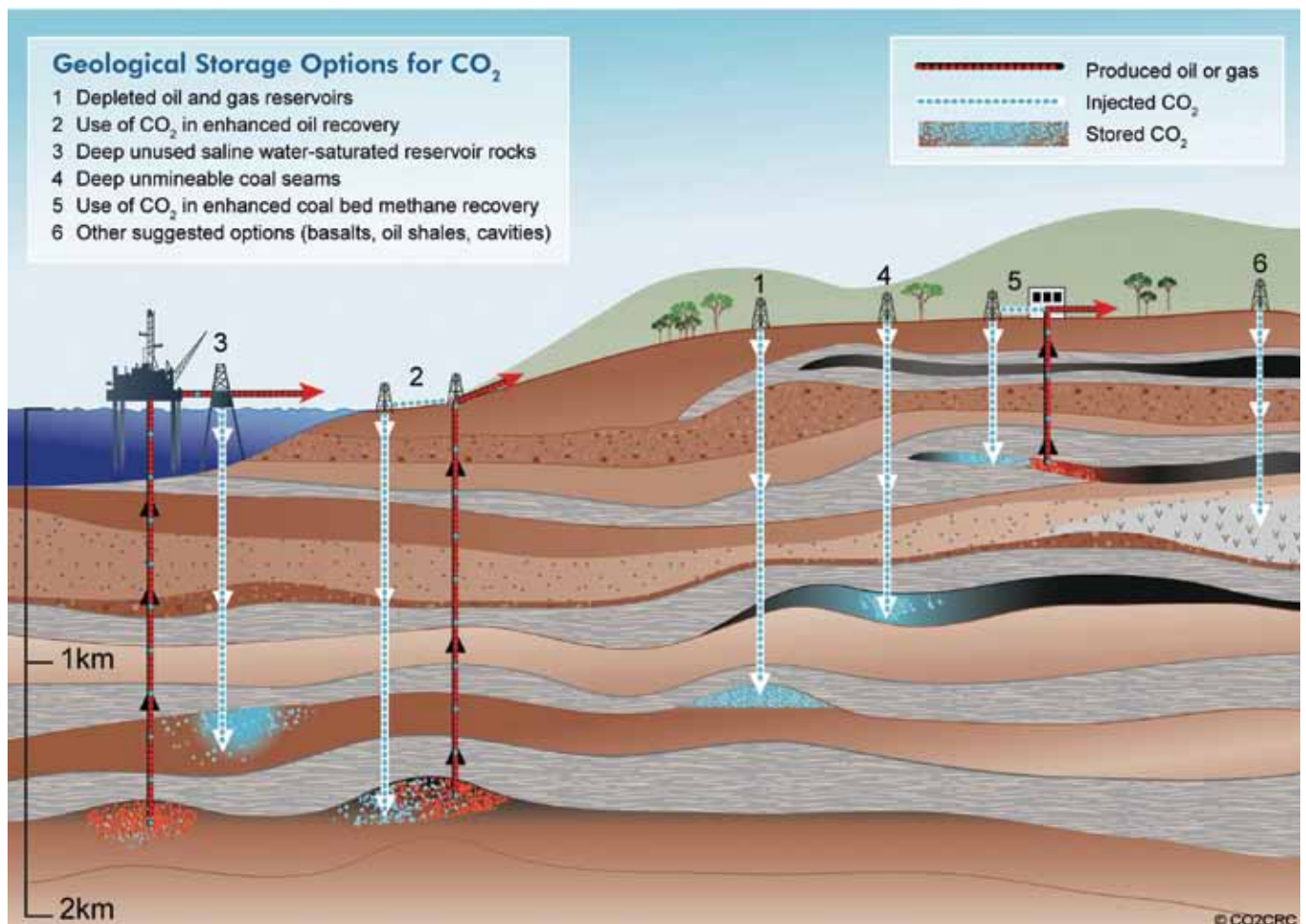
### The CO<sub>2</sub>CRC Otway Project

There are a number of storage projects underway or planned around the world, but there is only one project in Australia actually injecting CO<sub>2</sub> underground at this time – the CO<sub>2</sub>CRC Otway Project, the world's largest and most comprehensive non-commercial geosequestration research and demonstration project.

Based in south-west Victoria, the CO<sub>2</sub>CRC Otway Project has safely stored and monitored more than 65,000 tonnes of CO<sub>2</sub>-rich gas at a depth of approximately two kilometres during Stage 1 of the project. Stage 2, now underway, will inject smaller amounts into a different geological formation as part of ongoing experiments designed to fill in some of the knowledge gaps regarding CO<sub>2</sub> storage.

A major feature of the Otway Project is a comprehensive monitoring and verification program, one of the most rigorous in the world, which allows researchers from Australia, Korea, the US, New Zealand and Canada to better understand and model the behaviour of the injected CO<sub>2</sub>.

In planning the Otway Project, detailed geological models were built for the storage location, using regional data, depositional models and core data from well drilling. These models were then used as the basis for model-



ling the movement of the CO<sub>2</sub>, in order to predict how the injected plume would behave and guide the monitoring program. These models predicted that the CO<sub>2</sub> 'footprint' would be stable over long periods of time.

Data from deep subsurface monitoring in the storage zone is used to calibrate and test the project's computer models. A major outcome of the project is that the models will provide reliable tools for understanding CO<sub>2</sub> storage that can in turn inform future large-scale storage projects in Australia and elsewhere.

Assurance monitoring is also being carried out at the surface and near-surface. While no escape of CO<sub>2</sub> is expected, atmospheric CO<sub>2</sub> is continuously monitored to detect low levels of 'seepage' from the reservoir. In addition, soil gas levels are monitored seasonally, as is the chemistry of local deep and shallow water bores.

To enable researchers to distinguish between injected and naturally occurring CO<sub>2</sub> underground in the reservoir, the injected CO<sub>2</sub> has been uniquely marked with small amounts of chemically benign tracer compounds that allow researchers to track the movement of the injected plume and understand its behaviour.

Results from the monitoring program so far have found that the rate and direction of CO<sub>2</sub> migration has fitted within the range of predictions from pre-injection numerical modelling, giving researchers confidence that the models are robust and can reasonably predict how the CO<sub>2</sub> will behave.

The project's main technical achievement to date has been to demonstrate a carbon storage project from end to end, starting with site selection, geological and reservoir modelling, and moving on to the current phase of monitoring and verification. Site closure will follow in due course with a program of continued low-level monitoring that will be agreed with regulators.

The Otway Project has also tested the existing Australian legislation regarding CCS, identifying conflicts and overlaps between the relevant jurisdictions and helping to shape both the Victorian Greenhouse Gas and Geological Sequestration Act 2008, which provides a regulatory framework for onshore geological CO<sub>2</sub> storage, and the Australian Government's Environmental Guidelines for Carbon Dioxide Capture and Geological Storage.

Importantly the Otway Project is also demonstrating to the community, both locally and to the wider public, that CO<sub>2</sub> storage is both safe and secure. This is key if CCS is to be an effective element in the suite of tools needed to lessen the impact of climate change.

Korea plans to install two CO<sub>2</sub> storage demonstration projects by 2015. In order to reduce risks for these demonstration projects, technical specialists from Korea are utilising the Otway Project to gain experience for the better understanding of CO<sub>2</sub> geological storage and monitoring mechanisms. For this reason, Korean scientists and engineers are active participants and contributors to the Otway Project. ◀

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## Transitioning to a low-carbon future

knowledge of experts in policy and technology from around the world. Australia is providing \$10 million towards the GGGI because we see it as a very complementary initiative to Australia's other international efforts to help clean energy cooperation, including participation in the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), and the Clean Energy Ministerial. Most importantly, it provides a forum for countries to share learnings from work in the critical sector of transformational change in how we produce and use energy.

Australia looks forward to another 50 years of friendship with Korea. I particularly welcome the opportunity to continue to work closely on the goal of a global transition to a lower carbon future. ◀

**MR MARTIN HOFFMAN** is currently the Deputy Secretary of the Commonwealth Department of Resources, Energy and Tourism. He joined the Australian public service in March 2009 as a First Assistant Secretary in the Department of the Prime Minister and Cabinet. Mr Hoffman previously had a lengthy private sector career primarily in digital media and technology, including as CEO of NineMSN, Australia's largest internet media company, and as a venture capital investor and executive to smaller companies. He also held senior management roles with Fairfax Media and Optus. He holds an MBA(Hons), MAppFin, and BEc.

**JOHN KALDI** is the Chief Scientist for CO2CRC and Professor and Chair of Geosequestration at the University of Adelaide. His expertise is in CO<sub>2</sub> storage and petroleum geosciences and his previous role was heading the Australian School of Petroleum (ASP) at the University of Adelaide. Prior to academia, Professor Kaldi spent 18 years in the petroleum industry (with Shell, Arco and Vico), in both technical and managerial roles. He has received numerous honours and awards from professional societies, including the American Association of Petroleum Geologists (AAPG)'s Special Commendation for Significant Lifetime Contributions to Petroleum Geology; Distinguished Service Award; Honorary Member Award; and Public Outreach Award.

**DR DAE-GEE HUH** has been Principal Researcher at the Korea Institute of Geoscience and Mineral Resources (KIGAM) since 1989 and contemporaneously is President, Korean Society for Geosystem Engineering; Director, Petroleum Technology Research Organisation; and a Professor at the University of Science and Technology (UST). He is a former President of the Society of Petroleum Engineers, Korea. He has a PhD in Petroleum engineering, University of Southern California, and graduated in Mineral Engineering from Seoul National University.

# New technologies behind solar power integration



As third-generation solar moves out of the laboratories and pilot plants, we can look forward to photovoltaic functionality in our urban environments and everyday objects.



By Gerry Wilson and Sylvia Tulloch

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**A**s the costs of solar power get closer to the costs of power generation from nuclear and fossil fuels, scientists have begun working on new forms of solar technology that will enable solar power to be better integrated into our communities.

Solar power was long considered an expensive solution to the Earth's future energy needs and the quest to drive down manufacturing costs has stimulated much research into non-silicon PV technologies. This work, which began in the 1970s, led to a new generation of solar cells – generically called Organic Photovoltaics (OPVs), including Dye Sensitised Solar Cells (DSSC) and solar cells based on Bulk HeteroJunctions (BHJ).

While all solar technologies need to address issues of cost, longevity and efficiency, the approach taken can be quite different depending on the method of PV generation.

The potential benefits of OPVs can be summarised:

- they have very low barriers to entry (they rely on print and spray deposition techniques rather than the expensive turnkey systems required for silicon PV);
- they have low manufacturing and transport costs (reel-to-reel production speeds of up to 400 metres per minute and hundreds of metres of solar cells contained in a single roll);
- they are also lightweight, flexible/conformable, colourful, user-friendly and versatile both aesthetically and architecturally;
- the constituent materials also have a very low embedded-energy content compared to silicon; and, importantly,
- they can be integrated into products which are not stand alone solar panels, but that are integrated into buildings, vehicles and consumer goods.

DSC technology can best be described as 'artificial photosynthesis', using a multilayer configuration including an electrolyte, a layer of titania (a pigment used in white paints and toothpaste) and ruthenium dye deposited on glass, metal or polymer substrates. Light striking the dye excites electrons, which are absorbed by the titania to become an electric current many times stronger than that found in natural photosynthesis in plants. The titania layer is essentially a paint where the pigment is nano-scale titania, so conventional paint application processes such as printing, rolling and spraying can be used in the factories where the DSC panels are manufactured. Pilot plants already produce solar steel roofing panels, DSC solar glass façade panels and inserts for everyday objects such as backpacks.

Bulk HeteroJunction solar cells (BHJs) are multilayer devices that are deceptively simple both in terms of their structure and method of production. They comprise an active layer sandwiched between two electrodes – one of which is transparent. Laboratory-made BHJ solar cells have now reached efficiencies of about 10 per cent, which represents approximately a 10-fold improvement in the space of just five years. Substantial improvements have also been made in module durability and lifetime, with modules now lasting for thousands of hours under conditions of constant illumination and at elevated temperature.

Nevertheless, challenges remain, particularly in replicating these lab-based efficiencies under full-scale manufacturing conditions, and also in improving the longevity of modules to 100,000s of hours. However, the BHJ community remains very confident that these challenges can be overcome. The reason for optimism is that in much the same way as the silicon solar cell industry benefited from

A researcher in the Victorian Organic Solar Cell Consortium demonstrates ultrasonic spray deposition of a BHJ solar cell.



the earlier silicon computer-chip industry, so also are BHJ researchers benefiting from the enormous amount of research and investment in display technology, in particular Organic Light Emitting Diodes (OLEDs).

Simplistically, an OLED can be considered as a BHJ solar cell run in 'reverse mode' and because OLED displays face the same challenges as BHJ solar cells in terms of efficiency and durability, BHJ researchers can 'slipstream' the

research innovation of their display industry colleagues. Based on the increased R&D activity in both these areas and on the impressive progress to date, the future of BHJ solar cells looks very bright indeed.

As third-generation solar moves out of the laboratories and pilot plants and into factories, we can look forward to photovoltaic functionality being incorporated into our urban environments and everyday objects. ◀

**DR GERRY WILSON** received his BSc (Hons) from University College Dublin and a PhD from the Research School of Chemistry (ANU) where he used nanosecond and picosecond light pulses to study how molecules absorb, use and dissipate light energy. He joined CSIRO in 1992 to work on high-level security features for polymer banknotes. In 2006 he established the Flexible Electronics Theme at CSIRO whose activities focus on developing novel materials and manufacturing processes for thin-film solar cells, solid-state lighting and displays, and organic field effect transistors.

**SYLVIA TULLOCH** was the founding Managing Director of Dyesol, the leading corporation in commercialising Dye Solar Cell technology, and is now a director and major shareholder. Since 1995, she has been part of the Australian DSC R&D project. Her business focus is in the commercialisation process and the cleantech and advanced technology sectors. She is a past President of the Australian Sustainable Energy Industry Association, a member of the Future Manufacturing Industry Innovation Council, which provides advice to the Minister of Industry, and a director on the Boards of four technology companies.

## Academy calls for investment in research infrastructure

■ The Academy believes that the 2011 Strategic Roadmap for Australian Research Infrastructure needs to ensure that there is appropriate investment in research infrastructure that can underpin the translation of research results and intellectual property (IP) into commercial outcomes and economic benefits.

This includes adequate industry consultation in the scoping of research capability requirements and access to research infrastructure.

Furthermore, the Academy is particularly keen to see that any Roadmap for Research Infrastructure has a visible and stated target of attempting to maximise the innovation dividend from the public funding of research in Australia.

These are the key elements of ATSE's May 2011 submission to the DIISR Discussion Paper on the 2011 Strategic Roadmap for Australian Research Infrastructure.

ATSE's submission said it recognised that high-quality accessible research infrastructure, supported by expert technical staff, enabled high-quality research and supported the

need to focus resources into capabilities that address national research priority areas, while recognising that some of the capabilities cut across multiple priorities and working groups.

However, it noted that the discussion paper did not consider the distinct needs for research infrastructure to support the needs of industry (present and future).

First, there was a need to invest in research infrastructure that could underpin the translation of research results and IP from the academic and publicly funded research sectors, into commercial outcomes and economic benefits. It was widely recognised, ATSE said, that while Australia performed well against international benchmarks in a range of research areas, it was relatively poor at harnessing and transforming this activity.

In many areas of research there was a gap between the kind of infrastructure needed to support research and secure research publication outcomes (which is where NCRIS investment to date has been focused) and the type of infrastructure needed to support the commercialisation of the research, ATSE said. For example, the development of product prototypes typically formed a critical part of any technology commercialisation strategy, but generally required the establishment of pilot-scale fabrication and packaging facilities, generally not found in research organisations.

Typically, industry also did not have such

infrastructure, resulting in Australia regularly missing opportunities to transform industries or obtain economic returns on Australian research from licensing our IP because this gap restricted access to commercial opportunities. This problem was particularly acute for disruptive technologies because, by definition, such technologies had potential in industry sectors to which they were foreign – where there was no, or limited, relevant industry infrastructure.

Industry access to research infrastructure needed to improve, ATSE said. While there was some mention of this in the Discussion paper, it needed to remain a priority. In addition, ATSE recommended stronger engagement with industry during any future processes scoping research capability requirements.

ATSE emphasised that the most important challenges the nation faces, from climate change to improved medical diagnostics, required the development of knowledge and technologies that could not come from any one field or area alone.

Noting that current drivers of research activity and behaviour – such as the ERA assessment exercise and the structure of grant funding panels – discourage interdisciplinary-based drivers, ATSE urged DIISR to create an approach to funding research infrastructure that actively encouraged researchers to collaborate across discipline boundaries.

# New trends in silicon PV technology

The 'game-changing' technology of seeded casting of ingots, from which silicon wafers are cut, has been impacting on the industry since late 2010.



By Richard Corkish and Sangwook Park

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In 2010 the world's output of new solar cells grew by 118 per cent to 27.2 gigawatts (GW) generating capacity and the fraction made on silicon wafers grew from 84 to 88 per cent.

The share of the wafers of the single crystal type fell in favour of lower quality, but cheaper, multicrystalline or ribbon wafers. Amidst the production boom, we are not yet seeing the long-expected displacement of silicon wafer cells by any of the various competing thin film technologies but, rather, a swing back towards silicon wafers.

The costs of p-type wafer cells are reducing and are expected to reduce further for several reasons simultaneously.

First, since wafer cost dominates cell cost, reducing the kerf ('sawdust') loss in cutting wafers and gentler cell processing to allow thinner wafers cuts material costs. Making bigger ingots from which the wafers are cut also improves the manufacturing efficiency for wafer production but, more importantly, the 'game-changing' technology of seeded casting of ingots has been impacting on the industry since late 2010.

A handful of wafer manufacturers have recently revealed their ability to make silicon ingots by a hybrid multicrystalline growth technique that starts from a large single-crystal seed, producing ingots with such large crystals that single crystal wafers may be sliced from them. In addition, the problematical impurity of oxygen is low in these ingots.

The leading manufacturer of production equipment for multicrystalline ingots has now mastered the method and widespread adoption of this technology could follow if costs can be driven down. Using p-type wafers from seeded ingots can allow manufacture of 18-per-cent efficient cells instead of 16.5 per cent from normal multicrystalline wafers.

In parallel, there are worldwide efforts to develop cost-effective cell technologies on n-type wafers (doped with impurities from Group V of the periodic table). Single crystal n-type wafers have an advantage over conventional

single crystal p-type wafers but there is no obvious advantage for multicrystalline wafers, since they have less incorporated oxygen.

Looking at solar cell manufacturing technologies, the push for thinner wafers, to both cut material usage and directly boost cell efficiency, tends to reduce production yields due to cracking and breaking of cells, especially in the harsh step of screen printing the silver-loaded paste to form the metal contacts.

Gentler processes, such as metal plating, are being introduced by some manufacturers to form contacts while avoiding screen printing. Plating is compatible with thinner metal grid lines on the front of a cell and with avoidance of the prolonged heating of the cell to high temperatures in the 'firing' of the metal paste used in the conventional screen printing technique. Avoidance of such heating avoids degradation of wafer quality, especially in multicrystalline wafers and in even cheaper wafers made from poor-quality upgraded metallurgical grade silicon.

Another advanced cell approach, being implemented in several similar ways around the world, including with metal plated contacts, is that of forming a 'selective emitter' at the front surface of the cell. This means, for a p-type cell, that the phosphorus (Group V) that is normally heavily diffused into the entire front cell surface is restricted to selected, necessary, areas. This reduces the usual degradation of cell response to the blue/violet fraction of sunlight and, thereby, boosts cell efficiency.

Another technique, called 'metal wrap through', conducts the front contacts through holes through the cell to

A brief overview of some of the technological developments driving expectations of increased value from 'old hat' p-type (doped with impurities from Group III of the periodic table) wafer cells and moving the goalposts for challengers.

the rear, reducing blocking of light from the front and simplifying interconnection of cells.

Simultaneously, improvements are being made in processing the rear surfaces of cells. In order to allow highly efficient collection and conversion of light to electricity, the disruption of crystalline continuity at cell surfaces needs to be passivated with interface materials such as silicon oxide, silicon nitride, amorphous silicon or aluminium oxide. In conventional cells, though, a metal contact covers the whole rear.

New techniques, including inkjet printing, permit the patterning of passivating layers to beneficially reduce the contact area of silicon to metal.

It appears that a range of improved technologies is injecting new life into the old industry mainstay of p-type silicon wafer solar cells and it is not yet ready to yield ground to any of the many challengers. ◀

### Further information

Stuart Wenham, 'Manufacturing Trends', lecture to the SOLA2020

Photovoltaics Manufacturing class at UNSW, 21 April 2011

([www.pv.unsw.edu.au/videos/Wenham-Lecture/index.asp](http://www.pv.unsw.edu.au/videos/Wenham-Lecture/index.asp))

Fischer, M., *et al.*, International Technology Roadmap for

Photovoltaic, Berlin, 2010 ([www.itrpv.net/status.html](http://www.itrpv.net/status.html))

**DR RICHARD CORKISH** is Head, School of Photovoltaic and Renewable Energy Engineering, at the University of New South Wales (UNSW). He graduated with distinction as a Communications Engineer from the Royal Melbourne Institute of Technology in 1986, then worked with the CSIRO Division of Radiophysics on satellite earth-station antenna design and testing before studying for his PhD under the supervision of Professor Martin Green at UNSW's Centre for Photovoltaic Devices and Systems. After a brief period working with the Rainbow Power Company he has worked on solar cell theory, applications and education at UNSW.

**DR SANGWOOK PARK** has been a Principal Research Engineer at LG Electronics in Korea since April 2010. His group concentrates on new technologies in silicon solar cell production and research. Dr Park graduated in Chemistry at the KyungHee University in Korea in 1998 and worked for Samsung in Korea as a senior researcher for seven years. In 2009, he received his PhD at the University of New South Wales. He is author and co-author of more than 30 conference and 20 journal publications and 25 patents on high-efficiency silicon solar cells and Si Quantum Dot Solar cells.

## MMG congratulates the winners of the 2011 ATSE Clunies Ross Awards

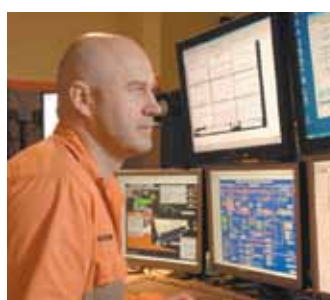
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MMG is proud to support initiatives like the ATSE Extreme Science Experience recognising excellence in science, and providing school students with opportunities to meet scientists and consider further education and careers in science and technology.





# Strengthening relations – link by link, project by project



David Palmer

The Australia–Korea Foundation has delivered a range of quality projects that have broadened and enhanced the links that bring the two countries together.



By David Palmer

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Young Korean  
leaders  
participating  
in the  
2010 Next  
Generation  
Leaders  
Program in  
Australia

**T**he importance of Australia–Korea relations for both countries is made clear by the crucial economic, political and strategic partnership we enjoy. On the other hand, it is also clear that people-to-people links have traditionally lagged behind other aspects of the relationship. One of the challenges has been, and to a large extent remains, the relative lack of awareness of Korea in Australia and of Australia in Korea.

The Australia–Korea Foundation (AKF) is the Australian Government's key public diplomacy program for strengthening people-to-people links. The AKF was established in 1992 and comprises a secretariat and a board of prominent Australians from a range of backgrounds.

The primary mechanism for the AKF to achieve its mission has been through an annual grants round. Through the funding of grants, the AKF has delivered a wide range of quality projects that have broadened and enhanced the links that bring the two countries together. These have in-

cluded high-profile cultural diplomacy events both in Korea and Australia.

These are even more of a priority this year with 2011 being the Australia–Korea Year of Friendship, commemorating the 50th anniversary of the establishment of diplomatic relations.

The AKF also funds a scholarship program, which aims to develop a body of Australian graduates with a good understanding of all facets of Korean culture and society, as well as of the bilateral relationship, thereby increasing Australia's capacity to engage with Korea in the future.

Developing partnerships and collaboration in science and technology is also a focus for the Foundation, and in this work we have been greatly assisted by the presence of Professor Mike Miller AO FTSE, who is a member of both the AKF Board and the ATSE Board.

The AKF has worked closely with our friends in ATSE to deliver quality projects. For example, the AKF helped

fund ATSE and the Australian Academy of Science (AAS) Early Career Researcher Program, which received a record number of applications this year; 15 successful applicants will undertake a two-week program in Seoul from 16 to 27 May.

The AKF also supported ATSE with its second international workshop on Australia Korea Green Growth, held in Melbourne on 17 and 18 March 2011. The workshop sought to take advantage of Australia's comparative strength in advanced, fundamental and applied technology research and Korea's comparative strength in advanced manufacturing and development, by looking at the possible implications of Korea's green growth initiatives for Australia.

This year also saw the latest iteration of the Korea Australia New Zealand Broadband Summit, with which the AKF has been proudly associated since its inception. The event was held in Hobart and we were pleased by the quality of the Korean delegation, which included the Korean Minister responsible for IT and communications as well as representatives from leading Korean IT companies.

Another highlight of the AKF's contribution to the development of Australia-Korea science and technology

partnership has been the Australia-Korea Next Generation Leaders Exchange Program, which is a major joint initiative with the Korea Foundation.

The last visit took place in August 2010 and involved 10 young Korean leaders travelling to Australia to participate in a program under the theme of 'Green Growth'. In November 2011, a delegation from Australia will undertake a program of visits in Korea under the theme of 'Sustainable Water Resource Management'.

For more information on the Australia-Korea Foundation, please visit the website ([www.dfat.gov.au/akf](http://www.dfat.gov.au/akf)). ◀

**DAVID PALMER is Chair of the Australia-Korea Foundation and Managing Director of Meat and Livestock Australia (MLA). Mr Palmer has been travelling to Korea for business purposes for more than two decades and has established strong links within the commercial sector in Korea. A former Executive Director of the Cattle Council of Australia, he joined the Australian Meat & Livestock Corporation in 1995, managing food safety and quality assurance programs. In 1998, Mr Palmer joined the newly formed MLA as General Manager, Industry Affairs and Communication, and then as North American Regional Manager. He was appointed Managing Director in 2006.**

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# Broadband leads current technology initiatives

International collaboration will be essential to take best advantage of opportunities flowing in modern digital economies.



By Mike Miller

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**M**ore frequently than ever before, Australia and Korean political figures are exchanging visits and discussing increasing collaboration in the high technology sectors.

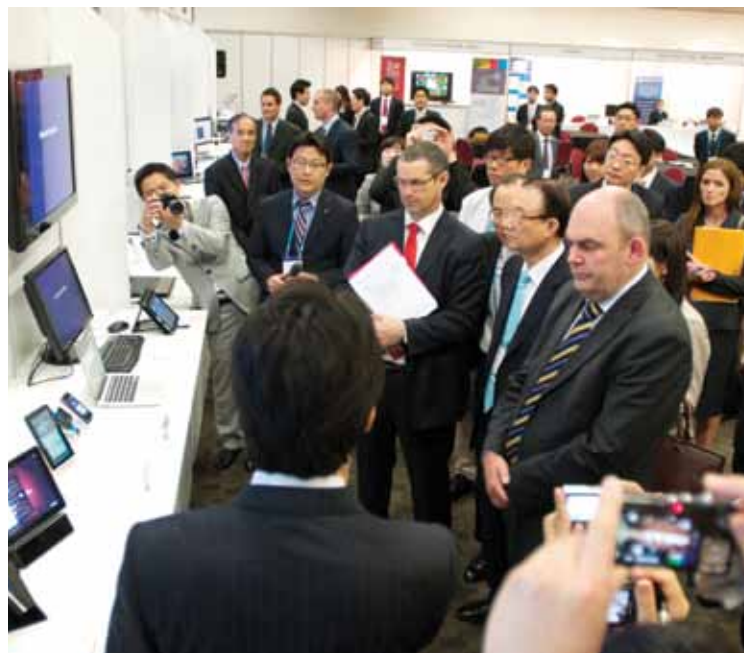
When Prime Minister Gillard met with Korea's President Lee Myung-bak in April, the most notable commitment in dollar terms was, in response to bilateral concerns regarding climate change, that Australia would contribute \$10 million to become a core partner in the Global Green Growth Institute (GGGI). GGGI was established by the Korean Government in 2010 to support the development of green industries growth strategies and policies in developing countries.

## KANZ2011 Broadband Summit

Only two days after the leaders' meeting, Mr See Joong Choi, the Korean Minister responsible for Information Technology and Communications, was in Hobart – together with a delegation of more than 60 representatives of leading Korean IT companies and government officials – to participate in the Korea–Australia–New Zealand (KANZ) 2011 Broadband Summit. They were welcomed by Australia's Minister Stephen Conroy and New Zealand's Minister Steven Joyce and more than 160 delegates from their two countries.

The KANZ Broadband Summit was the sixth in the series, held to provide opportunities for the ICT, communications and digital technologies industries, research entities and policymakers from the three nations to provide insights into their different experiences of moving into high-speed, broadband-enabled economies. They particularly aim at enabling participants to explore the potential for international joint ventures and other forms of collaboration.

I have been the Program Coordinator for the Summit Series, originally conceived by the Australia–Korea Foundation (AKF), since the inaugural Summit on the Gold Coast in 2003. The April summit was hosted by the Aus-



tralian Department of Broadband, Communications and the Digital Economy, the Tasmanian Government Department of Economic Development, Tourism and the Arts, AKF and Austrade.

The two-day event used webcast and social network facilities, resulting in more than 1000 live webcast viewers and generating 600 tweets. Given current Australian interest in the National Broadband Network (NBN) it was not surprising that the Summit was also prominent in the media.

## Summit highlights

The three national Ministers enthused about new ultra-high-speed networks being rolled out in their countries – to 93 per cent of Australians by 2020, to 75 per cent of Kiwis by 2019 and (at 1Gbps rates) to all Koreans by 2011.

The deployment of the NBN in Australia in the coming decade would allow for greater technology opportunities, according to Ms Cassandra Scott, a member of the NBN Co stakeholder relations team. Connections using interac-

(From left) Minister Conroy (Australia), Minister Choi (Korea) and Minister Joyce (New Zealand) at the KANZ exhibits of new broadband applications.



tive high-definition video, communications between all local premises and power utility, increasing carbon reduction opportunities with demand site energy management and connections between buyers and sellers of goods and services will be made possible, she said.

With the emergence of technologies demanding faster bandwidths, NBN aimed to put Australia in par with its international peers. Ms Scott said bandwidth requirements had grown more than 4000 times in the past 20 years, which underscored the importance of the NBN enabling peak speeds using a nationwide network of fibre, fixed wireless and satellite technologies.

Samsung's Dr Hung Song highlighted the need for integrated communications solutions. Smartphone users now wanted much more than voice, he said – they wanted integrating technologies such as cloud computing and social networking to be part of their lifestyles.

Jane Bennett of Tasmania's Ashgrove Cheese spoke passionately about the importance of regional and remote communities and businesses across Australia gaining access to high-speed broadband – for the future of their businesses, industries and local communities.

Other papers emphasised advances in digital convergence, telehealth, e-government and network security. Dr Kate Cornick, of the Institute for a Broadband-enabled Society, described new spin-offs from e-learning technology, such as aiding stroke victims to re-learn limb movements.

Professor Hugh Durrant-Whyte FRS FAA FTSE, CEO of NICTA, showed how major Australian companies were using broadband to overcome the challenges of remote Australia. Examples are the remote controlled operation of the Brisbane shipping terminal and remote control of mining in the Pilbara.

A major conclusion from the Summit was that inter-

national collaboration in research and innovation would be essential for all three countries to take best advantage of opportunities flowing in modern digital economies.

Videos of the presentations can be viewed via the KANZ website ([www.dbcde.gov.au/KANZ2011](http://www.dbcde.gov.au/KANZ2011)).

## NRF R&D Workshop

Methods of ensuring high quality standards in collaborative research were the subject of another workshop held in March in Korea by the National Research Foundation (NRF). Contributions came from the UK, the US and the EU as well as Australia, which I represented. The recent Excellence in Research in Australia (ERA 2010) evaluation of all research in Australian universities was described.

While noting the benefits emerging from ERA 2010, ATSE is continuing to press the Australian Government that, in future, quality evaluations, greater attention and weighting should be given to the impact and outcomes of R&D. ATSE believes ERA 2010 relies too much on measures such as publication citations with too little focus on applied R&D outcomes.

## Researcher Exchanges

To add to all the above activity, in May an Australian delegation of 15 researchers currently employed in research or academic positions spent two weeks in Korea under the Early Career Researchers Program (ECRP). This is a joint initiative of ATSE, AAS, AKF and Korea's National Research Foundation (NRF). Competition for places in the delegation was tough, with 40 applications for only 15 places.

The visit was intended to raise awareness and interest in Australian research experience in Korea, and to provide Australian participants with the opportunity to access equipment, knowledge and skills not available in Australia. It also aimed to facilitate the development and strengthening of personal research networks, institutional-level collaboration and possibilities for shared research infrastructure in both countries. ◀

**EMERITUS PROFESSOR MIKE MILLER AO FTSE is a Director of ATSE and Chair of its SA Division and is a Board Member of the Australia–Korea Foundation (AKF). He spent nine years with Telecom Australia and 35 years in the University of South Australia, where, as Director of a research institute, he led a number of mobile radio and satellite research contracts awarded by Korean agencies including Samsung Electronics and ETRI. With the AKF he has advanced linkages between Australian and Korean companies in the IT and other industry sectors. He was a founder and program coordinator for the six KANZ Broadband Summits held since 2003.**

## Fellows in key roles at CRCA conference

■ ATSE Fellows played key roles at the annual Cooperative Research Centres Association conference in Brisbane in April.

Vice President Peter Laver AM FTSE, a member of the CRC Committee, chaired a session on Innovation Policy and Dr Geoffrey Vaughan AO FTSE, former Chairman of the CRC Committee, was the MC at the celebratory lunch – titled 'Years of Innovation'.

Presenters and participants included: Dr Geoff Garrett AO FTSE, Queensland Chief Scientist; Dr Rowan Gilmore FTSE, CEO of the Australian Institute for Commercialisation; Professor Tanya Monro FTSE, Director of the Institute for Photonics and Advanced Sensing (IPAS) at the University of Adelaide; Dr Adi Paterson FTSE, CEO of ANSTO; Dr Jim Patrick FTSE, Vice-President, Cochlear; Professor Alan Robson AM FTSE, Vice-Chancellor of UWA; and Professor Margaret Sheil FTSE, CEO of ARC.

Wairakei Geothermal Power  
Plant in New Zealand.

# Geothermal: baseload power for green growth

Geothermal energy offers a virtually inexhaustible supply of baseload power with few environmental or societal impacts.



By Graeme Beardsmore

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One of the key challenges facing the global community as it tries to migrate away from carbon-based fuels is how to provide a low-emissions alternative to the baseload power capacity currently provided by coal-fired plants.

Geothermal energy offers a virtually inexhaustible supply of baseload power with few environmental or societal impacts. Geothermal energy can contribute to a reduction in greenhouse gas emissions by offsetting the need for fossil fuel generation of direct heat, or by powering new electricity plants in place of new fossil fuel power plants.

Geothermal energy is the heat stored within the Earth. The amount of heat stored within a section of the Earth is directly proportional to the rock temperature. Higher temperature means more thermal energy. At virtually any location on Earth, the temperature increases with depth in the ground, which means that a virtually inexhaustible supply of energy is available by simply drilling to greater depths. This heat is available 24 hours a day, 365 days a year. Geothermal heat can be used directly as thermal energy – for example, for heating of buildings, greenhouses or swimming pools – or can be converted to other forms of energy, most commonly electricity.

More than 10,500 megawatt electrical (MWe) of electricity is currently generated from geothermal resources around the world. The great majority of these existing

power plants are located in areas of active volcanic activity and are fuelled by natural pockets of steam intersected in fractured volcanic rocks at depths down to about 2000 metres. The potential for geothermal energy to provide power for green growth strategies, however, is vastly greater than the relatively modest current capacity suggests.

Geothermal energy can be utilised at the domestic scale in the form of ground source heat pumps (GSHP). A GSHP is effectively an HVAC (heating, ventilation and cooling) system, but is as much as five times or more energy efficient than a conventional roof-mounted HVAC system. A conventional system uses the outside air as a heat source and sink, whereas a GSHP – as the name suggests – uses the ground.

In summer, a conventional HVAC system operating in cooling mode removes heat from a building and pumps it into the relatively hot outside air. In winter heating mode, a conventional system extracts heat from the relatively cold outside air and pumps it indoors. In contrast, the ground remains approximately the same temperature all year.

A GSHP in cooling-mode pumps uses the relatively cool ground to store heat from a building, while in heating mode the relatively warm ground provides heat into the building. A GSHP operates with much lower thermodynamic resistance and thus requires far less compressor power than a conventional HVAC system. In parts of

the world, most notably parts of Europe, installation of a GSHP is virtually mandatory for new building constructions. The GSHP industry has grown substantially in Korea in the past few years, but is still in its infancy in Australia.

At the other end of the energy spectrum, generation of electricity from geothermal heat is also in its infancy in both Australia and Korea. Neither country has active volcanic systems suitable for 'conventional' geothermal power developments. Engineered geothermal systems (EGS), however, provide a means for extracting geothermal heat through artificially enhanced permeable fluid pathways in hot rocks. Australia is a leader in advancing the commercialisation of EGS technology, which offers the promise of almost ubiquitous, inexhaustible power at any location on Earth.

In an EGS system, water is pumped underground where it passes through a network of fractures in hot rocks made artificially more permeable by hydraulic fracture enhancement. The heated water is then extracted back to the surface through a production well, where the heat is utilised to provide vapour to drive a turbine. The cooled water is pumped back underground to complete the cycle. The world's first

commercial EGS power plant began operation in Germany in 2007. Independent economic studies consistently rate geothermal energy as one of the lowest-cost low-emissions technologies. Large upfront capital requirements for drilling boreholes, however, are currently proving a deterrent to private investment into this exciting clean energy technology.

Governments have a role to play in bringing a number of EGS projects to fruition in different geological settings to reduce the perceived investment risk and stimulate the commercialisation of the industry. ◀

**DR GRAEME BEARDSMORE** received his PhD from Monash University in 1996, then worked 18 months with geothermal researchers in China and the US. He has worked in the Australian geothermal industry since 2003, mostly as Technical Director of consulting company Hot Dry Rocks. He is a Board Member of the International Geothermal Association, an Adjunct Research Fellow at Monash University, and sits on numerous committees of the Australian Geothermal Energy Group and Australian Geothermal Energy Association. He co-wrote *Crustal heat flow: A guide to measurement and modelling* (2001, Cambridge University Press).



**Martin Thomas addresses the workshop, flanked by the Indian Convenor, Dr Ajay Mathur, Director General, Indian Bureau of Energy Efficiency.**

■ Energy efficiency was the key topic at a science and technology workshop in India in April organised by ATSE and the Indian National Academy of Engineering (INAE).

Experts from both countries discussed challenges in the development of advanced technologies for power stations, upgrading the energy efficiency of power stations, design and construction of efficient new buildings, and energy retrofits in existing buildings.

The two-day INAE-ATSE Workshop on Energy Efficiency, in New Delhi, brought together 26 energy sector professionals, researchers and policy makers from India and Australia. Participants sought to develop energy efficiency roadmaps for both nations and cooperative activities between the two Academies.

The 13-person Australian delegation was led by workshop co-convenor and Chair of

ATSE's Energy Forum, Mr Martin Thomas AM FTSE, and ATSE's Executive Director – Technical, Dr Vaughan Beck FTSE. The workshop was followed by two days of technical visits.

This initial workshop focused on leading edge technologies and provided an opportunity for exchanges between mid-career scientists from Australia and India. It examined the different imperatives and policy directives that drive energy-efficiency actions in the two countries. Both have different energy sector challenges, but the enhanced energy efficiency of coal-based power generation and commercial buildings are common issues.

Four Australian early career researchers were invited to participate in order to develop new linkages and collaborations to improve and broaden Australia's scientific, engineering and technological strengths. They were: Dr Clare Anderson, University of Melbourne; Dr Adam Berry and Dr Timothy Moore, CSIRO; and Mr Saha Chiranjib, Monash University.

Funding for this Workshop was provided through the International Science Linkages Science Academies Program (ISL-SAP) provided by the Department of Innovation, Industry, Science and Research (DIISR).



# Pricing carbon to fix the problem

Why not use the money coming from pricing carbon to fix the problem?



By Peter Laver

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**T**he debate about carbon pricing seems to have lost sight of what we are trying to achieve. We only hear about compensation, wealth redistribution, having the ‘polluters pay’, how international competitiveness will be undermined, whether payments should be as a tax or for permits, special pleading for exemptions and impacts on growth, all wrapped up in sterile political point scoring.

Isn't it time to direct policy thinking towards the real problems, which are investing in technology to cut greenhouse gas emissions and to reduce the demand for energy?

Here's a radical idea. Why not use the money coming from pricing carbon to fix the problem, to make the necessary investments in low-carbon electricity generation and improved energy efficiency? Instead of energy producers paying a tax or buying a permit, or users accepting higher energy costs as well as trying to find the capital to improve their efficiency, let them keep their money – provided they invest it in reducing emissions or energy use.

How can this be done? Initially the focus would be on the major generators, who would be levied with a tax for every tonne of CO<sub>2</sub> they emit, just as the currently contemplated Government scheme envisages. Under the current plans this money is then mostly spent on compensating the disadvantaged for the inevitable increase in energy prices. This leaves the electricity suppliers with a cashflow challenge as they have to meet their tax bill while at the same time attempting to raise capital to invest in new technology which will reduce their tax liability.

Instead of spending money on compensation why not leave it in an Emissions Abatement Fund and allow the generators to claim a rebate on the tax they have paid for the capital they spend on lowering their emissions intensity?

An economist's view of emissions abatement assumes there is a cost curve, which places a cost per tonne on various types of investment and this investment will occur if the cost per tonne is lower than the carbon price imposed. This means that the cheapest abatement will be funded first and as the price (tax or permit cost) increases more costly routes

to reduction will be viable.

Rather than invest in the ‘low hanging fruit’ types of emissions abatement the ability to claim a rebate on the tax they have paid would allow for bolder plans to be more readily executed by generators, closing inefficient plants and replacing

them with more efficient technology, such as combined cycle gas turbines or renewables and, in due course, possibly carbon capture and storage or geothermal resources.

The need for compensating energy users for higher prices as the tax is passed on might well almost disappear as the generators benefit from the improved costs and productivity flowing from installation of new technology.

ATSE has estimated that, if Australian emissions are to be reduced by 60 to 80 per cent by 2050, an investment in low-emissions technology in the range of \$350 to \$500 billion will be required. Without bipartisan certainty surrounding carbon pricing, this investment will not occur, particularly if at the same time the industry must pay an additional tax while trying to raise the capital it needs.

At the risk of adding additional complexity, this carbon tax rebate for expenditure on emissions abatement has the advantage of being able to be extended downstream to provide direct incentives for energy users. Under the current government proposals, downstream customers will invest in energy efficiency when the increasing energy costs they can avoid provide an adequate return on investment or acceptable payback period.

As an extension of the investment-centred scheme it would be necessary to identify the carbon tax component of a user's energy bill, in the same way as the GST component is recorded now. Capital required for investment in technology to improve energy efficiency could then be



We need to fund investment in low-carbon electricity generation and improved energy efficiency.

► MORE ON PAGE 39

# Australia's visionary innovators honoured

■ The winners of the prestigious 2011 ATSE Clunies Ross Awards are leading Australian innovators impacting global development in fields such as medical research, metallurgy, microwave telecommunications, metal detection and mineral discoveries.

The Awards recognise Australia's pre-eminent scientists and technologists who have bridged the gap between research and the marketplace and are awarded to people who have persisted with their ideas, often against the odds, to the point that their innovations are making a real difference to the economic, social or environmental benefit of Australia.

## THE 2011 ATSE CLUNIES ROSS AWARD WINNERS ARE:

- Mr Roy Woodall AO FTSE – who won a special Lifetime Contribution Award for his work as a geologist with Western Mining Corporation 1953–95 and was directly involved in a number of the most important mineral discoveries in Australia during that period through his application of science to mineral exploration in Australia;
- Professor Anthony Burgess, Professor Ashley Dunn and Dr Nicholas Gough FTSE – the scientists who first purified and cloned the blood cell growth factor GM-CSF, patented it and continued developing its biology to guide its current and future clinical uses;
- Dr John Clout – a renowned geometallurgical expert on iron ores, especially their specific end-use potential, widely respected as a leading authority on Australian iron ores and their downstream processing performances;
- Dr John Ness – an acknowledged leader in

the microwave telecommunications field in Australia, credited with the creation of a significant Australian industry in wireless and microwave systems with considerable national and international commercial success; and

- Mr Bruce Candy – known through his metal-detection technology and products as the leading scientist worldwide in his field, which has positioned Minelab Electronics Pty Ltd and Australia as world leaders in the provision of high performance, affordable and practical hand-held metal detectors.

The dinner, marking the 20th year of the awards, was also attended by the Queensland Treasurer, the Hon Andrew Fraser, and the MC was Professor Peter Andrews AO FTSE, former Queensland Chief Scientist. The dinner also marked the presentation of ATSE Medals to former Queensland Premiers Mike Ahern AO FTSE and Peter Beattie "in recognition of leadership for the growth of science, technology and innovative research,

The Governor-General, Her Excellency Quentin Bryce, addresses the dinner.



which has been a catalyst for technological advancement throughout Australia."

The 2011 ATSE Clunies Ross Award Winners follow in the footsteps of past winners such



ATSE President Professor Robin Batterham in discussion with Mr Roy Woodall, who won a special Lifetime Contribution Award.

The 2011 ATSE Clunies Ross Award were presented at a memorable dinner at the Brisbane Convention and Exhibition Centre in May, where the Governor-General HE Quentin Bryce welcomed more than 700 eminent entrepreneurs, decision makers, government officials, researchers, academics and business leaders.



Dr John Clout acknowledges his Award.



Years of work brings rewards for (from left) Dr Nicholas Gough, Professor Anthony Burgess and Professor Ashley Dunn.



Mr Bruce Candy makes his speech.



Dr John Ness at the microphone.

MC and former Queensland Chief Scientist  
Professor Peter Anderson in action.ATSE President Professor  
Robin Batterham  
congratulates former  
Queensland Premier Mike  
Ahern FTSE on being  
awarded an ATSE Medal.

as: Professor Ian Frazer FAA FTSE, inventor of the cervical cancer vaccine; Professor Graeme Clark AC FRS FAA FTSE, inventor of the bionic ear; Nobel laureate Dr Barry Marshall, who discovered the bacteria that causes stomach ulcers; Dr David Boger FRS FAA FTSE, a giant in the world of fluid behaviour; Dr Fiona Wood, inventor of spray-on skin; and Professors Martin Green FTSE and Stuart Wenham FTSE, international leaders in silicon cell technology.

"This year's ATSE Clunies Ross Award winners have made significant and positive impacts on the lives of many Australians and our economy through the development and commercialisation of health, communication and industrial innovations," said Mr Bruce Kean AM FTSE, Chairman of the ATSE Clunies Ross Awards Committee.

Following the Awards, winners joined more than 250 Year 10 students and teachers from

across Queensland the following day in the 'Extreme Science Experience', with hands-on activities to excite students about science and technology.

**The 2012 ATSE Clunies Ross Awards and Extreme Science Experience will be held in Sydney in May 2012.**

**To sponsor these events or for more information contact Johanna Gasser, 03 9864 0908 or [cluniesross@atse.org.au](mailto:cluniesross@atse.org.au)**



# 'Speed Meet' a highlight at Brisbane Extreme Science Experience

■ The 240 Year 10 Queensland students who attended the 2011 ATSE Clunies Ross Extreme Science Experience (ESE) in Brisbane had plenty of opportunities to learn that science and technology can provide exciting and rewarding career paths.

ESE was held at the Brisbane Convention and Exhibition Centre on 20 May, following the ATSE Clunies Ross Awards dinner the previous night. The one-day program had Clunies Ross Award-winning scientists participating in lively discussion and leading hands-on workshops. Queensland Chief Scientist Dr Geoff Garrett AO FTSE was guest speaker and the event was compered by the lively Bernie Hobbs of ABC TV's *New Inventors* fame.

A new session for the 2011 ESE was 'Speed Meet a Scientist', with 24 scientists – including the Awardees – seated with groups of 10 students to discuss science and technology. There was plenty of two-way talk, and every seven minutes the scientists moved on to a new group. The feedback on the session was extremely positive, with students wanting more time for each discussion.

ESE has workshops for students based on the area of research of each of the Clunies Ross Award winners. This year there were four workshops, with each repeated so the all 240 students could join two workshops.

Awardee Bruce Candy is an expert in the commercial applications of magnetic fields and his workshop, facilitated by ATSE STELR Manager Peter Pentland, had students searching for coins using metal detectors supplied by the Minelab Company, as well as making their own electric motors.

Dr John Ness, with the help of facilitator Christine Pitfield, had students measuring the speed of light using their ever-present mobile phones, with the best result having an error of less than eight per cent.

In Dr John Clout's workshop, he and facilitator Graham Baker set the students challenges in purifying iron ore and working



(From left) Kiara Lomas (St Stephen's Catholic College, Mareeba), Taylor Smit (Mackay State High), Malee Rowell (Elenora High) and Eliza Rynne (Nanango SHS).

out how much iron is in various breakfast cereals!

In the last workshop, Awardees Professor Anthony Burgess, Professor Ashley Dunn and Dr Nick Gough FTSE worked with facilitator Rod Dunstan to set the students the challenge of trying to find where an amino acid sequence was coded for on four 'strands' of DNA. There was a keen sense of competition in the room.

The day was a huge success, due in no small way to the great work done by volunteers from the University of Queensland and Queensland University of Technology, and the great support provided by Ms Amanda Nuell of Brisbane State High School. The day concluded with an extra bonus for this year's ESE students. They answered a set of questions to win two vouchers for an Apple iPad.

Rural and remote schools were well represented, with students from Thursday Island, Mt Isa, Mareeba and Tully attending. Many of these remote schools were sponsored by ATSE Clunies Ross and two were supported by the Xstrata Company.

## Some teacher responses

- *The whole concept of getting students together from different school across the state was great. Both the students and I wanted it to go over longer time. As we had to travel so far to get there, if it were over more days with more workshops and experiments, the students and I could get much more out of it. Overall, the students and I really enjoyed it. Awesome!*
- *I would recommend that 'Meet the scientist' went longer and students got the opportunity to meet scientists from different fields.*
- *Students liked the Speed Meet a Scientist but would like more information on the award winners.*
- *The students had a very interesting day and I think it was a worthwhile experience for them. I felt it was a shame that there wasn't a better balance of male/female science role models.*
- *My students had a great day. They learnt a lot and realise that there is much more to science than they originally thought. The*



Kai Priestley (St Stephen's Catholic College, Mareeba) fully focused in a workshop.



(Above) Tanya Jobi (Thursday Island-Tagai State College) with Dr Geoff Garrett.  
(Left) James MacDonald and Lucas Makara from Ipswich State High.

*activities were engaging and all the scientists were warm and personable, which made the experience just that much more enjoyable. Thank you.*

### Some student feedback

- *It was really fun. I got to win a prize for doing my experiment. It would be good if there were more individual prizes to win. It would be better if the whole experience went longer than one day. More workshops to participate in. More hands-on/thinking experiments. Gene Genie was really awesome.*
- *Fun day. Great to see a variety of people especially people from all over the state. Great exhibition bag. Some interesting things in the 'trade' display. Plenty of food, especially the choc chip biscuits.*



– ROD DUNSTAN, STELR Education Officer      Facilitator Christine Pitfield works with students at ESE.

## ACoLA wins research education study grant

■ The Australian Council of Learned Academies (ACoLA), of which ATSE is a member, was one of three organisations to receive a grant from the Government announced when Innovation Minister Senator Kim Carr launched its Research Workforce Strategy.

Senator Kim Carr said Australia must do more to inspire our best and brightest minds to undertake postdoctoral study and pursue research careers in academia, the public service and industry.

"Australia's research workforce is a vital asset. Our highly trained and skilled researchers help make our country innovative, prosperous and productive," Senator Carr said.

"The academic skills shortage in our country will increase as our current research workforce ages and retires," he said, adding that the Research Workforce Strategy would strengthen the nation's research workforce to 2020 and beyond.

"The future of our manufacturing and other industries depends

on our ability to innovate through research and development. This is important if industry is to prosper in the low-carbon economy of the future. Industry and researchers must work together to transform the products we produce and the way we manufacture.

"The strategy sets out the full range of research workforce issues we have in Australia, including the divide between research and industry.

To help inform policy development in this area, Senator Carr announced funding for sector bodies to conduct projects investigating best practice approaches to research education. The Council of Australian Postgraduate Associations will receive \$80,000, the Australian Council of Learned Academies \$80,000 and the Deans and Directors of Graduate Studies \$40,000 to look at these issues in their various domains.

The strategy – *Research skills for an innovative future: A research workforce strategy to cover the decade to 2020 and beyond* – is available at [www.innovation.gov.au](http://www.innovation.gov.au).

# Big challenges require tough

■ The hard work and deep commitment required – not just to produce new innovations, but to commercialise them – makes science and technology a genuine driver of commerce, ATSE Fellow Andrew Liveris told the ATSE Clunies Ross Awards dinner in Brisbane.

Making his keynote speech live via satellite from New York, Dr Liveris said it took “little more than a cursory look at the global economy to know that this is the work that will create growth and prosperity for developed and developing nations alike; that this is the work that will produce solutions to some of the world’s greatest challenges.”

Dr Liveris, Chair, President and CEO of Dow Chemical and one of Australia’s highest-profile international businessmen, said the nation had a role in providing those solutions.

“We have a unique perspective. We have particular gifts... remarkable assets. If we put them to effective use, we can transform the future – for Australia and for the rest of the world.

“There are big challenges ahead and, with them, big opportunities. As globalisation continues to reshape business and commerce, as it puts an even greater emphasis on Australia’s connectedness to the world, we need to ask ourselves: What will we make of it? To what purpose will we use it? To what greater good?

“This century will be defined, in many ways, by the rise of powers like China, India, Russia and Brazil. These countries are building a massive middle class and opening valuable markets for our exports.

“It will be defined, too, by environmental change and a skyrocketing demand for energy. It will be a century defined, in many ways, by scarcity – the scarcity of energy, the scarcity of water and of other finite natural resources.

“And it will be defined by social and demographic shifts – urbanisation, immigration, relocation – the flow, not just of commerce, but of workers and cultures and ideas into our cities. Economies are becoming ever more dependent on that kind of mobility, and on continued population growth.

“Big challenges require tough choices.

**Keynote  
speaker  
Andrew  
Liveris live  
from New  
York.**



Are we up to facing them? Do our political institutions have the capacity – or our political leaders, the will – to act? Do our business leaders have the strategic sense to orient their companies toward these emerging megatrends?

“These are the questions Australia must answer” he said.

Australia had its challenges, Dr Liveris said but had no “burning platform” that forced it to rethink big things – “what we’re doing and why”

“Australia is marvelous at handling adversity but not as adept, perhaps, at handling success. Why mess with success? If the resources boom has created essentially full employment, why rethink things at all?

“The rise of China provides a perfect example why. China’s meteoric rise is of incredible value to Australia. We provide the coal and gas that fuels their growth. We produce the minerals that build their cities and infrastructure. They will continue to grow, and both countries will continue to benefit.

“But we should take pause. We must not accept our current arrangement as the limit ... the end game. ... the only game in town. We must not accept it at the expense of seeing – and seizing – smarter, better opportunities down the line.

“Australia should do more to unlock (its) still untapped resources. It should invest in rail connections, gas pipelines, electricity transmission and port capacity – the infrastructure required for resource-driven growth.

“But I think we must go further than that – I

believe Australia’s resources below ground can be equalled – or exceeded – by our resources above ground – our intellectual resources ... our innovative capacity... our ideas.

“I believe we can build an economy that is far less dependent on the prosperity of others – one that won’t just make us the envy of nations, but a leader among nations.

“What I’m describing is a balanced economy. What I’m describing is an innovation economy. What I’m describing is Australia at the forefront of the solution space. That means a greater focus not just on resources or services, but on a robust advanced manufacturing base ... on creating higher value-add products.”

An advanced manufacturing economy would generate sustainable growth and long-term prosperity and allow Australia to tap our talent and to turn our ideas into innovations that could solve the biggest challenges it faced, he said.

“As someone who has dedicated his life to innovation, I would venture to say we have never needed it more than we do today. The world’s most pressing needs will be met – and mastered – by innovation.

Energy underpinned Australia’s chance to truly change the world for the better, Dr Liveris said.

The nation’s energy challenge was defined by dueling imperatives – economic growth and environmental conservation.

“CO<sub>2</sub> emissions and deforestation are causing temperatures and sea levels to rise. Our natural



# choices – Liveris

treasures, like the Great Barrier Reef, are threatened by pollution and climate change. The time for debate is over: these problems are man-made. And we need to do something about them.

"Many people assume that if we want to prosper, then forests are just going to have to make way for our fields and our roads, the oceans are going to have to make room for our refuse, and the atmosphere has to contain more greenhouse gases – the price of progress.

"Some of these problems are especially acute here in Australia – one of the most carbon-intensive countries in the developed world on a per-capita basis – a continent that is dry and in need of sustainable sources of water for residential use, agricultural use, industrial use.

"So we can't choose between these two. We have to find a sustainable way to do both. And we can – through science ... through chemistry ... through innovation," he said.

"We know, from our own experience, that science can ignite a true energy revolution ... and we know that Australia can lead it.

"If we do, this country will have more tools to advance its long-term prosperity. Our centres of innovation will become hubs of commerce. They will attract the best and the brightest. They

will attract business investment. They will attract manufacturers, who can commercialise products coming down the pipeline.

"But this will not happen by default. If this is the future Australia wants, it will take a heavy dose of determination. It will take more than just the innovation in your labs. It will require innovation in business models and business practices, and innovation in public policy."

Dr Liveris said Australia could not achieve it potential without sufficient human capital.

"Australia has a small worker base. To build an economy run by the best and the brightest, we not only need an education system that can produce them, but an immigration system that can attract them. We need population growth to fuel that future.

"We are, and have always been, a nation of immigrants. About 40 per cent of Australians were born abroad, or are the children of immigrants. People have come here from more than 200 countries to start families and build lives. At times, that makes an otherwise isolated island feel like the centre of the world.

"But over the next century, immigration will be important to Australia not solely for the culture and diversity it brings. We need to

find the right people with the right skills to do the work our economy demands. We need to ensure we have enough population growth to sustain our economic growth.

"I believe not in a small Australia or a big Australia, but in a great Australia," he said. "Australia is the envy of nations. It has wealth. It has a high quality of life. It has a vibrant democracy, a vibrant society. But does it have the will not just to be the envy of nations, but the leader of nations?

"If Australia can build up its manufacturing and innovation capacity in its economy, I believe it can be at the forefront of solving the world's greatest challenges. That is a role I think we should embrace. Doing so will take courageous leadership and an abiding commitment – the kind of commitment on par with fighting a war or seeking to put a man on the moon – a commitment of conscience and a commitment of resources.

"If Australia does these things, we will become the world's greatest laboratory. We will lead in the export of ideas. We will set an example for the global community to follow."

The full text of this address is on the ATSE website at [www.atse.org.au/resource-centre/func-startdown/418/](http://www.atse.org.au/resource-centre/func-startdown/418/)

## Pricing carbon to fix the problem

◀ FROM PAGE 33

claimed against the carbon tax paid.

While reducing energy intensity will be one objective, there are also likely to be other benefits of an accelerated capital stock replacement or upgrade in terms of output, productivity, quality and other cost savings.

A carbon tax as currently envisaged will only be economically efficient in terms of emissions reductions, while a capital incentive and rebate – as outlined here – will drive the greatest economy-wide investment efficiency. It does not rely on a government committee to decide if it is acceptable, it does not rely on a strict set of guidelines and it leaves investors able to choose what they invest in, so it is basically a market-driven approach.

All that is required for anyone wanting to finance their capital budget from their carbon price liability is that their emissions or energy consumption reduce. Even if the climate change deniers turn out to have a point, the Australian economy will have benefited from a renewal of its capital stock more rapidly than

would have been the case otherwise.

Of course life is not so simple. The same principle may be used to encourage motorists to invest in more fuel-efficient cars, but for industries such as steel and cement, where no amount of investment will remove all emissions, there may need to be exemptions once the industry can demonstrate it has achieved world best practice. A more detailed explanation of a possible concept can be found at [www.atse.org.au/resource-centre/func-startdown/395](http://www.atse.org.au/resource-centre/func-startdown/395).

ATSE Fellows are the leading applied scientists and engineers in the country and profess no particular expertise in taxation policy. Collectively, however, we are becoming very concerned about energy security in Australia unless some process is established that stimulates capital investment in new technology to address the problem we face. ◀

PETER LAVER AM FTSE is Vice President and Director of the Australian Academy of Technological Sciences and Engineering (ATSE).

# ATSE sponsored WiSE Summit



Dr Cathy Foley addresses the summit.

■ ATSE was a sponsor of the Women in Science and Engineering (WiSE) Summit in April in the Mural Hall, Parliament House, Canberra.

The Summit brought together leaders, advocates, and high-achieving young women in science and engineering in a high profile event to highlight the issues; encourage science and engineering leaders to take practical steps to secure a higher return on their investment in young women scientists and engineers; and explore other opportunities to improve gender equality in science and engineering.

Other supporters were Cochlear, CSIRO, Telstra Foundation, ANSTO and Walter and Eliza Hall Institute, ARC, Australian Academy of Science, CSL, NHMRC, Bio21 Cluster and VESKI.

ATSE and ANSTO Director Dr Susan Pond AM FTSE and ATSE CEO Dr Margaret Hartley represented ATSE and the Academy's Gender Equity Policy Statement and December 2010

ATSE Focus Article Australia needs women in the corner offices (By Dr Pond and Bronwyn Holland, from UTS) were included in the briefing papers for the summit.

ATSE Fellows were prominent at the event. Dr Cathy Foley PSM FTSE, President of FASTS, delivered the scene-setter address and the Stories from the Frontline session was chaired by Ms Ms Kathy Hirschfeld FTSE, non-executive Director, Snowy Hydro Ltd, with Dr Pond as a presenter. Professor Margaret Sheil FTSE, CEO of the ARC, was the lunch speaker.

Other delegates included Dr Megan Clark FTSE, CEO, CSIRO; Professor Simon Foote FTSE, Director, Menzies Research Institute, University of Tasmania; Dr Bob Frater AO FTSE, VP Innovation, ResMed; Dr Sue Meek FTSE, Chief Executive, Australian Academy of Science; Professor Mary O'Kane FTSE, NSW Chief Scientist and Scientific Engineer; Professor

Jim Patrick FTSE, Senior Vice President, Chief Scientist, Cochlear Ltd; Dr Ian Poiner FTSE, Chief Executive Officer, Australian Institute of Marine Science; and Dr Len Sciacca FTSE, COO, Defence Science and Technology Organisation (DSTO).

Minister for the Status of Women, Ms Kate Ellis, told the Summit she wanted to see a boost in the employment of women in the fields of science, engineering and technology, particularly in senior ranks, noting that women were seriously under-represented in these sectors, constituting just 22.3 per cent of professionals in some disciplines.

"This issue is important in terms of broadening opportunities for working women in Australia but it is also critical to our national productivity, innovation and international competitiveness."

"Australia simply cannot afford not to be making the most of such a significant component of our workforce, intellect and creativity," Ms Ellis said.

Ms Ellis said she was pleased to see the participation in today's summit by some of the nation's most senior decision makers.

"This shows that industry, governments and the community have heard the call to action when it comes to women in science and engineering. It shows that industry is not going to stand by and accept that the current experiences of many women in these sectors are alright."

Retaining women in the workforce was a priority, because when women left the workforce with them went hundreds of thousands of dollars of investment in their education and training, said FASTS CEO Anna-Maria Arabia in an on-line article published following the WiSE Summit.

"Retaining this highly specialised workforce should be a priority. It is a workforce taxpayers willingly invest in because the return is delivered in better health care, in hi-tech gadgets, in superior mining and defence capabilities, to name just a few," she says.

"But, particularly in the case of women, we train them up then fail to keep them in the business because practical and equitable career pathways aren't available when it counts."



**ATSE**  
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**FOCUS INTERNATIONAL**  
**JUNE 2011**



**STELR Project Manager Peter Pentland (third from left) works with teachers during a 2010 professional development workshop.**

## STELR gets strong ratings from teachers

STELR continues to be a great success with teachers and students alike.

A recent teacher satisfaction survey shows the esteem with which teachers regard STELR:

- 35 per cent agreed and 60 per cent strongly agreed with the statement "My students enjoyed the hands-on activities in STELR";
- 68 per cent of teachers surveyed strongly agreed with the statement "I would like to see other topics developed using the STELR model"; and
- 71 per cent strongly agreed with the statement "I would recommend STELR to other teachers and schools".

The STELR Project has now completed four years of development, moving from concept design in 2007 to proof-of-concept, pilot phase and then initial deployment in 2010 with 183 schools nationwide. By the end of this year more than 50,000 students will have engaged with the STELR Project.

Due to the generous support by ATSE, individuals benefactors, governments and our foundation corporate supporters – Rio Tinto, Orica and the Australian Power Institute (API) – STELR has been tested and deployed at no cost to schools. In 2011 STELR curriculum materials and equipment are being used in 185 schools nationwide

The STELR Project is now moving into the sustainable, ongoing phase of its operation. This will involve schools having some financial involvement, supplemented by monies provided by state governments, corporate sponsors and ATSE benefactors. ATSE acknowledges the generosity of our foundation corporate supporters Orica, API and Rio Tinto and their vital role during our next transitional phase of STELR.

The STELR team, led by ATSE's 'STELR Champion' Dr Alan Finkel AM FTSE, is fine-tuning the new transitional model that will take STELR to another 200 schools over the next two years and provide a sustainable model for STELR to be applied across the nation.

The STELR team is seeking supporters to assist it in securing sponsorship and support for STELR over the next two years so ATSE can maximise the enormous gains made to date.

## WA Eminent Speaker lauds designing dreams

Darren Lomman, CEO and founder of the Dreamfit Foundation, was the Western Australian Division's Eminent Speaker for 2011, presenting an inspirational address on designing dreams for people with disabilities through innovative engineering solutions.

He addressed Year 10 students in Perth in June, speaking at both Curtin and Edith Cowan universities and Presbyterian Ladies College as part of the Eminent Speaker program.

This free event was backed by the Division, with support from the WA Government, Scitech and the Science Teachers' Association of WA. It is an annual event conducted by the WA Division.

Darren was inspired to start Dreamfit after meeting former motocross champion Shane Thompson in a hospital carpark in 2003. Shane was left paralysed after an accident but dreamed of one day being able to ride a motorcycle again.

Darren was studying mechanical engineering at the University of WA and decided to use his next university project as

[CONTINUED ON PAGE 44](#)



**Shane Thomson (left) shares a light-hearted moment with Darren Lomman.**



## Alan Baker wins Michell Medal

Dr Alan Baker FTSE, one of Australia's leading materials scientists specialising in aeronautical materials and structures, has been awarded the 2011 AGM Michell Medal by the Board of the College of Mechanical Engineers.

Dr Baker, Emeritus Research Leader at DSTO's Air Vehicles Division, has been a Fellow since 1991. He developed and presented the technical program that led to the establishment of the CRC for Advanced Composite Structures.

The College says his early scientific research, at Rolls Royce Advanced Research Laboratories, was on metal-matrix composites. He conducted pioneering studies with these new materials, including manufacturing technology, mechanical performance and environmental behaviour.

His later contributions were largely focused on the repair/reinforcement of ageing military aircraft, based on the use of fibre composite materials and structural adhesive bonding. This work has been highly successful, saving Australia many hundreds of millions of dollars, and is now adopted worldwide.

Dr Baker has made important contributions to engineering education on advanced fibre composites in Australia and overseas by publishing textbooks and delivering workshops and lectures. He is also an active member of the editorial boards of several international scientific journals and two encyclopedias. He developed the technical program that led to the establishment of the CRC for Aerospace Structures in 1991, the forerunner to the present CRC for Advanced Composite Structures.

The Award perpetuates the memory of Anthony George Maldon Michell (1870–1959), an outstanding Australian mechanical engineer.

### Three Fellows join AAS

Seventeen leading scientists were elected to the Australian Academy of Science in March – including three ATSE Fellows – Professor Marilyn Anderson FAA FTSE, Dr Colin Ward FAA FTSE and Professor Aibing Yu FAA FTSE.



**Marilyn Anderson**

Professor Anderson, from La Trobe University, is distinguished for her discovery of the role of protective proteinase inhibitors, specific for different insect gut enzymes, in female sexual tissues of flowering plants.

Dr Ward, from the Walter and Eliza Hall Institute of Medical Research, is distinguished for his work in protein chemistry, including the elucidation of the 3D-structure of the extracellular domains of four growth factor receptors and their activation mechanisms.

Professor Yu, from the University of NSW, is distinguished for his work in particle science and technology, including methods to simulate and model the motion of individual particles within large populations in flowing systems.

Professor Anderson explained how plants practise safe sex at the AAS's annual celebration, 'Science at the Shine Dome', in Canberra in May. She described how plants reject unwanted suitors and protect their valuable reproductive organs against fungal diseases and insect pests.

### Tony McMichael honoured by US National Academy

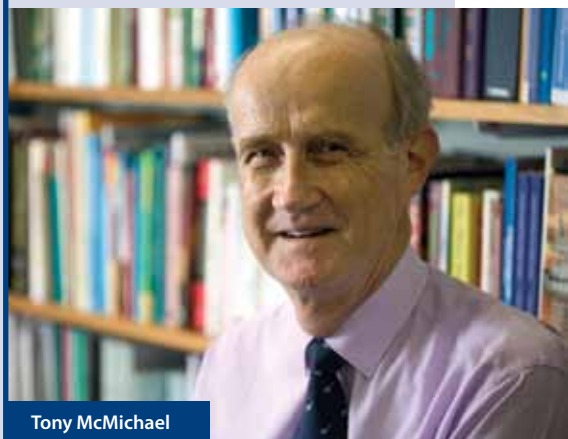
Professor Tony McMichael AO FTSE has been elected a Foreign Associate of the (US) National Academy of Sciences – one of 18 scientists from 15 countries, including two Australians.

Professor McMichael, a Fellow since 2003, is Professor and NHMRC Australia Fellow, National Centre for Epidemiology & Population Health, at ANU and Honorary Professor of Climate Change and Human Health, University of Copenhagen.

His citation read: "Professor McMichael is the founder of the scientific field linking human health impact to global change in general and to climate change in particular. He instituted the conceptual basis of this work during an already outstanding career of developing methods and conducting quantitative analysis of the health impacts of a range of other environmental insults, including seminal work on the cognitive impacts of lead exposures in children.

"He continues his rigorous quantitative studies of climate health effects, including those related to heat stress, malaria, dengue, and pioneering work on the interactions of sunlight, immune suppression, and multiple sclerosis. He is now the go-to senior scientist globally for careful, reasoned, innovative, quantitative, and insightful assessments of the impacts of global environmental change on health and has contributed to dozens of international assessments, most in leadership roles.

"Climate change and human health is emerging as a major area of research, both within Australia and internationally.



**Tony McMichael**

Professor McMichael played a key role in establishing the agenda, and he continues to play a leading role in new discoveries and in making the science available to scientists, policymakers, and the public."

Joining Professor McMichael in election was Professor Noel Hush, convener of the molecular electronics group and Foundation Professor Emeritus of Theoretical Chemistry, School of Molecular and Microbial Biosciences, University of Sydney.



Ian Frazer

## Two Fellows join Royal Society

Professor Ian Frazer FRS FAA FTSE and Professor Mark Randolph FRS FREng FAA FTSE have been elected Fellows of the Royal Society, among 44 new Fellows elected for 2011.

Professor Frazer, world-renowned co-inventor of the cervical cancer vaccine, has been Director of the Diamantina Institute in Brisbane and is Chief Executive of the Translational Research Institute.

Professor Randolph, a former ARC Federation Fellow, is Professor of Civil Engineering at UWA's Centre for Offshore Foundation Systems and an internationally recognised geotechnical engineer.

Announcing the new Fellows, Sir Paul Nurse, President of the Royal Society, said: "It is a pleasure to welcome this year's new Fellows to the Royal Society. They join the ranks of the UK and Commonwealth's leading scientists, counting themselves among early Fellows such as Isaac Newton, Robert Boyle and Charles Darwin.

"The Society aims to expand the frontiers of knowledge by championing the development and use of science, mathematics, engineering and medicine for the benefit of humanity and the good of the planet. It is the contribution of excellent individuals such as these which makes this possible."

"I would like to congratulate Professor Ian Frazer on being elected to the Fellowship of the Royal Society. This recognises and honours Ian's standing as a truly world-class scientist," said Queensland Chief Scientist Dr Geoff Garrett AO FTSE

"Ian's career has spanned many years and



Mark Randolph

areas of health and medical research, including his development of the Gardasil vaccine for the prevention of cervical cancer. Continuing in his groundbreaking work, Ian is now Chief Executive of the Translational Research Institute in Brisbane, Queensland. Here, Ian's vision is to improve and accelerate medical research and translate that research into greater patient care.

"It will be the first time in Australia that biopharmaceuticals and treatment are discovered, produced, clinically tested and manufactured in one location. It will be another great achievement in a remarkable scientific career."

Professor Frazer carried out his vaccine research while heading the Diamantina Institute and says his election is also an acknowledgement of the centre's work.

"Election to The Royal Society is a great and unexpected honour, providing an opportunity to interact with the world's leading scientists," Professor Frazer said. "I'm thrilled that the Institute's contribution to medical research has been publicly recognised in this manner."

UWA Vice-Chancellor Professor Alan Robson AM FTSE said Professor Randolph's election to the Society put him alongside the leading scientists, engineers and technologists of his generation.

"Professor Randolph is an internationally recognised geotechnical engineer working in a world-class Centre for Offshore Foundation Systems at our university," Professor Robson said. "He has worked hard to align the Centre's research themes to facilitate developments within the oil and gas industry."

Professor Randolph founded the Centre for Offshore Foundation Systems in 1997 to better understand the particularity of Australian soils and to develop suitable foundation solutions. Within the past decade knowledge of the North West Shelf seabed conditions has progressed significantly through the work of COFS, with particular insights gained from model tests conducted using the innovative centrifuge facility – the only such facility in Australia.

■ *The Royal Society is the world's oldest scientific academy in continuous existence, and has been at the forefront of enquiry and discovery since its foundation in 1660. The backbone of the Society is its Fellowship of the most eminent scientists of the day, elected by peer review for life and entitled to use FRS after their name.*

## Graham Schaffer hailed by powder metallurgy industry

Professor Graham Schaffer FTSE, Executive Dean, Faculty of Engineering, Architecture and Physical Sciences, University of Queensland, has been named a Fellow of APMI International, the professional society for the powder metallurgy (PM) industry, during PowderMet2011 – the 2011 International Conference on Powder Metallurgy and Particulate Materials at Princeton, New Jersey.

APMI International said Professor Schaffer was an international authority on particulate materials processing, primarily focused on the light metals, achieving significant academic and commercial impact, and transforming the field of aluminum powder metallurgy.

He had devoted 27 years to the PM industry and led research teams on the powder processing of aluminum, titanium, iron, and steel, as well as intermetallics, composites, nanomaterials and magnetic materials.

A member of APMI International for more than 16 years, he was an active member of the APMI International Liaison Committee, had written more than 100 articles and received five patents. He had served on numerous MPIF technical program committees and was executive editor of the journal *Powder Metallurgy*.

# Tanya Monro takes new science to Europe

Professor Tanya Monro FTSE, Director of both the Institute for Photonics & Advanced Sensing (IPAS) and the Centre of Expertise in Photonics (CoEP) at the University of Adelaide, has taken her expertise in new sciences to Europe.

An ARC Federation Fellow, Professor Monro recently addressed Ireland's National Centre for Sensor Research, the Spanish Institute of Photonic Sciences in Barcelona, the Technical University of Denmark, The Institute of Photonic Technology at Jena in Germany, and Italy's University of Trento.

She visited Europe to spread the word about new Australian science that will allow humans to probe our world in ways that have never before been possible. The research has implications for applications in medicine, defence, the environment, agriculture and many other areas of science and engineering.

"A lot of the challenges we come up against in solving pressing problems in these critical areas simply cannot be solved using existing sensing technologies," Professor Monro said. "We have pioneered new approaches to interacting light with liquids, and for controlling light on the nano-scale. These new platform

technologies are allowing us to detect chemicals or biomolecules of interest within just a few nanolitres of fluid or in difficult-to-access areas.

"For example, at the moment there is no way to measure an embryo's response to its environment as it develops. This emerging technology will allow us, for the first time, to 'listen' to the embryo and assess how it responds to its environment. This will ultimately lead to improved agricultural practices, increase the success rate of IVF treatment and improve our knowledge of fundamental reproductive biology.

"We are also working with Australia's defence scientists to develop smart optical fibres that can be embedded within aircraft or buildings to detect corrosion as it happens."

Professor Monro's team is also developing novel probes (for use in agriculture, wine monitoring and early screening for cancer) and new classes of advanced materials and lasers.

She is one of three Australian scientists to visit Asia, Europe and North America in 2011 to share Australian research and innovation with their international counterparts. She visited Europe as part of the Speaker Series – a joint



Tanya Monro

initiative of the Department of Innovation, Industry, Science and Research and the Australian Academy of Science.

## Susan Pond on ABRI Council

The \$20 million Australian Biofuels Research Institute (ABRI) will benefit from the \$5 million in funding announced in the May Budget for a foundation project at James Cook University in Townsville.

Dr Susan Pond AM FTSE, Adjunct Professor of the Dow Sustainability Program at the University of Sydney, has been appointed to the ABRI Establishment Council, which will advise the Government on how best to set up the ABRI.

The Establishment Council, chaired by Dr Bruce Godfrey, Australian Centre for Renewable Energy Board and principal of the Wyld Group, will also oversee the development of a significant new next-generation Biofuels Economics Study.

The study, commissioned by the Australian Centre for Renewable Energy, will inform the priorities of the ABRI. It will look at the prospects for developing biofuels that are neither derived from food sources nor will deplete Australian native forests.

At the same time, the study will inform the government on technical developments of next-generation biofuels worldwide and the economics of next-generation biofuels technologies, drawing on international and Australian research, development and commercialisation activities.

The ABRI's work is designed to drive down the costs of next-generation biofuel technologies.

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## WA Eminent Speaker lauds designing dreams

an opportunity to design and build a hand-controlled motorcycle. What started out as a one-semester project turned into a three-year passion to complete a hand-controlled motorcycle, which has now been licensed in WA.

In the seminar Darren discussed the genesis of Dreamfit and provided examples of projects Dreamfit and the volunteer students have undertaken, including a bicycle for a Perth boy born with no arms, a joystick-controlled hovercraft, a ski boat with a transfer hoist, a seated surfboard, a wheelchair-accessible trimaran yacht and an abseiling tower for wheelchair users.

Darren also discussed his mission to

inspire, create and support a sustainable global movement where industry, academia, government and the community partner together to fulfill dreams and overcome the challenges and frustrations of people with disabilities.

■ *Darren Lomman has a degree in mechanical engineering from UWA. He has been recognised with several awards for his passion, determination and commitment to helping people with disabilities, including 2006 WA Young Person of the Year, 2006 WA Citizen of the Year, 2007 WA Young Australian of the Year, 2008 Mechanical Engineer of the Year and 2010 Most Inspiring Young Engineer.*



# Meryl Williams completes ACIAR term

Dr Meryl Williams FTSE has completed her term as Chair of the Commission for International Agricultural Research at the Australian Centre for International Agricultural Research (ACIAR).

The new Chair is Ms Joanna Hewitt AO, former Secretary of the Department



**Meryl Williams**

of Agriculture, Fisheries and Forestry. She has held several Deputy Secretary positions at the Department of Foreign Affairs and Trade, has a Masters

in International Relations and was a lead negotiator with the World Trade Organisation. She is also a former member of the ACIAR Board of Management.

Dr Craig Emerson, the Trade Minister and Acting Minister for Foreign Affairs, extended the Government's thanks to retiring Commissioners, the Hon. Neil Andrew AO FTSE and Mr Barry Buffier.

"The Government would also particularly like to thank former Chair Dr Meryl Williams for her commitment to the Commission since her appointment in 2007, and in her previous role on the ACIAR Board of Management," Dr Emerson said. "ACIAR has certainly benefited from her involvement, and that of the previous Commissioners."

Dr Joanne Daly PSM FTSE, a member of the CSIRO Executive Management Council, remains a Commissioner.

## Cathy Foley backs climate report

"The science of global warming is clearer than ever, yet fewer Australians believe it is true," said Dr Cathy Foley PSM FTSE, President of FASTS, welcoming the recent release of the Climate Change Commission's Report, *The*

*Critical Decade*. "Polls show that between 46 and 65 per cent of voters no longer accept the science on man-made climate change, or they are simply confused."

"Unbalanced debates that pitch peer-reviewed science against opinion and anecdotal evidence have done nothing to improve Australians' understanding of climate change. I commend the Prime Minister for acknowledging the rigour of the peer-review process.

"In the face of well-understood, peer-reviewed climate science, it is incumbent on Australia's political leaders to act strongly and rapidly as recommended in the Report.

"Science is able to deliver the most for Australia's future when we have a supported and trusted science community; when governments are prepared to factor in the scientific evidence base in their decision making; and when the public is informed," Dr Foley concluded.

In a separate initiative, she argued that science was the future for Australia in an opinion article published in Melbourne's *The Age* in April. Rejecting threatened funding for science she concluded: "Let us instead support our science community and create sustainable growth for the next generation of Australians."

## SQUIDS help LANDTEM team win minerals award

A team of CSIRO Future Manufacturing Flagship scientists, led by Dr Cathy Foley PSM FTSE and Keith Leslie, has won a major mining industry award for the invention of the highly sensitive magnetic field sensor that sits at the operational heart of the mineral exploration tool, LANDTEM™.

LANDTEM is a portable exploration tool that uses highly sensitive magnetic sensors known as SQUIDs (Superconducting

Quantum Interference Devices) to differentiate the ore from other conductive material.

The team won the 2010 Australian Institute of Mining and Metallurgy Mineral Industry Operating Technique Award (MIOTA) for discovering the method for making the sensor using a high-temperature superconductor.

Dr Foley led the initial development and commercialisation of LANDTEM, in collaboration with BHP Billiton and the then Canadian mining company Falconbridge.

"LANDTEM represents a major innovation in our ability to unearth mineral deposits worth hundreds of millions of dollars – deposits which may have been missed without this technology," Dr Foley said.

LANDTEM has since been licensed to Australian start-up company, Outer-Rim Exploration Services. In the past eight years, 10 LANDTEM systems have been built and successfully deployed on four continents to help unearth mineral deposits worth about \$6 billion.

LANDTEM's development is a great example of science teams collaborating to deliver new technologies to multiple industry sectors. The underpinning SQUIDS technology – delivered through CSIRO's National Research Flagships program – has been applied to industries as diverse as mineral exploration, oceanography, security and defence.

The MIOTA award is presented annually to a person or team responsible for an innovative cost saving or effective mineral industry operating technique developed in Australasia, in the minerals sector.

PHOTO: OUTER RIM EXPLORATION



**Cathy Foley**



**LANDTEM™ can detect deeply buried, highly conductive massive sulphides, such as nickel.**



Professor Dongke Zhang (left) talks to Chairman Jia Qinglin.

## Fellows host top Chinese visitor

ATSE Fellows Professor Alan Robson AM FTSE and Winthrop Professor Dongke Zhang FTSE hosted a visit to the University of WA by one of China's most senior and influential officials.

Mr Jia Qinglin, Chairman of the 11th National Committee of the Chinese People's Political Consultative Conference, was in Perth on the first leg of a six-day Australian trip and visited UWA's Centre for Energy as part of an Australian visit to promote bilateral relations.

Mr Jia met UWA Chancellor Dr Michael Chaney, Professor Robson, Vice-Chancellor, and Professor Zhang, Director of the Centre for Energy, and later met Prime Minister Julia Gillard and Foreign Affairs Minister Kevin Rudd, as well as WA Premier Colin Barnett and WA Governor Ken Michael AC FTSE.

Professor Robson said UWA had many vital collaborative projects with important universities and tertiary institutions in China.

"These range from addressing the challenges of our two nations' ageing populations to research in energy," he said. "Our university regards international agreements and collaborations as a fundamental opportunity to enhance our educational programs and research capacity, as well as strengthening important international partnerships."

The Centre for Energy at UWA works with leading companies, institutions and government agencies and UWA's Energy and Minerals Institute to improve gas-to-liquid, clean coal and biofuel technology and to develop efficient and effective ways to minimise greenhouse gas and other emissions.

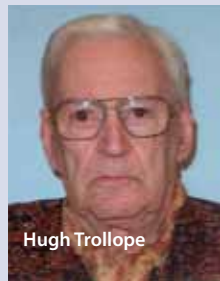
## Hugh Trollope was a noted engineer

Emeritus Professor Hugh Trollope, former Foundation Professor of Civil Engineering and later Deputy Vice-Chancellor of James Cook University, has died in Victoria, aged 86.

Professor Trollope, who was Honorary Director of the Centre for Disaster Studies at JCU following his retirement, joined the Academy in 1983.

Born in Swansea, Wales, David Hugh Trollope gained his MSc in Wales before taking his PhD at Melbourne University and obtaining a DEng at Queensland University. He was a Reader in civil engineering at Melbourne

University before moving to JCU in 1964 to establish the civil engineering course, where he further developed his expertise and influence in the field of geomechanics.



Hugh Trollope

He was Foundation Chairman (1970–72) of the Australian Geomechanics Society and Vice President, Australasia (1965–69) of the International Society for Soil Mechanics and Foundation Engineering.

Professor Trollope was a Fellow of numerous engineering bodies and was awarded the 1966 Warren Memorial Prize and the 1984 Kernot Memorial Medal.

## Paul Greenfield chairs Riverprize judging

Professor Paul Greenfield AO FTSE, Vice Chancellor of the University of Queensland, will chair the international judging panel for the 2011 International Riverprize. He is also a member of the judging panel for the 2011 Australian Riverprize.

The judging panels will select the finalists for the International and Australian Riverprize by July. The winners will be presented at the 14th International Riversymposium held in Brisbane in September.

International RiverFoundation works in partnerships around the world to drive the protection and restoration of the world's rivers,

lakes and wetlands. It began with a vision for Brisbane and its then Lord Mayor, Jim Soorley, to put best practice for restoration of rivers onto the global agenda.

The first Thiess International Riverprize was awarded in 1999 and the National Riverprize was introduced two years later.

International RiverFoundation Chairman is Professor Gary Jones, Chief Executive of the eWater CRC. He succeeded Mr Martin Albrecht AC FTSE, who was Chairman from its establishment in 2003 to 2010, but remains as a Director. Other directors include Professor Greenfield and Dr Jim Gill AO FTSE, the inaugural CEO of the WA Water Corporation from 1996 until his retirement in December 2008, and now Chancellor of Curtin University of Technology.

## Bhatia and Crozier awarded by UQ

Professor Suresh Bhatia FTSE, from the School of Chemical Engineering, and Professor Stuart Crozier FTSE, of the School of Information Technology and Electrical Engineering, were among 52 leading UQ researchers honoured in May as leaders in their diverse fields of discovery at the inaugural Q-Index Awards.

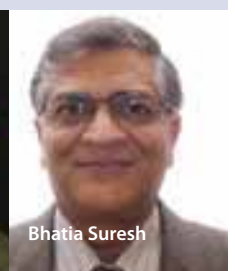
Attending the Award event were Queensland chief scientist Dr Geoff Garrett AO FTSE, ATSE President Professor Robin Batterham AO FEng FAA FTSE and UQ's Deputy Vice-Chancellor (Research) Professor Max Lu FTSE.

Also among those at the Customs House awards ceremony were past and present ARC Federation fellows, ARC Laureate fellows, Queensland Smart State Premier's fellows and NHMRC fellows.

The Q-Index, launched last year, provides each UQ academic with an individual composite index of research performance over a rolling six-year period.



Brian Crozier



Bhatia Suresh

## Celebrating Australian achievements

### 2011 **ATSE** Clunies Ross Awards winners

The **ATSE** Clunies Ross Awards Committee congratulates the 2011 **ATSE** Clunies Ross Award winners:  
**Dr John Clout, Mr Bruce Candy, Dr John Ness, Professor Antony Burgess,**  
**Professor Ashley Dunn, Dr Nicholas Gough** FTSE, **Mr. Roy Woodall** AO FAA FTSE

The 2011 **ATSE** Clunies Ross Awards were made possible through the generous support of the following sponsors:

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

The **2012 ATSE CLUNIES ROSS AWARDS**  
are now open **Nominations close 29 July 2011**

For more information about the nomination process or to download  
a nomination form visit [www.atse.org.au/clunies-ross-award](http://www.atse.org.au/clunies-ross-award)





# THE UNIVERSITY OF DISCOVERERS

Driven by a passionate commitment to research excellence and collaboration, The University of Queensland is making a bold investment in green energy.

Professor Paul Meredith is a strong advocate of renewable energy and is leading several solar infrastructure projects, including an extensive 1.2MW solar array at UQ, made possible through collaboration with industry and government.

Paul's research focuses on discovering new, economical and more sustainably advanced materials for solar energy conversion and high-tech electronics.

The 2010 Excellence in Research for Australia assessment confirmed UQ as having more researchers working in fields assessed above world standard than at any other Australian university.

UQ is firmly established as one of Australia's premier learning and research institutions and provides every opportunity to gain every advantage. The University of Queensland. The University of You.



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