AUSTRALIAN R&D REVIEW

ISSN 1320-8977
SEP-DEC 2011

Linking Australian Science, Technology and Business

INSIDE

Australia's marine environment is worth more than $40 billion annually to the Australian economy, not taking into account an untapped potential that is increasingly recognised by industry, as well as in policy and research circles. Recent developments, such as the proposed network of marine protected areas (MPAs) around Australia, as part of Government's draft marine bioregional plans, highlight the importance of our marine assets for the future of the nation, but also the struggle of balancing commercial interests with conservation issues. We report here on the development, and more broadly on the research and conservation issues related to the marine environment.

Ocean views

The commercial interest in the oceans and the rich genetic resource they contain, is growing. A recent study in *Science* found that the number of patents based on the diverse gene pool of marine species is rapidly increasing (see ARDR April-May edition, 2011).

Co-authored by ***Professor Carlos Duarte from*** **University of Western Australia's Ocean Institute**, the study demonstrated the enormous commercial potential, such as for new medical and biotechnological products, but it also raised important conservation issues associated with this development. This is a particular concern in international waters, where the race plays out on a 'first-come, first-served' basis due to a void of adequate international policy and regulatory tools.

There are other marine industries emerging, such as the harvesting of tidal power, seabed mining and the growing desalination industry. While these activities are understood to significantly contribute to our environmental, social and also economic prosperity, they may not yet be adequately reflected in official accounts of marine related industries.

Guarding our marine assets

In Australia, the latest annual **Index of Marine Industry**, released by the **AIMS** in December 2010, places the "measurable value of economic activity based in the marine environment in Australia" at around $44 billion in 2008-09, some $4 billion less than in the previous year. This is still an impressive figure, given that the gross value of all agricultural production in Australia was $41.8 billion in 2008-09. Around half of this marine industry value is related to mining activities, though, including oil exploration and extraction, and the production of LPG and natural gas.

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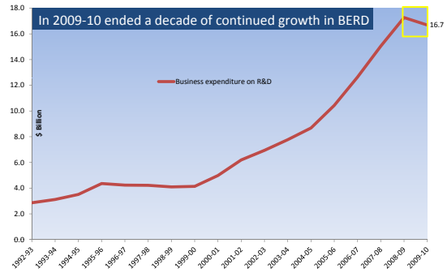
End of a trend

The **Australian Bureau of Statistics** has released a data series on business activities related to R&D, innovation and IT use. In this context we also summarise here a new research paper by the ABS, which used longitudinal data from Australian firms to examine the relationship between competition and innovation, and between innovation and productivity.

End of a run

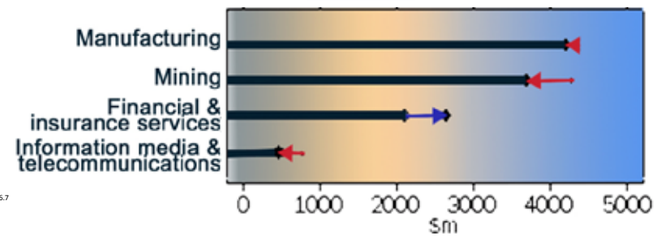
Australia has experienced a decade of continued growth of business expenditure on R&D (BERD), both in absolute terms as well as a proportion of GDP. But new ABS data show that in 2009-10 the trend reversed as BERD decreased by 3% (current price terms) to $16.7 billion. Australia's BERD to GDP ratio also dropped slightly from 1.38% to 1.30%, resulting in Australia to slipping from 12th to14th position in its OECD ranking.



Australia has come along way, though, having more than doubled its BERD to GDP ratio from the low 0.64% in 1999-2000. This has narrowed the gap to the OECD average, but a gulf nevertheless remains to the top tier of OECD countries, which include Israel (3.42%), Finland (2.83%), Sweden (2.55%) and Japan (2.53%).

While the long run of growth in BERD was largely driven by the expanding mining sector, weaker investment in the sector has now led to a decrease in 2009-10. R&D investment by the mining sector fell sharply, with $639 million or almost 15% less spent on R&D in 2009-10 than the year before. The weakness in the mining sector was paralleled by the information media and telecommunications industry, which spent $346 million or more than 40% less on R&D than in the previous year. In both industry sectors, large businesses with a degree of foreign ownership accounted for most of the drop. Thus the ABS data show that in 2009-10 businesses with 10% and more foreign ownership invested more than $1.5 billion less on R&D than in the previous year, while wholy owned Australian businesses increased their expenditure by $767 million.

BERD increases/decreases between 2008/09 and 2009/10
graph: adapted from Australian Bureau of Statistics



The drop in R&D investments in the mining sector also accounted for a significantly reduced BERD in WA, which decreased in both dollar and percentage terms more than any other state, by 19% or $689 million from 2008-09.

By contrast, NSW, the largest contributor to BERD in the country, profited from a strong performance by the financial & insurance services industry. With $548 million or 16% more spent on R&D than in the previous year, it was the only industry showing a significant increase in 2009-10, replacing professional, scientific & technical services as the third largest contributor to Australia's overall BERD.

R&D expenditure in the manufacturing industry was steady overall with $4.2 billion, and remained the largest post in Australia's total BERD, followed by mining with $3.7 billion.

As in the previous year, engineering and information and computing sciences shared more than 80% of the total BERD in 2009-10, but these fields of research also accounted for almost all of the decrease in total BERD over the period.

Size matters

Australian businesses remain by and large in Australian hands, with 98% wholy Australian owned. However, there are stark differences between industries. Results from the ABS *2009-10 Business Characteristics Survey* (BCS) highlight that almost a third (27%) of the mining sector reported some degree of foreign ownership. While this was 4% less than in the previous year, it is still more than three times that reported by businesses in wholesale trade, the industry with the second highest level of foreign ownership. The mining sector has a higher proportion of large businesses, which are also far more likely to have a degree of foreign ownership.

Most of the characteristics the survey investigated were strongly dependent on business size. Thus large businesses (200 and more employees) are far more likely to undertake a form of collaboration (38% versus 14% of all businesses), to protect their intellectual property (63% versus 21% of all businesses), or to receive income through the internet (66% versus 43% of all businesses).

Large businesses are also more likely to undertake an innovative activity (74% versus 44% of all businesses) and significantly, this relates to increased productivity: Over a third of innovation-active businesses (35%) indicated that they had increased their productivity compared to 2008-09, but only 16% of non innovation-active businesses.

Interestingly, there was not a great deal of disparity in the types of barriers that businesses identified as hampering their innovation or general business activities and performance.

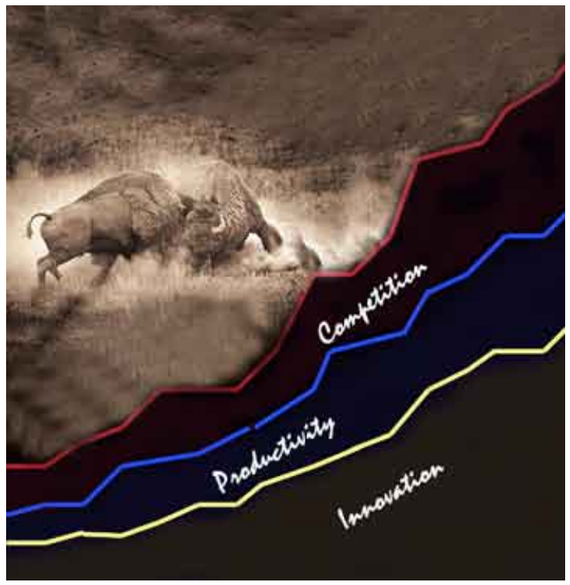
Thus, roughly half of businesses across all sizes indicated barriers to innovation, with the most common issue being lack of skilled people either within the business or in the labour market, and lack of access to additional funds (20% and 18% of all businesses, respectively). More than half of all businesses also experienced at least one barrier to their general activity or performance, with lower profit margins to remain competitive the main issue reported (24% of all businesses). A shortage of skilled labour was, however, a more common issue for innovation-active businesses, of which 24% reported this barrier – twice as often as non-innovation active businesses (13%).

And size of the business was an important discriminator for the type of skills used to undertake core business functions. Thus trades skills were most common in smaller businesses, while financial skills, and also IT skills were predominant in large businesses.

By contrast, scientific and research skills play little role in businesses, with 5% across all business sizes (18% of large businesses) indicating that they use these skills for core business activites. Hence these skills were also not seen as in undersupply, while a shortage of trades skills was most frequently reported by business of all sizes (10%).

Competitive benefits

The ABS has recently used data from several years of its Business Characteristic Survey series as well as financial data on firms to establish a Business Longitudinal Database (BLD). While the data is still limited in scope, covering only a few years and relying to a large degree on subjective judgement by survey respondents, the BLD has enabled an econometric study on the relationship between competition and innovation, and innovation and productivity in Australian firms. Such studies have so far been hampered in Australia due to the lack of suitable data, write researchers from the ABS and the **Productivity Commission** in paper a *Competition, Innovation and Productivity in Australian Businesses.*



The relationships are everything but trivial. Thus the most recent theory on the effect of competition on innovation suggests that, depending on the technological context of the product development, competition can either negatively or positively impact on innovation.

For Australian firms, the researchers found that competition has generally a positive impact on innovation. This includes measures such as having more competitors, having a lower price-cost margin, being an exporter, and reporting downward pressure on profit margins in order to remain competitive.

Some of these measures were found to lead to a larger number of different types of innovation, while others result in a higher degree of novelty.

Greater market share and larger firm size were also positively associated with innovation.

The researchers also confirmed a positive impact of innovative-activity in Australian firms on productivity, as firms

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reported a significantly higher productivity in response to four innovative-activities – goods and services, organisational process, operational process, and marketing.

▶ More information: www.abs.gov.au

Hosting hopes

In late November, governmental and research organisations from seven nations, including from Australia and New Zealand, formed an independent, not-for-profit company that will govern the **Square Kilometre Array** (SKA) project. The **SKA organisation** will centralise the leadership of the project and make legally binding decisions, including about the site of SKA, which is due in early 2012. It will succeed the **SKA Program Development Office** at the **University of Manchester** (UK), which so far has coordinated the project involving 69 organisations in 20 countries.

Earlier, in September, New Zealand and Australia submitted their joint proposal to host SKA, which is to become the world's largest and most sensitive radio telescope. Comprising thousands of antennas, SKA will have the power to detect an airport radar on a planet 50 light years away, controlled by a SKA central computer with the processing power of around 1 million PCs. Its scientific justification is that, despite the enormous recent advances in knowledge about the Universe, there are still major gaps in our understanding of fundamental concepts in cosmology. For example, the effects of gravity, as described by ***Albert Einstein***'s General Theory of Relativity, would predict that the expansion of the universe is slowing, yet the expansion was found to actually accelerate. While this fundamental discovery was recently awarded with the Nobel Price for Physics, a mysterious dark energy was proposed to drive the expansion, and to investigate its nature will be a key project of SKA. Among other objectives, the the power of SKA will also allow scientists to:

- test Einstein's General Theory of Relativity under extreme gravity conditions and investigate one of its predictions – gravitational waves;
- probe for so called protogalaxies, extremely faint and distant first luminous objects in the universe; and
- study the process of planet building, including of Earth-like panets.

SKA was originally conceived in the early 90s, and then set on its path by 11 countries, including Australia, in a Memorandum of Agreement in 2000. The project is currently in its preparatory phase, which will end in early 2012 when the site of its construction will be decided between the two remaining contenders for hosting the project, the NewZealand/Australia collaboration and South Africa.

The project's timeline includes a design and preconstruction phase from 2013, with the contruction then to begin in 2016. Full science operations will start from 2020 onwards.

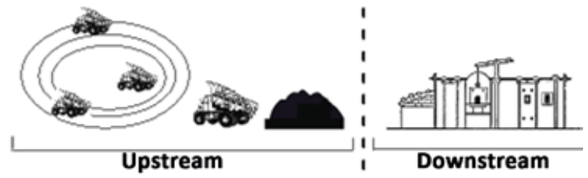
The potential rewards for the project host are significant, given the innovation and science involved in the project. SKA will also have significant industry involvement for the delivery and through-life support of the technologies and infrastructure.

According to the current SKA Industry Engagement Strategy, which is set out to 2017 and beyond, this will include niche R&D companies, high-volume manufacturers, technology systems vendors, site services and installation firms, and power and data transmission specialists, with funded procurements in the vicinity of €1.2 billion ($1.8 billion).

▶ More information: www.skatelescope.org

Taxing dig

Following the release of a second exposure draft legislation in September, the **Australian Government** introduced its *Minerals Resource Rent Tax (MRRT) Bill 2011* into Parliament in November 2011 as part of a package of 11 bills, together with explanatory material describing the framework under



Taxing point for the MRRT as indicated by dashed line.

which the proposed MRRT will operate. The legislative package also includes a *Minerals Resource Rent Tax (Consequential Amendments and Transitional Provisions) Bill 2011*.

On 23 November, the package past the lower house, and is now subject to Senate approval.

In its first exposure draft legislation, released in June, the Government had accepted all 94 recommendations outlined by the **Policy Transition Group** (PTG) in its December 2010 report. This included the extension of the existing **Petroleum Resource Rent Tax** (PRRT) to all Australian offshore and onshore gas and oil projects, including coal seam gas and oil shale projects (see ARDR Dec-Jan 2010/11). While the second draft then included some amendments, the broader proposed policy aspect remained unchanged, with a proposed starting date for the legislation of 1 July 2012. Further amendments were part of a deal the Government reached with the independent member of parliament ***Andrew Wilkie***.

In a nutshell, the MRRT will apply an effective tax rate of 22.5% to realised profits from coal and iron ore operations that exceed $75 million, although the proposed point of taxation could give rise to a great deal of complex accounting.

Thus the tax liability will be based on 'upstream' revenue created up to the point of the resource being extracted and stockpiled , but before any 'downstream' processes have added further value to it.

For the tax to actually apply, it needs to be triggered by a 'mining revenue event' in the form of a sale, such as through supply or export of the resource, or through the sale of something that has been produced using the resource, such as electricity from coal.

A key design principle of the MRRT is that it will not apply to profits that relate to the value added in the downstream process. Thus to work out the tax liability will require calculating the potential profits that relate to downstream activities. This calculation of the 'upstream' taxable revenue on the basis of actual realised profits will ususally require complex transfer pricing methodology and, as various tax experts have pointed out, is expected to create some uncertainty, given that these processes are often integrated. In addition, further reductions will take into account any royalty payments applicable within the States, a potentially contentious issue as any increases in royalty payments executed by State Governments could impact on the revenue stream to the Commonwealth.

Any expenditure occuring in the 'upstream' process will reduce the liable revenue, with investments treated as immediate write offs, allowing companies to access the deductions immediately rather than by claiming depreciation over a number of years.

Another important consideration in reducing the MRRT relates to the so called 'starting base' allowances for projects that existed prior to the announcement of the MRRT and which will be based on the market value of project assets at 1 May 2010. Some analysts have suggested this as another area of potential dispute.

If the royalty payments exceed the MRRT liability, the difference can be carried forward to the next year, as can any losses of a project in an earlier year. Additional avenues to reduce the taxable profit include incurred losses in other mining projects with similar resources, or losses that occurred in the lead up to the project, so called pre-mining interests.

▶ More information: http://minister.ret.gov.au

Flexible renewal on hot rocks

As announced in its May Budget, and following up on a key recommendation in the *Strategic Directions* from the **Australian Centre for Renewable Energy** (ACRE) Board, the **Australian Government** has opened the new $126 million **Emerging Renewables Program** (ERP) for applications in renewable energy technology projects.

The new program allows for a more flexible funding approach across the technology innovation chain, Resources and Energy Minister ***Martin Ferguson*** said at the launch. This is critical to ensure that the funding is tailored to the needs of the industry, he said.

ACRE will administer the program until the new $3.2 billion **Australian Renewable Energy Agency** (ARENA) is established on 1 July 2012 (respective legislation did pass the House of Representatives on 2 November 2011 with bipartisan support).

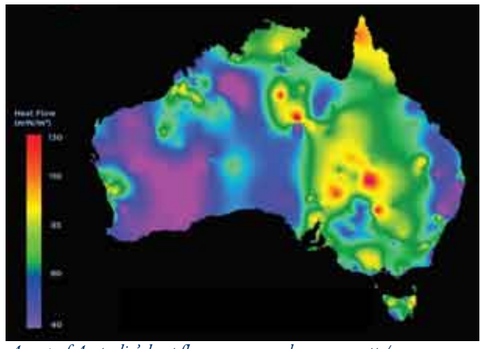
The May Budget had originally allocated $100 million for the ERP program. A further $26 million in funding was then made available after the **Geothermal Drilling Program** was closed in August, a decsion that was made because project applications in the second round of funding failed to attract matching private sector support.

However, the Government continues to strongly support the industry by committing at least a third of the ERP funds to geothermal energy projects.

▶ More information: http://minister.ret.gov.au

Hot promises

The vast potential of Australia's geothermal resource was recently highlighted by South Australian consulting company **HotDryRocks**. The company works together with **Google** and other international partners to produce the first 'Geothermal Map of the World'. The project uses a **Global Enhanced Geothermal Systems** (EGS) **Protocol**, which in



A map of Australia's heat flow – measured as megawatts/square metre through rock. The map was prepared by South Australian company HotDryRocks

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September was endorsed by the **International Energy Agency Geothermal Implementation Agreement** (IEA-GIA) as a valid mechanism for estimating and mapping regional resources.

When it all was still promising...the image shows first steam from Panax' Salamander-1 well in March 2010

Based on calculations using this protocol, Australia has the hottest known near-surface rocks outside of volcanic areas anywhere in the world, with an technical geothermal potential estimated at 2.9 million megawatts (MW) – almost 72 times greater than the power currently generated from coal and gas. If just 2% of the estimated thermal energy between three and five kilometres beneath Australia is recovered, the company says, there is generation potential of 417,000 MW – more than 10 times the power currently generated from coal or gas.

Hot pursuit, with some cooling...

However, the reality is that in Australia the industry is struggling to make good on its potential. There are only around 10 small companies actively engaged. This includes **Panax Geothermal Limited**, which received a $7 million grant in the first round of the Geothermal Drilling Program (GDP) for the only completed geothermal project under the scheme so far. Two further funded projects by **MINGI Pty Ltd** in South Australia and **Geodynamics** in New South Wales are still running.

The grant for Panax's **Penola** project helped establish the Salamander-1 well in the Otway Basin (SA) which contains hot water saturated sandstone reservoirs. By drilling into these 'hot sedimentary aquifers' the hot water could be tapped and used for electricity generation.

The outcome of the project has relevance for the broader industry as it is pioneering Hot Sedimentary Aquifer (HSA) developments in Australia, which are considered less risky than EGS projects.

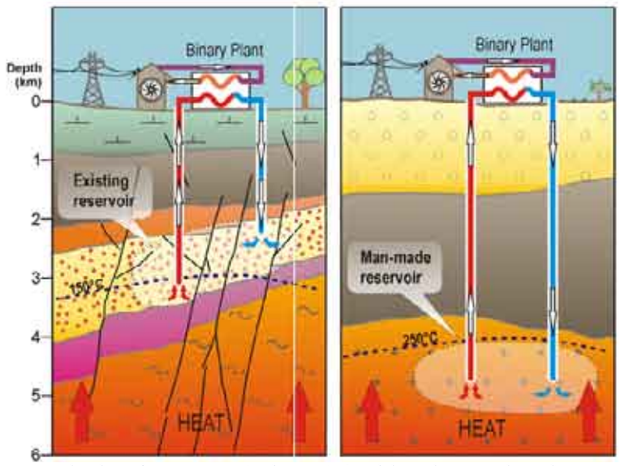
According to Panax, the geothermal temperature at a depth of 4000 metres was as predicted and high enough for geothermal energy production. Estimates for a second important parameter, the 'transmissivity' of the rocks, were also promising and in April 2010, Australia's media reported widely that the first steam was produced in a short flow test.

Transmissivity is a key parameter as it describes the potential flow rate of the hot water in the porous reservoir sediment. However, in so called 'discharge' tests the company encountered problems as the transmissivity decreased following each discharge. Panax says that the problems were in the well design, as the drilling fluids used were not fit for purpose, blocking the sandstone reservoir.

The preliminary outcome of the project highlights the technical challenges and risks associated even with HSA projects. Although the company claimed in its June quarterly report that the well is nevertheless a "success story", it is not willing to allocate more of its own cash for the project unless a greater portion of funding is provided by the Government.

But access to cash is an acute problem for the industry. Little is left from the market interest in geothermal industries that spurred the geothermal enterprises into life in 2007/2008, with the expectation of a soon to be implemented Emission Trading Scheme. For example, Panax's share value peaked at 24c per share in 2007 but has since dropped to around 1.5c. Other companies in the sector have not faired better.

This includes **Geodynamics Limited**, Australia's largest geothermal company by market capitalisation (currently $69 million). The company is a world leader in EGS technology, conducting the largest project of this kind in the world, a 25 MW demonstration plant in Cooper Basin, SA. The source is some 500 kilometres away from the national grid, but the project has more problems to overcome than the tryranny of distance.

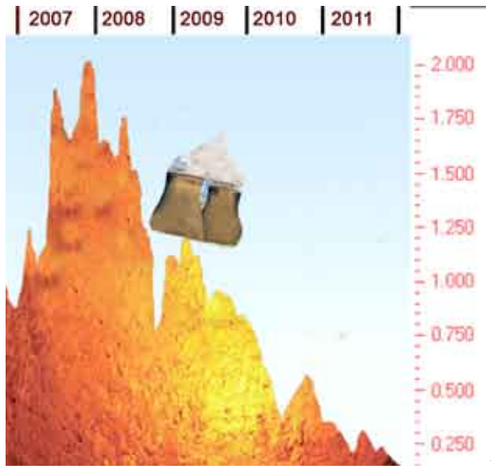


The scheme from a presentation by Hot Rock Ltd shows the two geothermal technologies.
Left: Hot Sedimentary Aquifer shown left allow use of geothermal reservoirs with adequate heat flows.
Right: Enhanced Geothermal Systems, targets impermeable buried granites artificially made permeable through 'hydraulic stimulation'.

Compared to HSA projects, EGS poses significantly more challenges as it requires accessing heat inside of dry and impermeable granite, trapped by an insulating blanket of overlying rocks around 3 kilometres below the Earth's surface.

The technology usually involves drilling and 'hydraulic fracturing' with cold water pumped into the existing fractures of hot rock, thereby creating micro-seismic events to increase the local permeability of the rock.

Geodynamics and its joint venture partner **Origin Energy Geothermal Pty Ltd** found that at its most promising well, Jolokia 1, 'hydraulic stimulation' did not create the required horizontal permeability of the rock, revealing the potential pitfalls of the technology apart from the risk of creating seismic events. The difficulties and the sharp drop in its share price prompted Geodynamics in June to issue a statement reassuring shareholders they would stay the course in the **Innamincka Deeps Joint Venture** (IDJV), being kept alive by a $90 million grant through the **Renewable Energy Demonstration Program**. The IDJV has since refocussed its operations on a new well at the site of Australia's first successful EGS fracture network, the Habanero location. The venture partners hope that this will lead to Australia's first EGS derived power plant.



Geodynamics share price development over the past 5 years

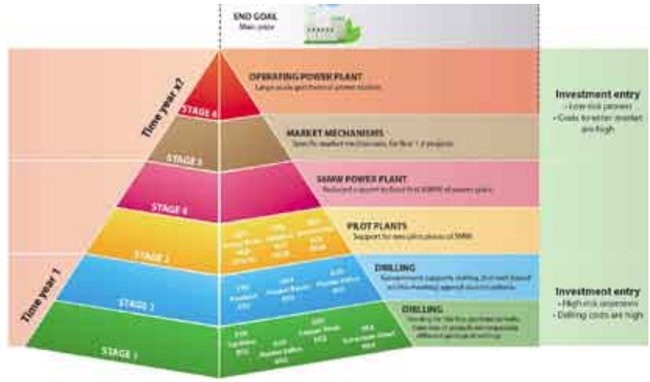
Since March, Geodynamics and Origin are also engaged in an HSA project at the SA Eromanga Basin, a presumed safer option complementing the EGS project.

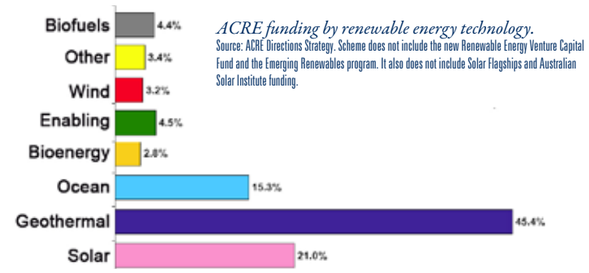
In its recent *Geothermal Directions* paper, ACRE concludes that the challenges of making geothermal energy economically viable in Australia are both technical and financial.

Whether companies can overcome the technical barriers to Australia's vast geothermal resource will largely depend on their ability to raise capital. In March, the **Allen Consulting Group** concluded in a report* to ACRE that for most companies the capital required to demonstrate the viability of geothermal energy for electricity production will be out of reach with potentially severe consequences, as 40% of the Government's renewable energy target is expected to come from geothermal. Building on this, a **Geothermal Expert Group** suggested a co-investment strategy, which would see the Government taking on a larger share of projects in the early and more risky stages, with less Government input in advanced stages. Specific market mechanisms, such as a feed-in tariff, could then help the last steps in the process.

ACRE's Geothermal Direction paper, which was informed by this expertise, outlines a modified co-investment model but notes that already Government funding has been significant with over $321 million invested by the Commonwealth and States. Nearly 50% of all ACRE funding went towards geothermal, which compares to 21% for solar and 15% for ocean derived energy. Thus ACRE's strategy goes towards filling gaps left by previous funding. This includes drilling and demonstration of HSA projects but also direct-use projects, which typically utilise heated groundwater as found in the Great Artesian Basin, which has large, low-temperature hydrothermal systems, with aquifers containing hot groundwater reaching the surface.

ACRE co-investment scheme





ACRE funding by renewable energy technology.
Source: ACRE Directions Strategy. Scheme does not include the new Renewable Energy Venture Capital Fund and the Emerging Renewables program. It also does not include Solar Flagships and Australian Solar Institute funding.

One of the largest demonstration sites of this kind is currently developed by the **CSIRO** and **Geothermal Power Pty Ltd**, which was funded with $20 million by the Government to provide cooling to the **Pawsey High Performance Computing Centre for SKA Science** (Pawsey Centre).

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...and signs of warmth

In November, **Greenearth Energy Ltd** signed a contract with the **Victorian Government** over a $25 million investment into its **Geelong Geothermal Power Project** (GGPP), awarded by the Government in 2009. Under the deal, the HSA demonstration project at Geelong will first receive $5 million to confirm the target hot sedimentary geothermal aquifer as a potential geothermal resource. The total costs of this stage are estimated at $30 million, with $18 million contributed by the company and a further $7 million provided by the federal **Geothermal Drilling Program** (GDP).

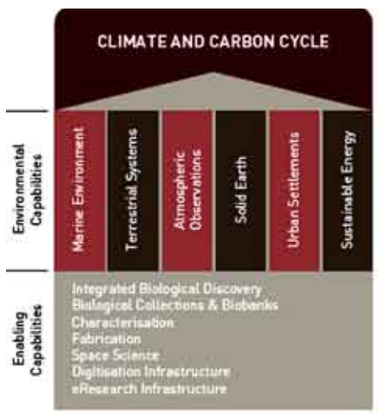
If successful, the Victorian Government will invest the remaining $20 million into the construction of a $74 million pilot, which will be a grid-connected 12 MW power station with the potential for a commercial plant generating up to 140 MW of baseload power.

It concludes many months of negotiations, Greenearth managing director ***Mark Miller*** said, adding that the company would now seek further support from the **Emerging Renewables** program.

▶ **More information: www.premier.vic.gov.au**

Building a research future

The **Australian Government** has released its *2011 Strategic Roadmap for Australian Research Infrastructure* which follows on from previous roadmaps in 2006 and 2008 and details areas in which investments in national, collaborative research infrastructure should be prioritised over the next five to ten years. The roadmap describes so called 'capability areas', which are predicted to require infrastructure investments of between $20 million to $100 million. These were identified with a strategic view of likely the future needs in the Australian research landscape and assuming that new funding opportunities will be available.



Linkages and interdependencies between capabilities addressing a specific challenge.

The roadmap is complemented by a **Strategic Framework for Research Infrastructure Investment**, which was prepared in parallel by the **National Research Infrastructure Council**.

The Giant Magellan Telescope, which will be the world's largest optical telescope is a piece of global collaborative infrastructure.
image: artists impression of the telescope in the Chilean AndesMountains - Todd Mason/Mason Productions

The Government's infrastructure investment has increasingly focussed on investing in infrastructure that is shared across fields of research and research organisations, which reflects that research has become more collaborative and interdisciplinary, and also generates an increasing amount of complex data. To accomodate this trend in research, the current major national capabilities for infrastrucure investment were formed, which include the **National Collaborative Research Infrastructure Strategy** (NCRIS), and the **Super Science Initiative** funded from the **Education Investment Fund** (EIF). Together these initiatives have so far invested $1.4 billion, complemented by a further $746 million in infrastructure funding through the EIF.

There is a high degree of interaction between the various detailed capability areas, which the roadmap broadly categorises as either supporting target specific research outcomes or enabling research across a range of areas. The identified capability areas also contribute to more than one of Australia's **National Research Priorities** and thus maximise broader benefits for society.

Australia's ongoing research success will also depend on better mangement of national and global research data environments, and on providing researchers access to a multitude of data sets from a diverse range of sources. This includes data collected by or for the public sector. One example of an initiative that intends to provide better access to these data is the recently established Data.gov.au initiative.

Australia may also benefit from collaborating in the creation of global infrastructure, or through accessing international facilities by way of subscription or membership.

- More information: www.innovation.gov.au

Regenerative opening...

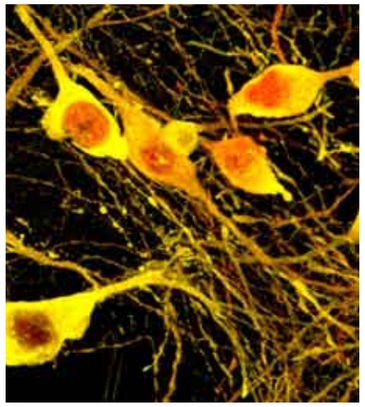
After the much publicised $50 million bionic eye research project, Australia's newest effort under the **ARC**s Special Research Initiatives scheme is on its way, this time providing a more modest yet still substantial $21 million.

The funding for the **Stem Cells Australia** initiative at the **University of Melbourne** was announced in December 2010. The initiative will not only aim for new stem cell research breakthroughs, but also take a leading role in the public debate about the ethical, legal and public issues associated with this type of research.

In its research Stem Cells Australia will focus on pluripotent stem cell biology, regeneration and repair in the heart and the brain, and blood stem cells.

Professor Martin Pera is leading the research program after returning to Australia from the US, where he led a major stem cell research centre at the **University of Southern California**. In his address at the launch Professor Pera highlighted the strength of Australia in this research area, which has also translated into promising commercial activities such as regenerative therapy company **Mesoblast Limited**. He also noted the favourable regulatory framework under which stem cell research is operating in Australia.

However, Professor Pera also cautioned that "early Phase I trials of embryonic stem cell derived therapeutics are in a sense rudimentary and are liable to pose more problems and challenges than they solve."



These neurons, which produce the mediator dopamine, were derived from stem cells and transplanted into the brain.
image: Lachlan Thompson, Stemcellaustralia

National partners in the initiative also include **Monash University**, the **University of Queensland**, the **University of New South Wales**, **Victor Chang Cardiac Research Institute**, **Walter and Eliza Hall Institute of Medical Research**, **Florey Neuroscience Institutes** and the **CSIRO**. Internationally the project has proposed collaborations with numerous organisations in countries including France, Germany, Italy, the United Kingdom and the United States of America.

▶ **More information: www.stemcellsaustralia.edu.au**

...and happy discoverers

In 2011-2012, the **ARC** will provide around $810 million in grants under the **National Competitive Grants Program**. This splits two streams of funding: the Discovery scheme covering broader 'blue sky research' and Linkage funding, which includes the ARC Centres of Excellence scheme and encourages national and international partnerships between researchers and other parts of society to secure the broader benefits of research.

In November, the Government announced grants worth $310 million for more than 1000 projects. Accross the different grant schemes the funding, which is administered over up to five years, includes:

- 778 **Discovery projects** will receive more than $236 million, of which 26 projects were also awarded a newly introduced Discovery Outstanding Researcher Awards (DORA) and a further 54 were awarded one or more **International Collaboration Award** (ICAs);
- 151 **Linkage Projects** will receive more than $42 million;
- 77 **Linkage Infrastructure Equipment and Facilities** (LIEF) will receive more than $28 million; and
- 10 **Discovery Indigenous** projects will receive more than $3 million.

For Discovery Project funding, this year's success rate remained overall steady at 21.9% (22% in 2010), although the total number of project proposals approved was only 778, a drop of 16% compared to 2010 when 931 projects were approved. Almost 40% of all approved projects addressed the National Research Priority 'Frontier Technologies for Building and Transforming Australian Industries', while another 37% addressed to roughly equal parts the priorities 'Environmentally Sustainable Australia' or 'Promoting and Maintaining Good Health'.

However, the success rate of applications differed greatly between administering organisations. Thus, 37.5% of all

proposals by **Australian National University** researchers were approved but none out of 26 applications proposed by **Charles Sturt University** researchers. According to our analysis, after removing the top 5 top performing organisations, the success rate of researchers from the 37 remainng organisations reduces to just 11.23%. Top performers in (indicative) funding approvals include:

- The Australian National University ($31.5 million);
- The **University of Queensland** ($29.8 million);
- The **University of Sydney** ($26.8 million);
- The **University of New South Wales** ($24.6 million); and
- **Monash University** ($24.0 million).

Just as in previous years, Australian researchers continue to collaborate internationally (480 projects, 933 instances), with a strong preference for the US (251 projects) and the UK (135), while Germany (80) and France (58) are a distant third and

fourth, and there is still comparably little engagement with Asia, including China (36) and Japan (29).

The University of Queensland came out tops in the first round of funding for Linkage Projects commencing in 2012, receiving $6 million for 35 projects, while the University of New South Wales attracted with almost $4 million most of the LIEF funding.

The projects funded under these schemes focus on building partnerships with organisations outside of the higher education sector and attract further cash and cash-in-kind contributions. Thus the 151 Linkage Projects and the 77 LIEF projects approved are expected to leverage around $165 million in contributions from partner organisations.

▶ More information: http://minister.innovation.gov.au

...with jobs for the bright

The Government also announced the **ARC Future Fellowships** and **Discovery Early Career Researcher Awards** (DECRA), which are components of the NCGP Discovery stream. With a total of $248 million in funding, the grants will support 480 researchers at the various stages of their career development.

Already in August, the Government announced the 2011 **Laureate Fellowships**, which are designed to attract world leaders in research to key positions in Australia. This year 17 researchers received fellowships together worth $44 million. Two of the fellowships were specifically allocated to oustanding female researchers who will also play a role as ambassadors to encourage other women to take up research careers. ***Professor Pippa Norris*** (USYD) was awarded the inaugural Kathleen Fitzpatrick Australian Laureate Fellowship, and ***Professor Mahananda Dasgupta*** (ANU) the inaugural Georgina Sweet Australian Laureate Fellowship.

▶ More information: http://minister.innovation.gov.au

China on the cards

To boost collaborations between Chinese and Australian researchers, the Governments of both countries announced earlier last year that they would jointly provide additional funding of $18 million over three years for a dedicated **Australia-China Science and Research Fund** (ACSRF). The fund is now open for applications and will close on 27 February 2012.

▶ More information: http://minister.innovation.gov.au/Carr/MediaReleases/Pages/AUSTRALIACHINASCIENCEANDRESEARCHFUNDOPENSTOAPPLICATIONS.aspx

It's a buck's life

The **Australian Government** has announced that ***Professor Simon McKeon***, the 2011 Australian of the Year, will chair the independent review of Australian health and medical research funding. The panel will further include ***Professor Ian Frazer***, ***Bill Ferris***, ***Elizabeth Alexander***, ***Professor Henry Brodaty*** and ***Professor Melissa Little***.

Meanwhile, this year's health and medical research splurge by the **NHMRC** hit record levels, with $673.7 million or 1,140 grants awarded to researchers, their projects and research institutions in Australia.

The funding includes $453 million for 768 **NHMRC Project Grants**, which in dollar terms is almost 10% more than in the previous year ($409 million for 745 projects). Research areas that will receive focussed funding support include $47 million towards age-related condition such as dementia, Parkinson's and bone disease, but also mental health research, which is supported with $35.7 million.

The NHMRC will spend $173 million on career support grants, which include **Research Fellowships** (87), **Early Career Fellowships** (127), **Career Development Fellowships** (65) and others.

The agency has further awarded $5.6 million for 9 **Collaborative Research Grants** between Australia and the EU, and almost $10 million for 13 **Partnership Grants**, which under the **Partnership for Better Health** initiative are designed to improve the availability and quality of research evidence to decision makers.

A further $31 million will be spent on 27 **Independent MRI Infrastructure Grants**, which are intended to cover overhead infrastructure costs that relate to research grants the NHMRC has awarded to independent medical research institutes.

The NHMRC will further support 15 **Centres of Research Excellence** with $37.3 million. These centres operate in the areas of clinical research (6), Population Health Research (5) and Health Services Research (4).

Victoria is the clear frontrunner in terms of research funding by the NHMRC. The state's researchers were awarded 472 grants funded with $278.2 million. By contrast, NSW just raked 305 grants worth $179.6 million, although the state's **University of Sydney** did narrowly have the better of the **University of Melbourne** as the top administrating organisation, being awarded $87.8 million for 149 project grants compared to $84.1 million for 155 grants.

Ending a bug's life

In November, the **Collaborative Biosecurity Research Facility** (ACBRF), the to date most advanced facility of its kind in the world, opened its doors at **CSIRO**'s **Australian Animal Health Laboratory** (AAHL) in Geelong, Victoria.

Funded with $8.5 million from the **National Collaborative Research Infrastructure Strategy** (NCRIS), the facility is set up as an internationally shared resource for the study of infectious diseases affecting humans, domestic animals and wildlife. The various laboratories are certified at the highest levels of biosecurity, physical containment level 3 and 4, and were designed for researchers to study pathogens in larger animals as well as insects while having access to high-end infrastructure such as the AAHL **Biosecurity Microscopy Facility** (ABMF).

The ACBRF will adopt the collaborative 'One Health' approach, which is supported by many leading animal and public health authorities worldwide. In February, Melbourne hosted the first international conference discussing

The ACBRF is located within AAHL's high containment facility and incorporates a linked Australian Microscopy and Microanalysis Research Facility that enables fundamental research with infectious disease agents that require the highest levels of biocontainment.
image: CSIRO

the approach, which aims to link human, animal and environmental health professionals together. According to AAHL director ***Professor Martyn Jeggo***, such collaborative effort is becoming crucial in dealing effectively with 'zoonotic' diseases, which can spread between animals and humans.

Around 70% of emerging human diseases are zoonotic, including Hendra, bird flu and SARS, and the study of their origin and potential treatment will be an important focus of the new facility.

▶ More information: http://minister.innovation.gov.au/Carr

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Cooperative joy trumps misery

In September, the **National Farmers Federation** released a statement in which it expressed disappointment that three agricultural Cooperative Research Centres (**Beef Genetics**, **Cotton Catchment Communities** and **Forestry**) did not progress into stage 2 of the 14th CRC selection round. The NFF argued that the $33 million in funding had been taken away at a time when the need for investment in agricultural research has never been greater.

As the lights dim at these CRCs, they brighten elsewhere as the outcome of the 14th round of CRC funding was announced. And in the end, there was also some good news for Australia's rural sector, with new funding of $19.7 million for the **Invasive Animals CRC**, which was established in 2004 and is developing technologies that will help reduce the impacts of new and existing pest animals. Successful also in its rebid, the **CRC for National Plant Biosecurity** (now **Plant Biosecurity CRC**), which received $29.7 million to address damaging plant pest incursions.

The Government funded 6 out of 26 bids with a total of $148 million, which according to the **CRC Association** was a better than expected outcome. In 2010, only 4 CRCs were selected out of 30 applications.

The successful CRC bids in the 14th round also include:

- **Automotive Australia 2020 CRC** – created in 2005, the CRC will again be funded with $26 million to research vehicle electrification, gaseous fuels and production of greener vehicles and components.
- **CRC for Polymers** – established as the CRC for Polymer Blends in 1992, and in 1996 transformed into the CRC for Polymers, the centre will be funded with $14.5 million to contribute to Australian products in the areas of health therapies, water and food security and low-cost solar energy.
- **CRC for Low Carbon Living** – funded with $28 million the CRC will be established to transform the built environment and develop new tools for reducing carbon emissions.
- **CRC for Water Sensitive Cities** – the new CRC will be funded with $30 million to deliver the planning, technology and decision support tools required to improve the efficiency and effectiveness of urban water systems.

While praising the Government for its continued support of the CRC program, the CRC association noted that the number of CRCs has still dropped dramatically in recent years, with 36

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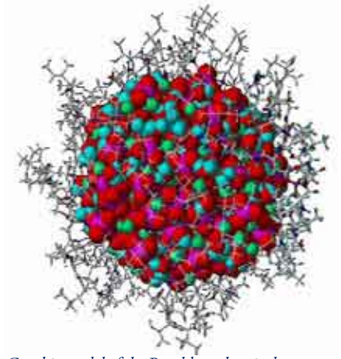
centres running in 2012 compared with almost double that number in 2006.

Recently, two CRCs were officially launched, including in October the **Oral Health Cooperative Research Centre** (CRC), which was established in 2009 at the **University of Melbourne** with more than $30 million in Government funding. The centre followed on from its successful predecessor, the **CRC for Oral Health Science**, to progress the commercial development of Recaldent™ for the prevention and reversal of tooth decay. Recaldent, which consists of a bovine milk protein bound in a complex with calcium phosphate, is now earning some US$400 million in global sales per year.



Graphic model of the Recaldent chemical.
image: modelling by Dr Keith Cross, Melbourne Dental School.

Oral diseases and disorders cost Australia each year $6.7 billion. This includes moderate to severe gum diseases including periodonditis afflicting more than 30% of Australians.

Mental Health expressed in a school project between J.L.Ilsley High School, the Sun Life Financial Chair in Adolescent Mental Health and the Art Gallery of Nova Scotia.

The Oral Health CRC aims to develop a vaccine against the disease, which not only is a major cause of tooth loss, but has been linked to other conditions such as heart disease, stroke, adverse pregnancy outcomes, dementia and cancer.

In November, the spotlight was on the new CRC for Mental Health, for which the Government allocated $23 million. The centre will focus its research on biomarkers for diagnosing the early onset of neurodegenerative diseases - including Alzheimer's and Parkinson's diseases - and psychoses such as schizophrenia. This will facilitate early intervention and help optimising drug treatments for more effective disease management.

▶ **More information: http://minister.innovation.gov.au/carr**

Protective response

Australia's patent system has been on the **Australian Government**'s agenda for a while now, and various aspects of the Governement's reform process were covered in detail in recent issues of the *ARDR*. In our *ARDR* Feb/Mar edition, we analysed the reviews by **IP Australia** of current legislation and the **Advisory Council on Intellectual Property** (ACIP) on what should be patentable as defined by patentable subject matter. And in our Jun-Aug issue we covered the *Raising the Bar* bill, in which the Government integrated aspects of these reviews with the general aim of raising the standard of Australian patents.

In the bill, the Government also clarified that non-commercial research and experimental activities would be exempt from infringement of commercially protected IP, a move that also addressed concerns about the issue of human gene patenting. This has been a matter of considerable community debate, in Australia and also abroad. In July last year, the US **Court of Appeals for the Federal Circuit** (CAFC) ruled in a lawsuit brought against **Myriad Genetics** and the **United States Patent and Trademark Office** (USPTO) that isolated DNA sequences are patentable because such molecules do not exist in nature. The ruling overturned a prior ruling in 2010 by a US district court, which jeopardised Myriad's intellectual property over a diagnostic test for two breast cancer genes, and more broadly threatened thousands of patents granted by the USPTO.

In the US, the struggle over whether human genes can be patented for medical research is not over yet, with the case now before the US Supreme court.

In Australia, a 2010 Senate committee into the patenting of human genes and genetic materials examined the issue, and the Government has now released a combined response to the Senate Gene Patents Report (see also 'Patent or not to patent...', ARDR Nov 2010), the IP Australia and ACIP reports, as well as a prior 2004 **Australian Law Reform Commission**'s Report No. 99, Genes and Ingenuity: Gene Patenting and Human Health (ALRC 99 Report).

The Government intends to strike a balance between the interests of the biotechnology industry and the interests of the public to be able to access affordable treatments and essential diagnostic tests. With its *Raising the Bar* bill and the general lift of the threshold of patentability and quality of patents the bill entails, the Government has already taken up many of the recommendations in the reports. In a statement to the media, the Government said it will also introduce a 'morality exclusion' designed to address community concerns about the commercialisation of inventions. It will also aim to amend the Patent Act with an objectives statement that reflects the specific intention that patents should not lead to Australians being denied reasonable access to healthcare.

Importantly, the Government supports the overall recommendation in the Senate Gene Patents Report not to exclude the patenting of genes and biological material. As various commentators have pointed out, it is thus unlikely the Government will support a still pending Private Members Bill, the *Patent Amendment (Human Genes and Biological Materials) Bill 2010*, which seeks to exclude biological materials, including genetic materials, from patentability.

It should be noted, though, that there are currently Federal Court proceedings to consider whether isolated genes can be considered legitimate patentable subject matter, with a decision expected in the coming months.

▶ **More information: www.ipaustralia.gov.au**

Bigger bang for the buck

In early November, the Government released a report in which the **Department of Innovation, Industry, Science and Research** detailed its review of current publicly funded research arrangements.

In releasing *Maximising the Innovation Dividend: Review Key Findings and Future Directions*, the Government also announced a new committee that will advise on research investments. Chaired by the Chief Scientist ***Professor Ian Chubb***, the committee will initially develop a national research investment plan.

Always good to have a strategy

In this the Government acts on a key recommendation in the report, which calls for a national strategic dialogue to achieve better coordination of research investments.

The review examined in broad terms how effectively the current public investment model supports the goals and aspirations that were set out in the 2009 agenda *Powering Ideas: An Innovation Agenda for the 21st Century*. Overall, the report paints a positive picture of the current investment structure. On the back of total government support for R&D reaching around $9.4 billion in 2011-12, there are no significant shortfalls in the current funding framework, and the review found that research activity is generally complementary rather than duplicative.

However, there is room for a more coordinated, coherent approach to maximise investment returns and this will also require an evaluation of the wider benefits of research. In accordance with this, the Government will initiate a feasibility study on how to develop a mechanism for evaluating these benefits. The Government will also act on another report recommendation by re-examining the current **National Research Priorities** (NRPs), with the possible addition of a new NRP to better reflect the contribution of humanities, arts and social sciences to the research sector. According to the review, priority goals under the NRPs should also become more tangible and measurable, with appropriate reporting of expenditure againse NRPs.

Finally, the report emphasised the importance of collaboration for innovation. As also highlighted in the *Australian Innovation System Report 2011*, Australian businesses and universities collaborate poorly and improving this relationship should be considered through amendments of existing programs and future initiatives.

▶ **More information: http://www.innovation.gov.au**

Mega works

Long seen as spectators in the genomic race, Australian researchers increasingly participate in or lead large scale genetic studies. We summarise here a series of recent major breakthroughs, which show the breadth of Australian involvement in this kind of research and also underpin the importance of large-scale global research collaborations.

Thus, Australia may not have entirely missed the genomic bus, or may still hang on to it, contrary to concerns that were raised in a *Nature News* article in 2008. The turnaround was also helped by the acquisition of new infrastructure providing Australian researchers with the neccessary tools for 'next generation' sequencing, a technology that has advance enormously in recent years. An example of this is the **Hi-Seq 1000 Illumina Deep Sequencer** just launched at the **University of Western Australia**. In a single day this new technology can sequence the equivalent of the entire human genome project, while a decade ago the same work took close to 10 years at a cost of $4 billion.

From an Australian perspective, the most important recent genome study may have been the first complete genetic mapping of a young ***Aboriginal man***, which was made possible by a hair lock he gave British anthropologist ***Alfred C. Haddon*** some 100 years ago.

Other major studies covered below in more detail include the first genome sequence of an Australian kangaroo and four major genome-wide association studies (GWAS) that focussed on blood pressure, multiple sclerosis , schizophrenia and melanoma. This kind of research investigates a large number of human genome samples to identify genetic variations between individuals that can be linked to a certain trait, such as a disease. As markers, the researchers frequently use mutations in single nucleotides, called single nucleotide polymorphisms (SNP), which are relatively evenly spread across the human genome.

Single nucleotide plymorphisms

Australian researchers were also involved or leading in major works on profiling the RNA molecules in cells or populations of cells, called the transcriptome, as a measure of gene activity. This includes a study in mitochondria, which are compartments within human cells central to energy production and regulation; and a major study on the changes of gene activity that concurred with the evolution of mammals.

Australians now also drive important technology developments for the analysis of genes and their activity. Thus a research team led by the **University of Queensland**'s **Institute for Molecular Biology** describes in *Nature Biotechnology* a new strategy called targeted RNA capture and sequencing or RNA CaptureSeq, which they used to uncover an unprecedented range, depth and complexity of the humans transcriptome. They identified many new transcribed versions of important cancer-causing and developmental genes, as well as many novel RNAs that do not encode proteins, together suggesting that the human transcriptome is far from fully characterised yet. The researchers believe that the RNA CaptureSeq methodology could become an important approach for a wide range of research and clinical applications.

Recent genome research in which Australians have participated (but not covered here in detail) also include a study on asthma, led by the **Queensland Institute of Medical Research** and published in the *Lancet* in September, and the discovery of the role of multidrug transporter genes in the childhood cancer neuroblastoma, published by the **Children's Cancer Insitute Australia** in the *Journal of the National Cancer Institute*.

Un-locked story of ancient travellers

Ninety years after a lock of hair from an Aboriginal man from Western Australia found its way into a British museum drawer, scientists have used it to obtain DNA for the first mapping of an Aboriginal genome. Using the DNA from an Aboriginal male from the early 20th century had the advantage that while the DNA was highly fragmented it was free from recent European influence or contamination, an international team of scientists writes in *Science**.

Above: Electron Microscope image of the lock of hair used in the study.
Below shows the first wave of migration into Asia (purple) reaching Australia, followed by a second wave giving rise to European and Asian populations. The tree indicates the split of Han Chinese, Europeans from Aboriginal Australians some 62,000 to 75,000 years ago.

image: science/AAAS

The study was led by the **University of Copenhagen**, and also involved researchers from **Griffith** and **Murdoch** universities and the **University of Western Australia**.

While the authors acknowledge the constraints of the analysis, which is based on only one sequenced Aboriginal genome, they believe they have confirmed Aboriginal Australians as one of the oldest continuous populations outside of Africa. The authors suggest that after a group of early humans left Africa, the forebears of Aboriginal Australians split from an ancestral Eurasian population some 60,000 – 75,000 years ago. This first wave of migration into Asia reached greater Australia (Australia and Melanesia, including New Guinea) around 50,000 years ago. A second wave of migration into Asia, around 25,000 – 40,000 years ago, then gave rise to modern European and Asian populations.

This multiple-dispersal model contrasts with the so far leading theory, according to which a single wave of migration brought first a split into European and Asian populations, from which then Aboriginal Australians decended.

The picture is complex, though, as Aboriginal Australian and PNG Highlands ancestors were not completely isolated, at least until 15,000 to 30,000 ago. This led to genetic exchanges with Aisan populations potentially masking subtle demographic signals. Thus the scientists found that Aboriginal Australians are genetically closer to East Asian populations than to Europeans. However, the authors discerned patterns of similarity between the Aboriginal genome, and genomes of Han Chinese, African and European individuals, which the authors say are consistent with a muliple-dispersal model, but are incompatible with a single-dispersal model.

The study also raised ethical questions, as summarised in a *Nature News*** article by ***Ewen Callaway***. According to the article, the researchers, unaware of the issues, sought and were given approval from an indigenous representative body only after the genome had already been sequenced.

▶ More information: www3.griffith.edu.au; *Rasmussen et al (2011) Science; 334:94-98; **Callaway (2011) Nature; 477: 522-523

Hopping revelations

Researchers from the **University of Melbourne** and the **Walter and Eliza Hall Institute** have led a whole genome study on the tammar wallaby. The study, which commenced in 2004 as a joint project between the US **National Human Genome Research Institute** and the **Australian Genome Research Facility**, was published in *Genome Biology** and also involved a number of other Australian research organisations.

Kangaroos belong to the family of macropodidae or 'big footed animals', which feature a specialised body plan, prolonged lactation, and the ability to delay the development of their young. This made them an attractive choice for a whole-genome sequencing project, ***Professors Elizabeth Murchison*** and ***David Adams*** from the **Welcome Trust Sanger Institute** write in a commentary on the paper in the same issue**. The study of the tammar found critical genes across a range of biological systems, including reproduction, development and immunity, shedding light on various aspects of marsupial and mammalian biology and genome evolution. Key points include:

- Similar to other mammals, the tammar wallaby genome was found to share many thousand of genes with humans despite the divergent evolution. This includes essential genes for gonadal differentiation, spermatogenesis and development.
- Sophisticated lactation by the mother roo provides the young with milk perfectly matched to its developmental stage. Mother roos can even express two different types of milk in adjacent teats in a pouch, and accordingly a large number of genes were discovered that are predicted to produce milk proteins.
- A set of genes were identified that produce antimicrobial peptides secreted into the milk. This provides the immunologically largely defenseless young with an arsenal which it requires to evade potential attack by pathogens present in the dirty pouch.
- The researchers identified some 1,500 olfactory receptor genes, which support the tammar wallaby's extremly developed sense of smell.

More information: http://genomebiology.com; * Renfree et al (2011) Genome Biology 12: R81; **Murchison and Adams (2011) Genome Biology 12: 123

Croppy achievement

Australian researchers are also taking part in the **Multinational Brassica Genome Sequencing Project Consortium**, which now has mapped the entire genome of the Chinese cabbage, one of many agricultural and horticultural crops that make up the *Brassica* genus.

The small model plant Arabidopsis thaliana, right, belongs to the same taxonomic family as members of the genus Brassica genus, which includes important crops such as the Chinese cabbage (bottom left), and canola (bottom right).

When in 2000 the very small genome of *Arabidopsis thaliana* was published,

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it was thought that the new knowledge would also benefit the agricultural use of *Brassica* species. After all, the model plant *A. thaliana* is a relative of *Brassica* species with similar physiology and developmental biology. However, the genomes of *Brassica* species are very much more complex as the set of their chromosomes has multiplied several times during their ancestry. This phenomenon, called polyploidy, is a common in plants but the structural complexity with the dramatically increased number of genes also poses a major challenge for sequencing projects. Thus the progress of revealing the first *Brassica* genome was slow until the recent major advances in sequencing and assembly methods.

Blackleg stem lesions
image: Beth Hoar, Canola Council Canada

Published in *Nature Genetics**, the outcome of 10 years of research provides important insights into how the *Brassica* genome evolved, and it will be useful in studying the genomic structure and function across the various *Brassica* species.

This could also have important benefits for Australia, where a member of the *Brassica* family, the canola crop, has developed into a major agricultural industry but is still threatened by potential outbreaks of fungal diseases such as blackleg.

According to co-author ***Dr David Edwards*** from the **University of Queensland** (UQ) the unravelling of the genetic code could be a big leap forward' in the task of identifying genes associated with disease resistance, but also yield and quality traits.

Other Australian organisations involved in the work include the **ARC Centre of Excellence for Integrative Legume Research** and the **Australian Centre for Plant Functional Genomics.**

▶ More information: www.uq.edu.au; *The Brassica rapa Genome Sequencing Project Consortium et al (2011) NATURE GENETICS 43: 1035–1039

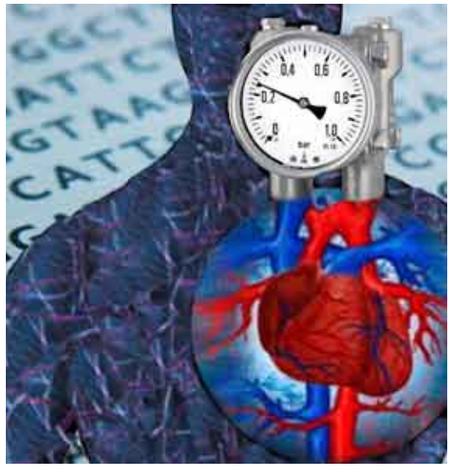
On the pulse

A study published by the **International Consortium of Blood Pressure Genome-Wide Association Studies** (ICBP-GWAS) in two papers in *Nature** and *Nature Genetics*** has identified new defined regions of the human genome, also called genetic loci, which are associated with blood pressure and blood pressure related conditions.

Even small changes of blood pressure can increase the risk of heart conditions or stroke, and the studies revealed inherited influences that underlie these health conditions, possibly leading to new strategies for their prevention.

The undertakings were based on data from more than 270,000 people of European decent, including data from the European **Busselton Health Study**, one of the world's longest running epidemiological research programs.

By analysing the association of genetic variations between people with their systolic and diastolic blood pressure, the *Nature* study found 12 previously published and a further 16 novel genetic loci, which were also found associated with conditions such as hypertension, stroke and coronary artery disease. Some of the new found loci harbored genes known or suspected to regulate blood pressure while others revealed clues about the physiology of blood pressure.



The related second study in *Nature Genetics* focussed on the measurement of pulse pressure (PP) and mean arterial (MA) pressure, both predictors of hypertension and cardiovascular disease. Six new loci were found associated with either PP or MA, suggesting genetic pathways which in different ways impact on systolic and diastolic blood pressure.

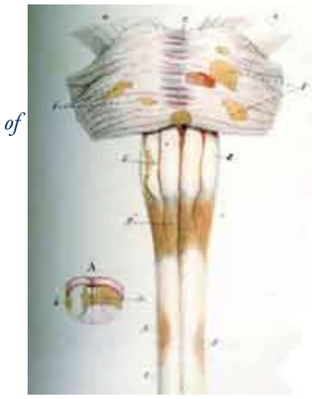
More information: www.news.uwa.edu.au; *Ehret et al (2011) Nature doi: 10.1038/nature10405; **Wain et al (2011) Nature Genetics, doi:10.1038/ng.922

Nervous genome mining

Australian researchers from across the country took part in two large genome-wide association studies (GWAS) on multiple sclerosis, published in *Nature* and the *Annals of Neurology*.

Both studies involved the **International Multiple Sclerosis Genetics Consortium** (IMSGC), including a contribution by the **ANZgene** consortium, which was led by ***Professor Graeme Stewart*** from the **University of Sydney** and involved 18 researchers from Australia and New Zealand.

Multiple sclerosis affects the central nervous system through inflammatory and neurodegenerative processes, which are triggered by environmental factors in people with a genetic predisposition. Previous research has identified genetic loci associated with MS, including a key involvement of a cluster of genes that encode immunological markers for the body's own cells, the major histocompatibility complex.



A drawing from a book by Robert Carswell, a british anatomist who in early 1800 described MS lesions in the brain and spinal cord. The illustration below shows how attacks by the immune system in MS patients damages supporting and insulating myelin sheaths of nerve fibres, which disrupts the connection between brain and muscle.

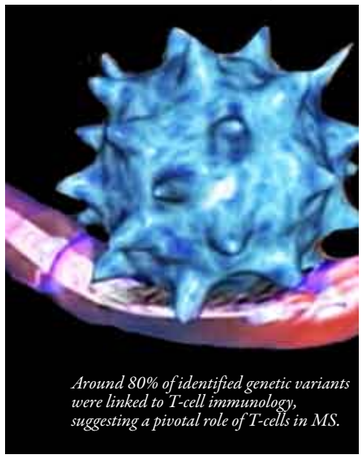
However, the genetic architecture of the disease is likely to be complex with many genes weakly or modestly associated with MS and require studies with sample sizes that go beyond that currently available to individual research groups. The *Nature* study involved close to 10,000 MS patients of European decent collected by 23 research groups in 15 countries. It confirmed most of the more than 20 genetic loci previously associated with the disease, and uncovered at least 29 new ones. The study also implicated other gene variants which may contribute to the overall risk of developing the condition.

Around 80% of the genetic variants found associated with MS were linked to T-cell immumology, while none were part of neurodegenrative pathways independent of inflammation.

The results highlight that inflammatory immunological mechanisms are key drivers of MS pathology, and that T-cells, important players in orchestrating the body's immune response, may play a pivotal role.

The multitude of genes found associated with MS also included genes relating to environmental factors such as Vitamin D deficiency, confirming previous data from Australian research.

The second study published in the *Annals of Neurology* used data compiled from seven GWAS together involving a total of 5,000 MS cases. The meta analysis identified 3 new regions of the genome associated with an increased likelehood of people developing the disease.



Around 80% of identified genetic variants were linked to T-cell immunology, suggesting a pivotal role of T-cells in MS.

The researchers also found that many of the loci identified to date are shared between autoimmune diseases, although in some instances gene variants showed an opposite effect in MS and other diseases. For example, some genetic variants, which increase the risk for celiac disease – an autoimmune disease affecting the small intestine – reduced the risk of developing MS. According to the authors, this demonstrates "the complexity of the shared architecture among the inflammatory disease".

▶ More information: http://newsroom.melbourne.edu/news/n-600; * International Multiple Sclerosis Consortium & the Wellcome Trust Case Control Consortium 2 (2011) Nature; 476:214; **Patsopoulos et al (2011) Annals of Neurology DOI: 10.1002/ana.22609

Disturbed clues

The largest genome-wide association study (GWAS) on schizophrenia to date was published in *Nature Genetics** by an international consortium involving 135 organisations. The research found significant associations with schizophrenia for

5 new and 2 previously implicated locations on the human genome. The study is a major contribution towards a better understanding of the complex genetic architecture underlying the disorder, a prerequisite for the development of earlier diagnosis and improved patient management.

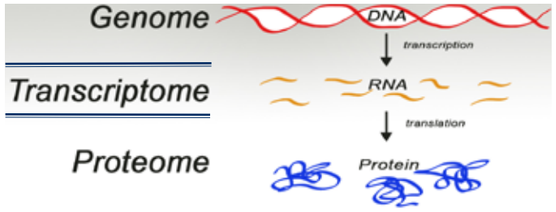
As with other hereditary disorders, such as MS, and consistent with earlier findings, the study suggests a 'polygenic inheritance', with many genetic variations found to have a small effect in predisposing an individual to the disorder, which then may develop after contact with certain environmental factors. Thus the study found genetic variations in a region containing numerous immune-related genes strongly associated with the disease, suggesting that autoimmune responses or infection may trigger schizophrenia.

However, the researchers also identified a region containing a so called mircroRNA 137, or MIR137, which has been previously implicated in the regulation of neuronal development in adults. This points to a novel mechanism underlying schizophrenia, as genetic variations in the identified MIR137 locus may lead to abnormalities in brain development. The researchers were also able to confirm a previously discovered genetic overlap between bipolar disorder and schizophrenia, which would point towards shared roots for these mental disorders.

▶ More information: www.uq.edu.au/news/index.html?article=23819

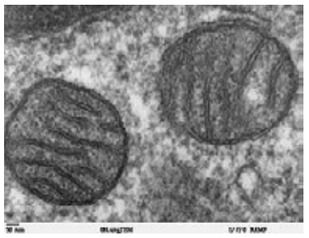
Power work

A team led by ***Professor John Mattick*** from the **University of Queensland**, in a collaboration with researchers from the



University of Western Australia, **SA Pathology** in Adelaide and colleagues in the US, has shed new light on how energy production is controlled in human cells.

Mitochondria are the power plants of eukaryotic cells, a domain of life to which human cells belong. According to the endosymbiotic theory, these complex organelles have their orgin in once free-living prokaryotes, which were taken up by another cell and then began to form a stable symbiotic relationship with their host. As a remnant of their origin, mitochondria still contain a separate set of DNA, which shares features with a prokaryotic bacterial genome and is passed on between generations through the mother's egg.



Electron microscope image of mitochondria, small organelles within eukaryotic cells.
Image: Louisa Howard

Defects in the mitochondrial DNA can give rise to a heterogeneous group of diseases, many of which affect the nervous and muscular systems. However, despite our knowledge of the genetic variations, there is little known about the fine regulation of mitochondrial gene expression and how genetic variations relate to the development of disease.

Published in *Cell**, this recent study applied high through put 'deep sequencing' technology to reveal a comprehensive snapshot of the organelles transcriptome, including small and rare RNA species that have regulatory roles. The researchers found an unexpected complexity in the regulation, expression, and processing of RNA. Thus they observed that the amounts of individual RNA species varied widely between each other despite being cleaved from a common long transcript.

The researchers also studied the binding of regulatory proteins to mitochondrial genome sequences, which together with the profiling of RNA production provides an important resource for the study of mitochondrial function and disease.

More information: www.uq.edu.au; *Mercer et al (2011) Cell, 146:645–658

Life saving brownie points

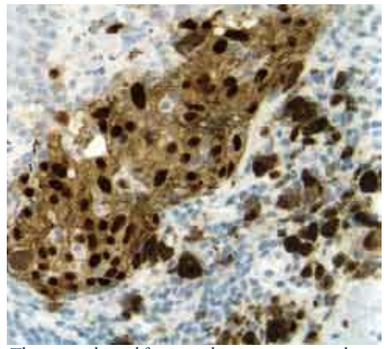
Just as the **Melanoma Institute Australia** has launched the first stage of a new $5 million **Melanoma Genome Project** – the program was launched in September – two papers in *Nature** and *Nature Genetics*** authored by Australian researchers report on major discoveries in melanoma genetics.

In a paper published in *Nature** in November, the researchers presented their results from an ongoing study which investigated several families with cases of melanoma. The study first started in the 1980s and had already previously revealed a melanoma-associated gene variant p16.

However, the recent advances in sequencing technologies have now enabled the researchers to sequence the DNA of every gene of one person in these families. This identified a new gene variant of a gene called MITF, which previous GWAS studies have not implicated in melanoma, despite it being an attractive candidate: the MITF gene, an abbreviation for melanoma-lineage-specific oncogene microphthalmia-associated transcription factor, is known to control the development and function of pigment-producing melanocytes.

The mutation has some impact on the biological function of MTF, which could become important over the lifetime of a person, the authors write.

The mutated gene moderately increases the risk of individuals developing melanoma – about 2.5 times the Australian average. Importantly, though, in follow-up studies with thousands of patients in the UK and Australia the variant was found to be widespread, with around 1% of Australians carrying the mutated gene.



The picture derived from a melanoma case report shows malignant melanocytes, which were immunologically stained for MITF.
Image: Susan Repertinger, Jeff Wang, Edward Adickes, and Deba P Sarma, in Cases Journal, 2008, 1:263, open access creative commons license

In a second paper published in *Nature Genetics***, a GWAS with more than 2000 Australian melanoma patients identified a new disease-associated genome locus, which spans potentially ten genes. However, the elevated risk associated with the new locus was found to be small, and lower than for previously identified loci.

Both studies were carried out by researchers from the **Queensland Institute for Medical Research**, and **University of Sydney**'s **Westmead Institute of Cancer Research**, **University of Melbourne**, **Queensland Cancer Fund,** together with international collaborators.

More information: http://sydney.edu.au; Yokoyama et al (2011) Nature; 480: 99-103; MacGregor et al. (2011) 43: 1114-1118

Expressive evolution

Mammalians share traits such as lactation, hairs and large brains, while having developed distinct anatomical, physiological and behavioural characteristics. There are an increasing number of genomic studies describing how changes in the structure of genes have led to these phenotypic differences. This includes a study on the egg-laying monotreme platypus, for which a draft genome sequence was published in 2008, revealing intricate overlaps of reptilian and mammalian characters.

While these kind of studies can reveal important information on species differentiation, a recent paper in *Nature* co-authored by Australian researchers, focussed on how the activity rather than the structure of genes changed over time, and how this drove mammalian evolution over the past 200 million years.

Determining the transcriptome of cells or tissues through RNA-sequencing analysis, the researchers compared the activity of genes in six organs across ten species, including the platypus. Together the investigated species represented all mammalian lineages.

The analysis of the monotreme platypus delivered important clues in the study.

The analysis revealed that the rate by which gene expression evolved in response to evolutionary pressures varied between tissues and lineages, and also between the different types of chromosomes.

In general, more closely related species evolved a more similar tissue specific gene expression, but the rate in which the profile of gene activity changed differed between the tissues. Thus, the testis featured the most significant changes in the pattern of tissue specific gene activity. In contrast, the transcriptome of nervous tissue evolved much slower than others, despite the substantial changes in the size, structure and cellular composition of the brain that occurred during mammalian evolution. This, the researchers speculate, may reflect a more finetuned expression of genes in the brain than in other organs.

At the level of chromosomes, the researchers found in therian mammals different rates of transcriptome development between chromosomes that determine sex and the remaining so called autosomal chromosomes.

The sex chromosomes (X and Y) of therian mammals evolved from the same autosomal chromosomes after the lineage split from monotremes around 166 million years ago. In the period shortly after the split, as sex-related forces started to shape the X-chromosome, the sex chromosome showed an increased rate of change in the regulation of its gene activities compared to other (autosomal) chromosomes, which then evened out later in evolution.

More information: Brawand et al. (2011) Nature; 478: 343-348

Stinging success

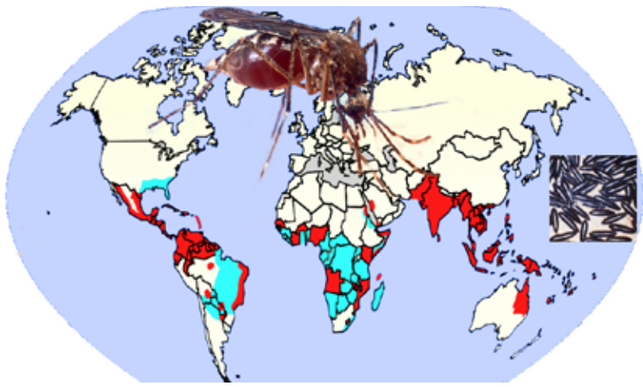
In its field trial in Queensland, the **Eliminate Dengue** project has shown that a strain of the bacterium *Wolbachia* can invade *Aedes aegypti* wild populations and stop the mosquito from spreading dengue virus.

The successful trial, which was led by ***Professor Scott O'Neill*** from **Monash University** and reported in two papers in *Nature**, paves the way towards a cheaper alternative to the current use of insecticides.

Early efforts of 'vector control' by workers somewhere in the US in the 1920s. Digging a drainage ditch removed standing water, the breeding ground for mosquitoes transmitting malaria and dengue fever.

While major human pathogens, such as the malaria causing *Plasmodium* parasite and the dengue fever virus, are very successful in being transmitted through the bite of infected mosquitoes, this route of transmission also provides a possible avenue for disease control through targeting the insect vector.

The application of insecticides has been a common measure, although with mixed success. In the case of dengue, the most important mosquito-born viral disease, there are now also growing concerns that the transmitting mosquitoes may become resistant to the available chemicals.



Distribution of dengue fever (red) and additional areas where the mosquito occurs. Top and right insert: Aedis aegypti mosquito and eggs
image: map by the Agricultural Research Service of the US Department of Agriculture; eggs pic by CDC

The approach pursued by the Eliminate Dengue project, which is funded through the **Bill & Melinda Gates Foundation**'s **Grand Challenges in Global Health** initiative, is based on the finding that mosquitoes infected with the bacterium *Wolbachia* do not transmit the virus.

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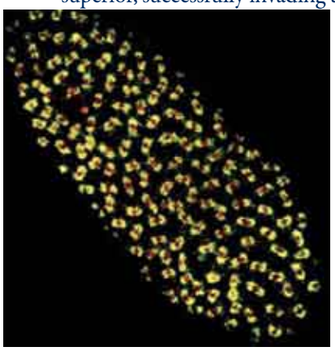
The bacterium is common in many insect species, although *Wolbachia* is usually not found in mosquitoes transmitting pathogens such as the malaria parasite or the dengue virus.

In 2009 a team led by Professor O'Neill, then at the **University of Queensland**, described a strain of the bacterium, which was obtained from fruit flies and stably transferred into *A. aegypti* mosquitoes. The strain was found to shorten the mosquitoe's life span, and this provided a potential for reducing the transmission of the dengue virus, which occurs mainly through older female mosquitoes. However, an observed 'loss of fitness' in the infected insects also meant a lower chance of successfully invading natural populations of *A. aegypti*.

Fortunately, *Wolbachia* has a second characteristic. Professor O'Neill's team was able to show that certain *Wolbachia* strains can also directly reduce the viability of the virus in the insect host, and this discovery led to a *Wolbachia* strain *wMel* which impacts only mildly on the fitness of *A. aegypti* while still having strong antiviral properties. Used in the field trials in comparison with Professor O'Neill's original strain, *wMel* was found superior, successfully invading the local mosquito populations, while both strains were able to block transmission. One of the lead investigators in the trial, ***Professor Ary Hoffman*** from the **University of Melbourne**, discovered the wMel strain in fruit flies in which it naturally occurs. "This Wolbachia strain is important because after years of experiments, it is the first one trialed that does not have any major side effects for the mosquito to carry and is able to survive through the dry season", Professor Hoffman said in a university statement.



The picture shows a fluorescent microscope image of Wolbachia in a 1.5 mm fruit fly embryo.
image: Dr Ben Heath from the University of Bath, UK.

▶ **More information: www.uq.edu.au;**

Naturally energetic

Hydrogen may offer an ideal alternative to fossil fuels that can be transported and used in various applications to generate 'clean' energy in a controlled reaction with oxygen producing water. However, at present hydrogen is produced mainly by using fossil fuels, such as natural gas, in a process called 'steam reforming'.

If a sustainable 'hydrogen economy' is to become a reality, its production would have to be based on renewable energy sources. And the photosynthesis of plants provides an obvious template for how to do this. Plants absorb sun light with green pigment and then use the energy, facilitated by a complex machinery of enzymes, to split water into it's components oxygen and hydrogen. However, instead of producing highly reactive and volatile hydrogen, the energy is immediately stored in high-energy molecules and then used to manufacture sugar from atmospheric carbon dioxide.

The development of technology that is able to mimic this ingeneous process is a hotly pursued and rapidly progressing field of research, as also highlighted in an excellent recent *Science* News article entitled *Turning Over a New Leaf*.

An example of Australia's efforts in this area is provided by **AquaHydrex**, a prospective spin-off from the **University of Wollongong**, and finalist of the **2011 Australian CleanTech Ideas Competition** and the **UQ Business School Enterprize Awards**. The AquaHydrex technology is a device, which can be cheaply produced and is capable of artificial photosynthesis for generating hydrogen on-site with a low carbon footprint. The product is based on synthetic 'biomimetic' catalysts, which are integrated in modular photoelectrochemical (PEC) cells. Similar to the photosynthesis machinery in plants, the device uses solar energy to split water into oxygen and hydrogen, but can at night also be powered by off-peak electricity from the grid enabling continuous hydrogen production.

While hydrogen may become a major energy carrier in the future, the device is targeted towards those industrial processes, in which hydrogen is used as a major feedstock. This includes the removal of sulphur from crude oil, an essential step in the refinement of petroleum.

The CleanTech competition was won by another new invention, though, an air-conditioning system developed by SMART Technologies (see 'Clean Prize', Innovation Watch)

▶ **More information: http://media.uow.edu.au/releases/UOW109538.html**

Please, do not disturb

Any major human disturbance will reduce biodiversity in old tropical forests, according to a recent study published in *Nature*. And this includes also agroforestry systems, in which planted trees and agriculture are combined to maximise commercial or environmental outcomes.

There has been a debate as to whether secondary forests, which includes forest that has regrown either artificially or naturally in previously cleared areas, may mitigate some of the damage in tropcial areas. For example, a *Nature News* article in 2009 highlighted the debate among ecologists on reports that secondary forest may potentially restore most of the diversity of species that were present in the original undisturbed primary forest. However, in the recent *Nature* study, an international team of researchers has now demonstrated that secondary forests cannot substitute for the conservation value of primary undisturbed forests.

Co-authored by scientists from the **University of Adelaide**, the **South Australian Research and Development Institute** and **James Cook University**, the study combined data from 138 studies covering 28 countries. It found a varied impact of human activities on biodiversity, with agriculture and burning being most detrimental, while pastures, plantations and secondary forests showed lesser, although still significant impact.

Selective logging was found to be an exception, having only a small effect on species diversity. Hence restoration of such areas could help alleviate loss of biodiversity, the authors conclude.

There were also regional differences. Studies on Asia, most of which focussed on South East Asia, revealed a more sensitive biota than was found in other regions. This is of concern, the

image: Tropical forest, wikipedia, public domain

authors say, given the recent expansion of palm oil plantations in South East Asia.

Different taxonomic groups were found to vary strongly in how they are affected, with mammals, including bats, being relatively resilient against landscape changes. Some mammal species even seem to benefit from human disturbances, while birds in particular, but also plants and arthropods, were found to be highly sensitive to human activities.

The authors conclude that overall primary forests are irreplacable for sustaining tropical biodiversity, and consequently they strongly urge enhanced protection of these areas, including through increasing the network of reserves and curbing the demand for products that result in the destruction of primary forests.

▶ **More information: www-public.jcu.edu.au; *Gibson et al (2011) 478: 378-381**

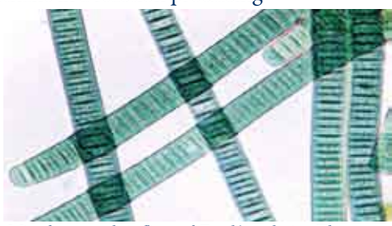
Metallic clues

The banded iron formations in Western Australia, which give an account of the state of the oceans over past millenia, also hold important clues on early microbial life and how this influenced some of the dramatic atmospheric changes during Earth's evolution, such as the Great Oxidation Event. This epic event for both the biosphere and geosphere saw molecular oxygen (O_2) dramatically increase in the atmosphere, paving the way for the evolution of animal life. Yet how and when O_2 accumulated on Earth continues to be a major puzzle, and has been the research focus of ***Winthrop Professor Mark Barley*** from the **University of Western Australia**.

Banded iron formations, such as this one in Western Australia, precipitated out of the Earth's early oceans billions of years ago.
image: Mark Barley, University of Western Australia

In 2009, we reported on a *Nature* paper in which Professor Barley, together with a team led by ***Professor Kurt Konhauser*** at the **University of Alberta**, described how in the lead up to the Great Oxidation Event methane-producing microbes may have become starved of nickel, which they require to survive. Studying banded iron formations they found that prior to the GOE nickel concentrations in the oceans declined, presumably as the Earth's mantle cooled and less vulcanic nickel was supplied to the surface.

A widely held view is that photosynthetic bacteria, cyanobacteria, became a major source of O_2 but the gas was trapped by atmospheric methane in a reaction producing CO_2. However, as less methane was released by nickel starved microbes, it enabled oxygen concentrations to increase, triggering possibly the largest extinction event in Earth's history, as the oxidising atmophere wiped out much of the anaerobic inhabitants at the time.



Microbes strongly influenced Earth's evolution Thus photosynthetic cyanobacteria (above) are believed to have caused the rise in atmospheric oxygen during the Great Oxidation Event, while aerobic chemolithoautotrophic bacteria changed the geochemistry of the Earth's surface.
image: UC, Berkely

Now the collaborators revealed another piece in the puzzle, providing new evidence about when the GOE took place.

Studying the banded iron formations, the research team found that chromium concentrations in the oceans increased from around 2.48 billion ago, supplied from largely immobile chromium sources on land. The researchers could show that

this was linked to the mobilisation of continental sulfide minerals, including the common iron sulfide, pyrite.

Previously it was proposed that oxidative weathering dissolved sulfide minerals as oxygen increased in the atmophere. Thus pyrite (FeS_2), in which sulphur is in a reduced state, is oxidised to sulfate when exposed to the atmosphere. However, the researchers provide evidence that instead of oxidative weathering, the dissolution of pyrite was caused by bacteria that respired oxygen and produced energy by oxidising pyrite.

With this process, these chemolithoautotrophic bacteria would have created an acid environment which, the researchers concluded, accounts for the observed acidic rock drainage with chromium being washed out into the sea.

The chemolithoautotrophic bacteria needed atmospheric oxygen to survive, and this allowed the researchers to determine when cyanobacteria had begun to increase O_2 in the atmosphere, and how long it took before its levels were enough to support the growth of life. The authors write that the GOE was a protracted process, occurring between 2.48 and 2.32 billion years ago. And as the studies have shown, the evolution and activity of microbes was intimately linked with the redox evolution of the Earth's surface, "although sometimes in unexpected ways".

Pyrite (FeS_2), is also sometimes called 'fool's gold' because it can resemble gold

▶ **More information: www.news.uwa.edu.au/201110204059/international/new-evidence-first-production-oxygen-earth**

Earth's fluid history

Australian researchers take aim at revealing the inner workings of our planet, which we still know relatively little about.

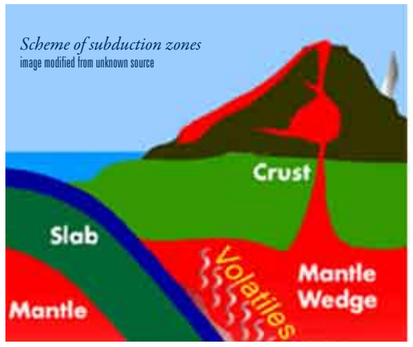
In November, ARC chief executive officer ***Professor Margaret Sheil*** officially launched the **ARC Centre of Exellence for Core to Crust Fluid Systems** (CCFS) at **Macquarie University**, which is established in partnership with the **University of Western Australia**, **Curtin University** and the **Geological Survey of Western Australia**. The centre, which is led by Macquarie's ***Professor Sue O'Reilly***, will focus on the Earth's fluid systems and deep Earth dynamics, which may have implications for areas such as future resource exploration. The CCFS will also have five collaborating nodes overseas, in France, China, Canada, and Germany.

One of the chief investigators in the centre is Macquarie's ***Professor Simon Turner*** who, coinciding with the launch, published in November a paper in *Nature Geoscience** on the water cycle of the deep Earth, the volcanic activity in the Pacific and the potential catastrophic effects when these two combine.

As the Earth's tectonic plates drift towards one another, subduction occurs, as one tectonic plate is pushed under another into the underlying mantle. In the process fluid-rich oceanic sediments and oceanic lithosphere can also enter the convecting mantle. As the subducted slab melts to magma and may form volcanoes, a fraction of the volatile fluids will return to the surface, while the remainder sinks deeper into the mantle.

However, the fate of the volatiles, such as when and where fluids have transferred into volcanic rocks, is difficult to determine.

Scheme of subduction zones
image modified from unknown source



Professor Turner and co-workers in the US, France and Australia focussed on a set of very rare geological samples – source rocks from xenoliths in the Philippines. These are very young rocks of the upper mantle, which carried deep water samples as they were transported to the surface by volcanic eruptions.

The researchers applied a method based on the precise measurement of nuclides in the so called uranium (^{238}U)decay chain or U-series, which includes uranium, thorium and radium isotopes. Macquarie is one of few labs in the world cabable of undertaking such studies, with laboratories solely dedicated to U-series work. The ratios of the isotopes (eg. $^{234}U/^{238}U$), which in stable systems would eventually reach equilibrium, can tell a story about the dynamic history of a geological system, as daughter and parent nuclides may fractionate differently during geological events, for example due to differences in solubility.

With this approach the authors were able to determine the nature and timing of the fluids in the xenoliths, which they found originated from wet oceanic sediments and the fluids in the tectonic slab. In addition, they were able to show that a significant amount of water is retained at the base of the mantle wedged between the slab and the earth's crust, and at even deeper layers. Heated this could form mantle plumes that erupt in large volcanic provinces.

The discovery is important for the understanding of past and potentially future catastrophic geolocical events, such as the Deccan Traps in India some million years ago, when released volcanic gases caused a mass extinction.

▶ **More information: www.mq.edu.au/newsroom/control.php?page=story&item=4753**

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The AIMS report points out, though, that their approach is limited to value flows, and does not take into account the social, environmental and other non-tangible dimensions of the marine environment,

By contrast, a recent report by the **Centre for Policy Development** received considerable media attention for its finding that significant economic benefits are associated with

CPDvalue estimate of Australian marine ecosystem services
Data: Tocking up: Securing our marine economy report

Food (market value of recreational catch)	0.4
Raw materials .	0.9
Climate regulation	15.8
Biological control	4.6
Lifecycle maintenance (esp. nursery services)	1.6
Opportunities for recreation (spend by recreational fishers)	1.9
Total	25.2

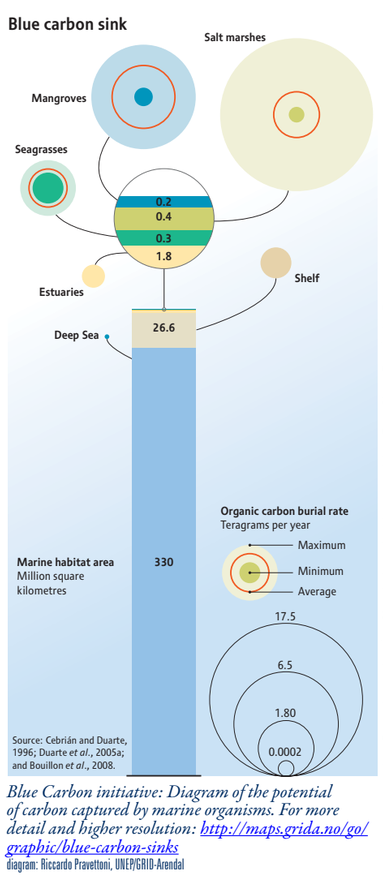
'Ecosystem Services'. According to the report these are generally overlooked in traditional accounting practises. The *Stocking Up: Securing Our Marine Economy* report estimates the economic value of such non-market benefits at around $25 billion. It is a conservative figure according to the authors, with almost $16 billion relating to 'Climate regulation' and another $4.6 billion to 'Biological control'.

In the climate regulation space, the report highlights the significant value of seagrass. Worldwide seagrass is in decline – according to the CPD report around 30% of seagrass areas have disappeared since 1879 (a rate faster than that of coral reefs or tropical forests). And with it is lost not only the supportive value of seagrass for commercial fisheries, but also its capacity to store carbon – it is estimated that seagrass stores 10-40 times as much carbon per hectare than forests.

Australia, especially the South-West region of Western Australia, contains extremely valuable marine ecosystems, including corals, coastal shelf acting as nurseries for fish species, and extended seagrass meadows. Commenting on the scope of the Government's proposed network of MPAs (see below), the CPD concludes that few areas of coastal shelf and seagrass are included, yet if adjusted for the South-West bioregion, the MPAs could cover and protect an additional $1.1 billion per year in ecosystems value.

This view is shared by scientists such as ***Professor Jaques Fourqurean***, who says that the decline of seagrass populations is mostly due to poor watershed management practices and declining quality near shore.

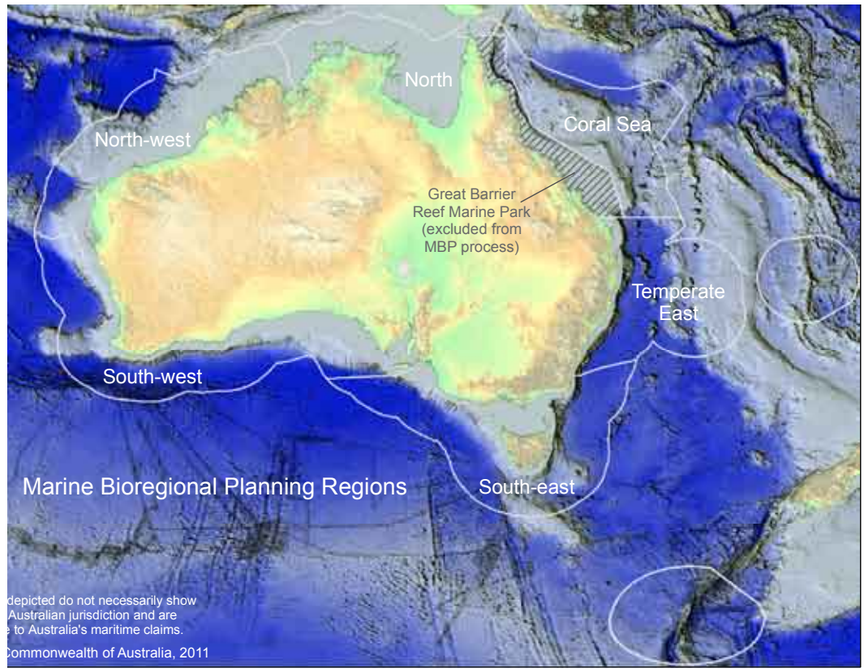
The US researcher is currently a Gledding visiting fellow at the Oceans Institute and a member of a new global initiative aimed at utilising seagrass meadows to help mitigate climate change. The relatively recently established **Blue Carbon** initiative is integrated in **GRID-Arendal**, a collaborating centre of the **United Nations Environment Programme (UNEP)**. Its core project explores the monetary value of the carbon in seagrass meadows as part of a possible offset scheme. This is a difficult undertaking, though. As stated on the initiative's website, the "evidence base and peer-reviewed literature for carbon sequestration and cycling in coastal ecosystems is still relatively sparse compared to equivalent knowledge generated for terrestrial counterparts. Gaps include understanding the carbon sequestration and cycling capacities of many marine and coastal ecosystems, the extent of seasonal or latitudinal variations, the aerial extent of some ecosystems, human impacts, and the carbon flows that keep carbon dioxide within the biological cycle rather than releasing it."



Blue Carbon initiative: Diagram of the potential of carbon captured by marine organisms. For more detail and higher resolution: http://maps.grida.no/go/graphic/blue-carbon-sinks
diagram: Riccardo Pravettoni, UNEP/GRID-Arendal

image: David Harasti; NSW Primary Fishing and Aquaculture

However, continued research is filling the gaps. In August, a statement by the UWA reported on Professor Fourqurean's analysis of the extensive seagrass meadows in WA's Shark Bay, with a spread of around 400,000 hectares one of the largest seagrass meadows recorded in the world. The calculations suggest that the seagrass meadows store around $350 million tonnes of carbon equivalents, which at a carbon price of $23 per tonne could be worth $8 billion.



The Marine Bioregional Planning Regions.
image: Commonwealth of Australia, 2011

Long term run with end in sight

During 2011, the Government concluded the establishment of draft marine bioregional plans for Australia's Commonwealth waters, and proposed an extensive network of MPAs including the world's largest MPA in waters of the Coral Sea, the **Coral Sea Commonwealth Marine Reserve**. The initiative is part of Australia's national and, as a signatory to the **Convention on Biological Diversity**, international commitment to establish **National Representative System of Marine Protected Areas** (NRSMPA) by 2012. This long term conservation program was initiated in 1991, and then agreed to by all Australian governments in 1998, with the legal framework for its implementation provided by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Separate to activities by states and territories, the Commonwealth commenced a marine bioregional planning process, which includes the development of marine plans for the management of Commonwealth waters, and proposals for new Commonwealth MPAs as part of a network of marine reserves.

To this end, five large-scale marine bioregions were defined as South-west, North-west, North, East, and South-east located in Commonwealth waters, which usually start at the edge of state or territory waters 3 nautical miles (5.5 kilometres) from shore and extend to the outer limits of Australia's exclusive economic zone, around 200 nautical miles off the Australian coastline.

For the identification of new MPAs, the Government is guided by defined goals and principles, which aim to draw on existing scientific knowledge. However, our understanding of the marine environment is still patchy, and the process frequently relies on the use of surrogates for biodiversity such as water depth, substrate and geomorphology.

Proposals for new marine reserves need to strike a balance between conservation issues and socio-economic costs, and this is taken into account in the proposals, as stipulated in the EPBC Act, through distinct marine reserve zones that are each assigned to one of the seven protected area management categories as defined by the World Conservation Union (IUCN).

For example, Marine National Park zones (IUCN category II) set high levels of protection by establishing a 'no-take' zone that excludes any form of extraction from the sea including recreational and commercial fishing. Multiple Use zones are less restrictive and allow sustainable economic use and recreational fishing, while Special Purpose zones and General Use zones permit further activities.

The process of identifying marine reserves, the type of zones and their location has remained politically sensitive, though, largely due to its potential impact on recreational and commercial fishing. Thus prior to the 2010 federal election, the Liberal party's policy paper on MPAs criticised the Labor Government for a lack of balance, failing to consult appropriately with the fishing industry and the wider community, many of which it said are relying on fishing or related business.

Yet, the process is lengthy and protracted. The proposal for a Coral Sea Marine Reserve, released in November, is one of two separate components for the bioregion East, with the split hoped to assist the consultation process. A proposal for the second component, Australia's Temperate East region, was also released in November and the consultation for both components will close 21 February 2012, after the Government extended the initial 60 day consultation period to 90 days.

With the draft marine bioregional plans and proposed

marine reserves for the East bioregion, proposals for all five bioregions have now been released but the process has still some way to go. The public consultation process will follow the development of final proposals with further public consultations in a formal statutory consultation process. The declaration of new Commonwealth marine reserves will then be followed by the development of marine reserve management plans, again with public consultations.

Spanning a net

In 2007, the **South-east Commonwealth Marine Reserve Network** became the world's first temperate deep sea network comprising 14 marine reserves stretching from the far south coast of New South Wales around Tasmania and Victoria up to Kangaroo Island off South Australia.

At its western boundary it joins with the South-west marine region featuring a highly diverse mix of tropical, subtropical and temperate species, including a third of the world's whale and dolphin species. By global standards, a large number of species is also native to the region (known as endemism) and this contrasts the Australia's southern waters from its northern marine estate, which are also highly diverse, but where most species are not unique to the region. In the Great Australian Blight, 85% of known fish species, 95% of known molluscs and 90% of known echinoderms are thought to be unique to the area. The area also features an existing MPA, the **Great Australian Bight Marine Park**.

By and large the waters are of comparably poor biological productivity, largely due to the warm Leeuwin Current, which prevents the upwelling of nutrients from deeper cold waters. There is also little nutrient supply from land through run-off. Nevertheless, commercial fishing is a major industry in the region, aside of petroleum exploration and production, and marine tourism,

The Governments' draft bioregional marine plan for the 1.3 million square kilometres spanning region proposes an extensive network of MPAs covering around 538 000 square kilometres. Submissions of comments closed in August, but stakeholders continue to intensely lobby the Government, highlighting both the conservational and economical importance of this region.

Thus the Western Australian Fisheries Minister ***Norman Moore*** issued a statement in October in which he rejected calls by conservationists for more of Western Australia's oceans to be 'locked up'. "I am not opposed in principle to 'no take' zones provided they are established to meet clear, measurable objectives, and biodiversity conservation outcomes that cannot be delivered through fisheries management arrangements," Mr Moore said. Reacting to a leaked map of the proposed marine reserve network, under which several areas prized by both fishers and conservationists would be turned into sanctuary zones, he added that in "this case, it is just drawing lines on a map without any real regard for environmental outcomes or the long-term impacts on the Western Australian and broader Australian communities and businesses."

The impacts on fisheries may go beyond that of potential commercial hardship, though. As pointed out in a joint submission to the draft plan by groups representing the South and Western Australian commercial fishing industry, the economic and social contributions by the sector also include marine science and knowledge of the marine environment. And the submission raises the question how the marine planning processes will impact on Australia's food security, which the Government currently seeks to address by developing a National Food Plan.

The North-west Marine Region – the region represents an area of around 1 million square kilometres of which around 40% is less than 200 metres in depth and also includes two areas of abyssal plains where water depths are 5000 metres. Typical for the region are shallow-water marine ecosystems with high species richness and strongly influenced by surface currents in shallow waters, and the strong seasonality of wind direction and rainfall. The region includes significant breeding grounds for Humpback whales, and at Shark Bay one of the largest remaining dugong populations in the world. There are also marine turtles, sawfish and several dolphin species. Ningaloo Reef, which was recently included as part of the World Heritage Area, supports over 200 corals and over 400 reef fish species, and is significant for its annual aggregations of whale sharks.

Whale shark at the Ningaloo Reef
image: Wikipedia, creative commons

The North Marine Region – adjoined to the North-west Marine Region, this region covers 625 000 square kilometres, including a characterisitcally wide continental shelf with water depths of generally less than 70 metres. Only in the past 6000 years have ocean levels stabilised to present levels, providing a relatively new marine environment, and many species may still be colonising it. The region is home to a rich diversity of tropical species, but in contrast to the southern marine regions of Australia, few species are native. Six of the world's seven species of marine turtle are found in the region and all are listed as endangered or vulnerable. The Australian snubfin dolphin is resident in the region, as are protected species such as sawfish, 28 of the 35 known Australian species of sea snakes, the saltwater crocodile, and a vast array of seahorse and pipefish species.

In November, the public consultation period ended also for draft plans covering two further marine bioregions, the North-west Marine Region and the North Marine region (for details see box). In both regions the Government proposes an extensive network of MPAs, covering an area of approximately 377 296 square kilometres in the north-west, and 121 723 square kilometres in the north.

Reefing up

The proposed Coral Sea Marine Reserve with its likely implications for Australia's Great Barrier Reef is the Government's most significant component in its proposed network of marine reserves. The reserve would extend at its western end from the **Great Barrier Reef Marine Park**, with its nearest point 60 kilometres off the coast, and stretch over some 989 842 square kilometres of tropical ocean to the eastern rim of Australia's territory. The reserve encompasses six provincial bioregions with broadly similar characteristics in terms of fish species and ocean conditions. The reserve will also include two already existing protected zones, the **Coringa-Herald National Nature Reserve** and the **Lihou Reef National Nature Reserve**.

Corals Sea Commonwealth marine reserve proposal. Green delineates the proposed 'no-take' zone. The figure was modified from a figure by the Australian Government. For the original figure and more detail: http://www.environment.gov.au/coasts/mbp/coralsea/index.html

The Coral sea harbors a diverse array of coral reefs, sandy cays, deep sea plains and canyons, and according to Environment Minister ***Tony Burke*** there is no other part of Australia's territory where so pristine oceans, magnificent coral, and also military history come together. Yet there are still significant gaps in our knowledge of the species present. As pointed out in an analysis paper accompanying the released draft plan, the defining of boundaries to the various protective zones had to rely to a great extent on surrogate measures and computer simulations, such as with the **Marxan** conservation planning decision software developed at the **University of Queensland**.

The reserve would encompass a vast range of tropical and deepwater habitats across depth ranges to 5000 metres, and although the deeper areas of the region, including the significant Queensland Trough and the Townsville Trough, are yet to be fully explored, according to the proposal there is evidence for biological systems home to still undiscovered species.

Thus the Gloria Knolls were recently discovered in the Queensland Trough, a site of vulnerable and unique coldwater coral communities.

Reefs, cays and herbivorous fish of the Queensland and Marion Plateaux are key ecological features of the proposed reserve, also including the northern extent of the Tasmantid seamount chain, which is thought to play a critical role as 'stepping-stone' in the genetic pathways that link the Great Barrier Reef with the broader South Pacific islands.

Transforming the 2009 Coral Sea Conservation Zone, an interim measure established to protect an area of around 972 000 square kilometres, into a permanent reserve is a bold proposal by any measure, not only because of its overall size, but also due to its extended cover of proposed 'no-take' zones. As with the proposals for marine reserves in the other marine bioregions, various zones across the reserve administer different protective levels, while petroleum resources exploration and development, or other mining activities, will not be permitted anywhere in the reserve.

More than half (507 487 km$^{2)}$ of the proposed area would be declared as a 'no-take' Marine National Park Zone, precluding any extractive activities. Various levels of less restrictive protection will apply to the remaining zones, with most falling into the Multiple Use and Special Purpose category. While acknowledging that the proposal would remove commercial fishing activities from a significant portion of the region, the Government says that the location of the zones will allow existing recreational, charter and game fishing to continue their business. The impact on commercial fishing activities will be comparably low as commercial fisheries have a relatively small presence in the region, the Government argues, and much of the area adjacent to the GBR Marine Park will fall under the less restrictive Special Purpose category. Still, 12 of the 15 fisheries operating in the region are likely to be affected, the proposal states, and some will no longer be able to operate.

The Government received the backing by the **Queensland**

Government, with the Environment Minister ***Vicky Darling*** recently commenting that the proposal could considerably boost the protection given to Queensland's coastal waters via the Commonwealth's Great Barrier Reef Marine Park and state marine parks. The initiative was also welcomed by ***Professor Terry Hughes***, director of the **ARC Centre of Excellence for Coral Reef Studies**, who said that a level of 51% no-take area compares to 33% in the GBR Marine Park. Yet, he also pointed out that more than 20 coral reefs would still be located outside of no-take zones and be left vulnerable to catch-and-release fishing. "This should really be called 'catch-and-release-and then die' fishing," Professor Hughes said, given the uncertain survival rate of released fish in an area full of sharks. He also recommended considering more regulation of long-lining (connected lines up to many kilometres long), which he said would continue in the proposed multiple-use zone. "The by-catch from long-lines is a major threat to seabirds, turtles and pelagic sharks."

The Temperate East Marine Bioregion covers 1.47 million square kilometres of temperate and subtropical ocean, the Government proposes a network of MPAs extending over 371 114 square kilometres and representing different marine ecosystems and habitats from shallow waters on the continental shelf to deep ocean environments in the outer reaches of Australia's Exclusive Economic Zone. According to the proposal, the marine reserves would have a minimal affect on commercial fishing, displacing less than 1% of the gross value of fisheries production, and leave more than 95% of the region open for recreational and charter fishers.

In November, the Government also released its plans for the second component of the East Marine Bioregion, the Temperate East Marine Region, which completes its set of bioregional marine plans and proposed marine reserves in Commonwealth waters (see box for detail).

Southern protection

At the *2002 World Summit on Sustainable Development* in Johannesburg, the international community set a target of managed networks of MPAs protecting 10% of each of the world's marine and coastal ecological regions by 2012. However, the set goal is unlikely to be achieved. A report published by the IUCN in 2010 calculated the total number of MPAs at around 5880, protecting some 1.17% of the marine area in the world, with almost all located in national waters.

While most MPAs cover coastal and continental shelf waters, the protection is very uneven, the report states.

Thus, some 44 coastal ecoregions have more than 10% MPA coverage, while a further 102 have less than 1%. In addition, the quality of protection through the MPAs is difficult to assess as 'no-take' areas account for only a small portion of the MPA coverage.

Krill
image: Rob King

Still, since 2003 the total amount of protected area has risen by over 150%, and there are plans for very large MPAs, such as the Coral Sea Marine Reserve proposal. A similarly large proposal was put forward by the Cook Islands Government, which intends to turn 1 million square kilometres or just over 50% of the country's exclusive economic zone into a marine park.

A network of MPAs is also envisaged for the protection of marine ecosystems in the Southern Ocean, which essentially are enclosed within the natural boundaries formed as Antarctic waters meet warmer waters to the north. The phenomenon is also known as the Antarctic convergence. Given the proximity and importance of Antarctic waters for our shores, it is not surprising that Australia is an important driver in developing protection mechanisms for the region, as well as an important contributor of research on Southern Ocean ecosystems. Thus the Australian Antarctic science strategic plan 2011-12 to 2020-21, which the Government released in June 2011 as a framework for Australian Antarctic research over the next decade, has a dedicated research theme to address environmental change and conservation challenges in the region. Australia is also a

t ice near Mawson station
: Nisha Harris

Antarctic convergence, a biological and climatic boundary created as cold and less saline water around the land mass meets warmer and more saline waters to the north of the convergence zone.
graphic: Philippe Rekacewicz, UNEP/GRID-Arendal; source: ICAIR, GRID-Christchurch, New Zealand

signatory to the*The Convention on the Conservation of Antarctic Marine Living Resources* as part of the **Antarctic Treaty System**. The convention was established in 1982 amid concerns that increased harvesting of krill could harm species that rely on the swarming crustaceans as a major food source, such as whales, penguins and seals. As in other parts of the world, new potential pressures on marine life have emerged, with primary concerns now including commercial fishing of krill, icefish and toothfish, climate change and ocean acidification.

A **Commission for the Conservation of Antarctic Marine Living Resources** (CCAMLR), headquartered in Hobart, was tasked with managing the marine resource in a designated area of the Southern Ocean. It is a daunting endeavour given the harsh conditions and the enormous size of the area – some 35 million square kilometres, which makes it difficult to enforce conservation measures, with illegal, unregulated and unreported fishing a significant problem.

The establishment of MPAs, including no-take marine reserves, is to form a major milestone in CCAMLR's effort to effectively manage and conserve Southern Ocean resources.

Table coral of genus Acropora
image: National Oceanic and Atmospheric Administration

The vision may be easier pledged than implemented. When the first MPA was declared in 2009, a 90,000 square kilometres area south of the South Orkney Islands near the Antarctic Peninsula, it was seen as a major achievment, yet it is only the first piece in a network of MPAs to be established by 2012.

The task ahead is complex given that the body is bringing to the table representatives from 24 countries, and concerns have been raised that the resources available may not be sufficient to meet the 2012 target.

Nevertheless, there is some progress, with the commission finalising a conservation agreement in November 2011 to create a roadmap for establishing a representative system of MPAs in the Southern Ocean. Environment Minister ***Tony Burke*** hailed the agreement as a major breakthrough, although qualifying that the step was only the beginning of a process to determine MPAs – "but just getting this far is a massive advance," he said.

According to the Government, the agreement paves the way for specific proposals to be considered by the CCAMLR by November 2012, and Australia, together with France, are already working towards a representative system of MPAs in East Antarctica.

Cold fate in warm future

The establishment of MPAs is traditionally directed towards protecting marine habitats against unsustainable exploitation, such as overfishing, and other disturbances related to human activities. However, the potential threats from climate change, and ocean acidfication are emerging as a major concern for marine biodiversity. This is currently also being addressed as part of a parliamentary *Inquiry into Australia's biodiversity in a Changing Climate.*

The establishment of MPAs may not directly address the potential impacts of climate change or ocean acidification. Although it will help build resilience of species under pressure from human disturbances, fire, weeds, and introduced pest animals. This argument was also made in a Government commissioned report by **Hyder Consulting Pty Ltd** in 2008 on the impacts and implications of climate change on MPAs.

Enhanced ecosystem resilience will be a key in protecting coral reefs from potentially unavoidable climate change and increasing ocean acidification. Thus Australian researchers ***Drs Kenneth Anthony*** (**University of Queensland**) and ***Jeffrey Maynard*** (**Melbourne University**) write in a recent editorial in *Carbon Management* that mitigating local-scale stressors caused by human activity [such as overfishing of herbivorous fish and nutrient enrichment from run-off] promotes the resilience of reefs to the global threat from carbon emissions, while failing to mitigate local-scale stressors on reefs will result in irreversibly declining conditions of many reefs during this century. MPAs, the authors say, are part of the toolkit to reduce such local stressors.

However, as pointed out by Hyder Consulting, there are a number of uncertainties in terms of how climate change may impact on the effectiveness and the management of MPAs. Among the various gaps in current understanding are lack of knowledge of how the geographic ranges of native and introduced species may shift, and which species are most likely at risk.

Shifting existence

Indeed, the need for marine species to relocate as climatic conditions change in the World Oceans may be more profound than previously anticipated, particularly so in the 'Coral

The effects of climate change may particularly impact on marine life in the Coral Triangle, the most diverse and biologically complex marine ecosystem on the planet.
image: sourced from http://oceanexplorer.noaa.gov; original file from www.reefbase.org/main.aspx

Triangle', a triangular-shaped area to the north of Australia that spans tropical marine waters including around Indonesia, Papua New Guinea and the Solomon Islands. The significance of the area as a focal point of marine biodiversity, supporting the lives of more than 150 million people was recently highlighted in a special issue of *Decision Point*, a monthly magazine produced by the **ARC Centre of Excellence for Environmental Decisions**.

As detailed in the issue, the area covers just 5.7 million square kilometres but contains more than 75% of all known coral species, 53% of the world's coral reefs, and some 3,000 fish species. Already marine life in the Coral Triangle is under pressure from overfishing, illegal fishing, unsustainable coastal development, and pollution. Regional Governments are now moving to address these problems, for example through the multilateral **Coral Triangle Initiative** (CTI), which includes plans for a network of MPAs.

A recent study published in *Science** suggests, though, that the region's marine life is also most sensitive to the effects of climate change. The study involving Australian researchers from the **CSIRO**, the **University of Queensland** and **University of Western Australia**'s Ocean Institute analysed how defined temperature ranges on land and at sea, also called isotherms, have shifted geographically over the past 50 years. This 'velocity of climate change' also sets the pace by which species will have to change their distribution to keep within their optimal temperature range. In addition, the study analysed the rate by which the timing of seasons has changed over the period, which will impact on major life cycle events of species that are synchronised with seasonal changes.

In general, marine organisms will either have to move to a climatic 'comfort zone' or, if that is not possible, to adapt to new conditions or face extinction. The study found that while the overall rate of warming is around three times faster on land than at sea, the velocity of climate change is similar at most lattitudes. Seasonal changes, such as the timing of spring temperatures, were overall found to be greater at sea, which challenges the perception that marine life in the ocean will respond more gradually than species on land because of slower warming in the oceans. At sea, small temperature changes may require species to travel large distances in order to stay in their comfort zones, which is particularly problematic for marine organisms such as corals.

The analysis of regional impacts of climatic change is complicated, though, as patterns of temperature changes do not occur uniformly across the Earth. Different regions are warming or even cooling at different rates, creating a complex mosaic of climatic changes that deviate from simple poleward migration and earlier springs or later falls.

Thus the median velocity of climate change was much faster in the Northern Hemisphere ocean (37.3 km/decade) than in the Southern Hemisphere ocean (14.6 km/decade). And it was particularly pronounced in the sub-Arctic and close to the equator, where the velocity of climate change at sea was found to be 2-7 times faster than on land.

The rapid divergent velocities and seasonal shifts may cumulatively impact on species-rich equatorial and coastal regions, such as the Coral Triangle. Here no communities from even warmer regions exist to replace those moving out, and the presence of Australia may interfere with the displacement of biological ranges.

▶ **More information: www.csiro.au/news/No-plain-sailing-for-marine-life; *Burrows et al (2011) Science 334, 652-655**

Off the edge with no refuge

A new study led by ***Assistant Professor Thomas Wernberg*** from the Ocean Institute adds to the still sparse body of knowledge of how future warming may effect marine biological systems. Their results do not bode well, since with future warming, up to one quarter of seaweed species in southern Australian waters may be driven towards the edge of the Australian continent, beyond which there is no refuge.

Australian seaweed Pterocladia retangularis.
image: Thomas Wernberg

Macroalgae, better known as seaweeds and not to be confused with seagrass, are ecological foundations for most near-shore temperate marine ecosystems. Kelp forests formed by brown macroalgae are thought to be among the most productive and dynamic ecosystems in the world. But macroalgae also provide important ecosystem services with uses ranging from food to the production of nutraceuticals and pharmaceuticals, as well as lower value aquafeeds, stock feeds and a wide range of garden fertilisers.

While Australia is a net importer of seaweed, a recent report published by the **Rural Industries Research and Development Corporation** (RIRDC) highlighted a number of Australian species that could help local industry to tap into an estimated US $6 billion market.

Indeed, Australian waters have an abundant wealth in macroalgae, with most species found in its southern temperate regions. The rocky reefs along the 4000 kilometre temperate coastline of southern Australia are globally recognised to harbor one of the world's most species-rich macroalgal floras, with some 25% of species unique to the region*.

However, as the new research published in *Current Biology*** indicates, climate change could pose a serious threat to this wealth.

The study used a database of more than 20,000 historical herbarium records collected since the 1940s, to investigate changes in the distribution of seaweed communities and species.

They found that on both the Indian and the Pacific Oceans side of the continent, macroalgal communities south to the tropical-temperate transition have become progressively more similar to past communities in the north. The changes were greatest on the east cost, where the dissimilarity between assemblages reduced by 42% by 1990-2009. The authors believe this is compelling evidence that entire seaweed communities have rearranged in response to the observed warming of ocean waters over the past five decades. They also found evidence that temperate species have shifted their distribution polewards. Given that seaweeds perform broader ecological functions, such loss or replacement of species could have substantial negative implications for ecological function and biodiversity, the authors state.

The picture is not entirely clear cut, as a number of seaweed species were found to have shifted to the north, although to a lesser degree, and while the authors outline explanations for this seemingly counterintuitive result, it indicates that not all shifts were linked to changes in climatic conditions.

The data presented data raise the spectre that if, as is projected, sea surface temperatures increase by between 1°C by 2030 and 3°C by 2070 an estimated 100–350 seaweed species could be lost over the next 60 years. A potential loss of some 25% of the current southern seaweed flora, of which as much as a quarter are unique to Australia, is a scenario that implies a profound increase in global extinctions, the authors conclude.

▶ **More information: www.news.uwa.edu.au; *as detailed in Wernberg et al; Marine Climate Change in Australia; Impacts and Responses; 2009 Report Card; **Wernberg et al. (2011) Current Biology, 21, 1828-1832**

Global warnings getting acid

In June, the **International Programme on the State of the Ocean** released a preliminary summary report of an international workshop it had held earlier in 2011. The report received considerable media coverage with its main message that the world's ocean are at high risk of entering a phase of species extinction unprecedented in human history.

The group of scientists, including ***Professor Ove Hoegh-Guldberg***, director of **University of Queensland**'s **Global Change Institute**, warn that multiple stressors – fishing and other extractions, pollution and habitat destruction, and introduced species – cumulatively reduce the resilience of many marine ecosystems, with the most biodiverse marine ecosystem, coral reefs, a prime example. This increases the overall vulnerability to climate change related impacts, including rising sea temperatures and sea levels, and ocean acidification caused by oceans absorbing atmospheric CO_2.

The coccolithophore Gephyrocapsa oceanica
image: NEON ja, colored by Richard Bartz; creative commons license; wikipedia

The impacts of climate change and its 'evil twin', ocean acidification, are extremely complex and still not well understood. A recent example of international research, a study published by French and US scientists in a paper in ***Nature*** in August 2011 illustrates this. The study not only highlighted the potential impacts of atmospheric CO_2 and ocean acidification on marine life, but also possible feedbacks influencing global climate.

Extremely abundant marine algae called coccolithophores use photosynthesis to transform CO_2 in the upper ocean into organic carbon. However, they also produce shells, which account for much of the ocean's calcium carbonate. Intriguingly, this process counteracts the effect of photosynthesis, as it uses alkaline oceanic bicarbonate ion (HCO_3^-) and produces CO_2, which then can 'outgass' into the atmosphere. While on balance more carbon is absorbed than produced, changes in the ratio of organic carbon to calcium carbonate in algae particles sinking to the ocean floor, also called the 'rain ratio', could influence the ocean carbon cycle.

How these extremely abundant phytoplankton will respond to a warmer and more acidic environment has been the subject of intense research, with previous results from laboratory

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experiments suggesting the algae produce more shell as the oceanic CO_2 increases.

In this study, the scientists directly measured the tiny organisms in hundreds of seawater samples and ancient marine sediment cores. They found that with higher CO_2 concentrations coccolithophore communities tend to shift towards species that produce less thick shells. It may be too early to speculate how this may influence global climate, but it does highlight that as atmospheric CO_2 rises and oceans become more acidic, there will be significant impacts on marine calcification processes.

Closer to home, there is intense research on how anticipated ocean acidification will impact on our most precious marine assets, notably coral reefs. There is consensus that coral reefs are highly vulnerable to more acidic environments as it reduces their ability to maintain coral structures and fish habitats.

Bleached Elkhorn coral
image: provided by the US National Oceanic and Atmospheric Administration

But according to a recent study published in *Science* in July 2011 and led by researchers from UQ's **ARC Centre of Excellence for Coral Reef Studies**, some projections of immanent global-scale collapse of reefs within the next decades may overestimate the rapidity and uniformity of the decline. Although widespread degradation is underway, the emerging picture is complex as reefs are naturally highly diverse and likely to respond to the changed conditions in different ways and at varying rates. Some coral reef systems will decline more rapidly – especially those subject to other human pressures such as overfishing – while others may change in composition, but manage to persist for longer.

Past extinction crises in coral reef ecosystems appear to coincide with episodes of rapid global warming and ocean acidification, but the researchers highlight some critical knowledge gaps, including effects of climate change on interactions between species, and the potential rates of adaptation of reef species to warmer and more acidic conditions.

Recent papers published in *Global Change Biology* and led or co-authored by ***Dr Kenneth Anthony***'s team at the **AIMS**, address some of these gaps.

One of the studies, published early in 2011, suggests that warming, acidification, overfishing and nutrient enrichment all promote a shift from healthy predominantly coral-dominated states to predominantly algal-dominated states. The study used model simulations to investigate different scenarios of atmospheric CO_2 ranging from 350 parts per million (ppm) to 1000 ppm. Importantly, the results indicate that, under the current fossil-fuel intensive carbon emissions path, acidification and warming will severely impact corals, while at lower CO_2 scenarios below 540 ppm, local management can improve coral survival by reducing fishing and nutrient pollution.

image: Ken Anthony

Two further studies, published in December, show that different types of reefs can either reduce or promote the acidity of their environment, depending on the composition of the reef community. Again, the key here lies in the two processes of photosynthesis and calcification (as well as respiration) that occur in coral reefs and which alter the carbon chemistry of seawater as it flows across shallow-water reef communities.

Dr Anthony explained in a media statement on the studies that some reef areas take up more CO_2 than they produce (through photosynthesis), which also benefits neighbouring reef areas. Other reefs with greater coral cover produce more CO_2 than they consume (through calcification and respiration), which locally promotes ocean acidification. Overall, shallow-water reef areas have greater potential to influence their local seawater pH than areas exposed to ocean currents. This implies that reef managers could benefit from ocean acidification risk maps to better understand which areas might in fact lower the impact of ocean acidification in neighbouring areas, and which will further acidify themselves.

Healthy, with sick potential

In December 2011, the Australian Government released the *State of the Environment 2011* report. It is the fourth in a series of reports, which every five years assess the current condition of the Australian environment, the potential risks and available protection measures, and provides a future outlook.

While the report is beyond the scope of this article, a major component is a review of the marine environment, and we reflect here briefly on some of its key findings.

Australia's oceans are in relatively good shape, the report states, but there are some areas of concern. There is substantial degradation in the east, south-east and south-west, with ecosystems near the coast, bays and estuaries in poor and very poor condition – mainly the result of past and present human activities. Unregulated human activities such as in river catchments, urban and coastal developments, and fishing are major contributors to the degradation. Fishing and offshore developments, particularly oil and gas extraction, all have local impacts on marine biodiversity, the report says.

Although the effects on Australian oceans are still limited, the report notes various increasing pressures related to climate change and anticipates changing patterns of biodiversity and productivity in nearshore waters. These pressures include:

- increasing sea level;
- increased severity and incidence of extreme weather events;
- altered ocean currents and associated changes in productivity;
- increasing acidity of the oceans (resulting from higher carbon dioxide levels).

Notably, the report notes the still limited knowledge of biodiversity and ecological processes, although there is progress in our understanding of seabed geology and topography, oceanographic systems and physical processes.

Above all, though, the report highlights that while the cumulative pressures on Australia's marine ecosystems are rapidly growing, present-day management systems lack integration among the various federal, state and local government systems that provide for planning, regulation and management of the marine and estuarine waters.

"Foremost, among the many issues is the lack of an integrated national system for assessment and reporting of marine condition. Without an integrated and genuinely national system of multilevel governance for conservation and management, it will be difficult to properly maintain the natural wealth of our oceans in the face of the challenges ahead."

Since the last report in 2006, Australia's national marine territory has significantly increased, after the **UN Convention on the Law of the Sea** granted in 2008 an extended continental shelf application, effectively increasing Australia's seabed territory by 23% to 13.86 million square kilometres, the third largest jurisdiction in the world. In our April 2009 issue we reported in detail on the implications of this development, and also on the *2009 National Framework for Marine Research and Innovation*.

In this document, the **Oceans Policy Advisory Group** (OPSAG) noted that insufficient investment in marine science was causing economic loss and was reducing the potential for the development of Australia's marine industries. Since then the Government has ramped up its investment in marine science, including through the 2009 Super Science initiative, which focusses on marine (and climate science) as one of three priority areas of funded research. We were informed that OPSAG is currently concluding a follow up on the framework, which is expected to be released in the coming months.

▶ **More information: www.environment.gov.au**

SPOTLIGHT

Troubled waters in brief

At the end of November, the **Murray-Darling Basin Authority** (MDBA) released its draft Basin plan, which is now open for public comment. The plan sets out an interim pathway for managing the Murray-Darling Basin to 2019, when the plan will be fully implemented. It follows on from the much criticised discussion paper in October 2010 (see also "A plan for troubled waters", *ARDR* Nov 2010).

The MDBA says it has based its proposal on a hydrological indicator site approach that is more robust then the end-of-systems approach previously used. The draft plan and the reactions of stakeholders to it will be covered in more detail in our next issue, but here a brief summary of the major points.

The MDBA proposes to limit the long term average use of surface water in the Basin to 10, 773 gigalitres per year (GL/y). This would reduce the water use by 2,750 GL/y (compared to 2009 diversions). The MDBA says that accounting for contracted water recovery to date, only an additional 1,468 GL/y is left to be recovered for the environment across the Basin by 2019. Of this, the MDBA estimates that 400 GL/y could be recovered through future investments in water-saving infrastructure, including changes to the infrastructure and operation of the Menindee Lakes. The remaining 1,000 GL/y would be recovered through other measures. The MDBA also proposes a Basin-wide long-term average limit of 4,340 GL/y on groundwater use. However, a mid-point review at 2015 may lead to adjustments as new knowledge is acquired.

The MDBA also proposes to separate the management of the northern basin from the southern basin. To this end it will initiate a Northern Basin Committee of community representatives to work with the MDBA.

Broad rejection

The **Wentworth Group of Concerned Scientists** has strongly criticised the plan and called on the Government to reject it. It says the plan does not provide the information required to make an informed decision. This includes that the volume of water required for a healthy river was not identified. The plan also lacks a modelling of the impact that increasing groundwater extractions by over 2,600 GL will have on surface water flows.

The scientist say the draft plan also does not provide information on the effectiveness of the proposed measures in the case of extended dry periods, and the long term diversion limits are based on the assumption that climate change will not pose a risk to river health.

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Tools for the nation

Nano toys

The **Australian National Fabrication Facility Limited** (ANFF) has formally opened another member of its collaborative network of facilities, the **ANFF ACT** node at the **Australian National University**. Together with connected facilities at the **University of Western Australia,** which were launched in March, the node will provide multi-million dollar infrastructure for the fabrication of photonic and semiconductor devices, photonic crystals and waveguides.

The ANFF comprises a network of eight university-based nodes, which draw on existing infrastructure and expertise, with each node offering a specific area of expertise for the fabrication of materials. These include metals, composites, ceramics and polymers used in a wide range of applications.

The project has 19 member organisations and is supported by federal and stage governments, including a $91 million contribution by the **Australian Government**'s **National Collaborative Research Infrastructure Strategy** and the **Education Investment Fund**.

The ANFF is headquartered at its **Victorian Node**, the **Melbourne Centre for Nanofabrication** at **Monash University**. Further nodes include the:

- **Queensland Node**, featuring the **Soft Materials Processing Facility** and the **BioNano Device Fabrication Facility** at the **University of Queensland**,
- **Materials Node** consisting of the **Intelligent Polymer Research Institute** and the **Institute for Superconducting and Electronic Materials** at the **University of Wollongong**, and the **Centre for Organic Electronics** at the **University of Newcastle**'s;
- **New South Wales Node**, which is hosted by the **Semiconductor Nanofabrication Facility** (SNF) at the **University of New South Wales**;
- **OptoFab Node** headquartered at **Macquarie University**, further including facilities a the **Bandwidth Foundry International**, the **University of Sydney** and the **University of Adelaide**; and
- **South Australian Node**, consisting of **NanofabricationSA** facility within **The Wark**™ at the **University of South Australia**.

▶ More information: http://news.anu.edu.au/?p=11901

Get smart w/o 99

Australia's challenging infrastructure needs in cities and regional centres will require a rigorous evidence base for public policy decisions, and a better understanding of how to plan more stragegically and long term. One of the largest infrastructure research facilities in the world, opened officially at the **University of Wollongong** in November, aims to address this issue by providing data and analytical capability for the development of a national integrated infrastructure plan.

One objective of the $62 million **SMART Infrastructure Facility** will be to forge a new branch of research called 'integrated infrastructure planning and management' to analyse the individual and combined effects of infrastructure systems and how they can better work together to serve the community.

Short for Simulation, Modelling Analysis, Research and Teaching, the SMART facility will have 30 specialist research and education laboratories working on a wide range of infrastructure services , such as electricity, energy, water, gas, transport, rail and road. A simulation centre will integrate the laboratories and allow researchers to model infrastructure services and their interactions with each other. This will be supported by a computing facility with high end computational and visualisation capabilities of the bio-physical characteristics of, for example, road, rail, water, electricity and communication in a particular area, including how people interact with these assets.

The facility is a major investment by the **Australian** and **NSW Governments,** which contributed $35 million and $10 million, respectively, towards its establishment. This comes with the expectation that SMART will have a major impact on infrastructure policy, and Government and university have agreed to exchange information freely for a smoother translation of the facility's research into policy.

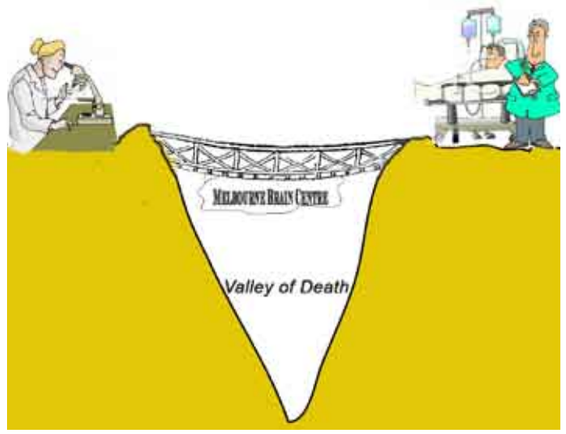
SMART chief executive officer ***Garry Bowditch*** will be supported by a recently appointed high-profile Advisory Council, which will be chaired by former head of Treasury, ***Dr Ken Henry.***

▶ More information: http://smart.uow.edu.au/index.html

Brainy days in Melbourne

Connection matters

After the launch of the **Austin Building** in Heidelberg in June, the second new purpose built facility of Victoria's new **Melbourne Brain Centre** opened in Parkville in October. Together with its third component, the **Centre for Translational Research** at the **Royal Melbourne Hospital**, the $225 million project establishes one of the top five brain



research centres internationally with the aim of boosting collaboration between scientists and clinicians. Its facilities will house 700 scientists from the **Mental Health Research Institute**, the **University of Melbourne**, **Melbourne Health**, **Austin Health** and the **Florey Neuroscience Institutes**.

▶ More information: www.premier.vic.gov.au

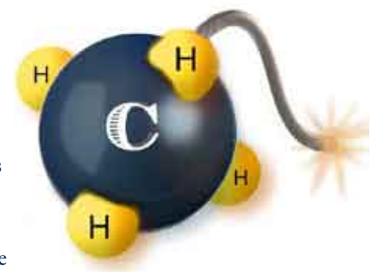
Mental focusation

The new **Centre for Neural Engineering at the University of Melbourne** has officially opened its doors at the University of Melbourne in October. The centre, which had received $17.5 million from the **Education Investment Fund** (EIF), will be led by ***Professor Stan Skafidas***, an expert in the development of microelectronics, wireless communication and other communication systems. As part of the **Melbourne Neuroscience Institute**, the centre will focus its research on new biotechnologies, next generation neural prostheses, and engineered systems that replicate biological networks and are resilient to faults.

▶ More information: www.cfne.eng.unimelb.edu.au

Seam-ingly obvious need

A centre with five new professional chairs and focussed sole on one commodity, coal seam gas (CSG), will be established at **University of Queensland**'s **Sustainable Minerals Institute** (SMI).



The initiative was established in response to increasing demands for scientific research into CSG, and, according to SMI director ***Professor Chris Moran***, also due to a degree of public anxiety around the issue. He said the centre would "bring the scientific rigour and data that have been lacking to date to the social, environmental and technical challenges the industry faces".

The centre's research focus will include the treatment and utilisation of coal seam water, social and community performance, geoscience and petroleum engineering. In addtion, the centre will focus on developing and delivering professional education relevant to the CSG industry, such as a new Masters in Petroleum Engineering it will offer in partnership with **Heriot-Watt University**, Edinburgh.

▶ More information: www.uq.edu.au

Free piggies to market

The **University of New South Wales** (UNSW) has announced it will undertake a radical step to boost the translation of university research into commercial applications – a chronic shortcoming in Australia's economy.

The university's commercialisation company **NewSouth Innovations** (NSI) will implement a new **Easy Access IP** strategy, under which the university will offer the private sector free development of a selection of UNSW intellectual property, with simplified, one-page agreements replacing complicated licensing negotiations.

Internationally, the approach has been adopted by a number of universities, but UNSW will be the first in Australia to take the step.

UNSW deputy vice-chancellor (research) ***Professor Les Field*** said the new stragey would mark "quite a radical departure from the way that UNSW and most universities have been doing business." So far 80% of the university's IP is never commercialised, he said in a video explaining the new strategy, which the university hopes will translate more university research into 'real world' applications.

According to chief executive ***Dr Kevin Cullen***, the Easy Access IP aims to remove barriers and obstacles in the licensing process, although the new rules will exclude IP where UNSW can identify signficant commercial value. To qualify for IP under the Easy Access portfolio companies will have to:

- acknowledge UNSW's contribution and report on their progress; and
- agree that if they have not exploited the IP within three years, it will be transferred back to UNSW.

A licence will also require that UNSW's is not limited in the use of the IP for the university's own research.

▶ More information: http://newsroom.unsw.edu.au/news/social-affairs/unlocking-ip-business

A series of unfortunate events

Stirling Products Limited is currently in voluntary administration. On 23 August 2011 the company's securities were suspended from official quotation on the ASX due to a failure to pay the annual listing fees. The company is now in a deed of company arrangement, a formal agreement between stakeholders intended to prevent the liquidation of the company.

It has been a long protracted decline in fortunes, after the company's shares peaked at $0.14 in June 2007. On 30 June 2011, the last day of trading, they were worth 2 cents.

Tracing the story of Stirling it appears that when the new board, including managing director ***Peter Boonan***, took up the reins in February 2009, growth ambition took the better of financial prudence in a constrained Australian market. Until then the company had focussed on the development of the animal health product R-Salboutamol, but then experienced financial difficulties with the prospect of being forced into voluntary administration.

The new board reset the company's path on expansion. In an interview with Finance News Network he said in December 2009: "Our strategy is not complete yet, it's global, it's big, it's aggressive and we're not there by a long shot yet. We've got another year of hard work, but we are expecting significant revenues to start during the first quarter of next year."

The company's increased product portfolio included commercialisation rights for the natural immune booster Immunoxel, which it obtained through a partnership with Australian banking group **Zodiac Capital Limited**. Only in May this year the venture announced a collaboration agreement with Canadian **Immune Network Limited** to accelerate the development of ImmunoXel for the treatment of TB.

In 2010, Stirling also acquired a $20 million pharmaceutical manufacturing facility in Canada, which the company said it bought at a bargain of $4 million thanks to the global financial crisis. However, in his latest report to shareholders Mr Boonan said that for the fully licensed manufacturing capacity to attract more substantive contracts it would have had to demonstrate a financial capacity to carry the projects through.

Lacking funds also marred plans to establish a stable revenue stream through the telehealth solutions company **TeleMedCare**. In 2010, Stirling acquired a 65% stake in TeleMedCare, which at the time was in administration. TeleMedCare turned into a substantial drain on Stirling's limited funds and failed to attract independent funding. In June this year, Stirling was forced to enter a conditional sale of TeleMedCare with Spains Grupo Neat, which was announced as a $3 million deal. According to Mr Boonan, however, Grupo Neat has since varied its initial offer of $3 million down to just $1.7 million.
Stirling's string of unfortunate events was then brought to a head in a recent unsuccessful placement of shares.

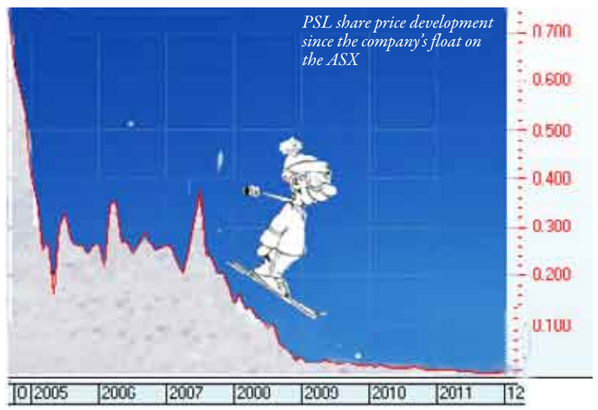
Earlier in the year, the ASX had already raised concerns about the prospects of the company, given the extensive commitments, with a low base of funds and revenue stream. In answer, the company stated that, while it had encountered some difficulties in raising capital, it would continue to achieve its key business objectives.

It's reported loss for the half year January to June 2011 was $8.2 million.

▶ **More information: http://www.stirlingproducts.net**

...and troubled road to nowhere

Tyrian Diagnostics Limited is another Australian company in strife. The company started out as **Proteome Systems Limited**, founded in 1999 by scientists from **Macquarie University** led by ***Professor Dr Keith Williams***. He was also the inaugural director of the **Australian Proteome Analysis Facility**, the birthplace of the term proteomics and at the time the world's first dedicated high throughput proteome facility. PSL focusseds its business on developing proteomics technology and floated the company five years later on the ASX in 2004, boyed by being awarded the *2003 Frost & Sullivan Award for Technology Innovation* for its novel technologies and unique proteomics automation products.



PSL share price development since the company's float on the ASX

However, in the year leading up to the float, revenues dropped to less than 40% of their previous years' levels, and while the company was able to raise $20 million at $1.20 a share issue price, it was unable to meet the high market expectations with a drop in share price to less than $0.40 in the first year. In 2005, ***Dr Bruce Rasmussen***, deputy director at **University of Melbourne**'s **Centre for Strategic Economic Studies** (CSES), wrote in a CSES working paper that PSL appeared to face a common barrier for Australian bioinformatics companies with a small local commercial customer base, which "need to retain the confidence and funding from investors, while sales are insufficient to cover costs and perhaps trending down."

Instead of increasing its investments in sales and marketing of its technology products, the company changed leadership and opted to change course and instead progress its medical diagnostic and therapeutic product developments. In 2008, the company changed its name to **Tyrian Diagnostics Limited**.

Encouraging developments were a $2 million Government grant to further develop a new sputum-based diagnostic test for active tuberculosis, with a licensing deal negotiated with US-based manufacturer **Becton Dickson** in 2007. Tyrian also entered a collaboration with multinational **Bayer CropScience AG** focussed on agricultural diagnostic products utilising a novel point-of-need test platform DiagnostIQ. The partnership was to provide a revenue stream needed to finance Tyrian's early stage diagnostic products, and a first product, a test kit for alpha amylase to determine the extent of rain damage in wheat, was released in 2009. However, commercialisation of the product did not meet expectations. In August, Tyrian announced that Bayer had ceased the collaboration to further develop the ReadRite tests, essentially cutting off the company's main revenue stream.

In its 2011 annual report released in late September, the company details a cost reduction plan with all staff to be made redundant, and assets to be sold.

The company said at conclusion of the restructure it will have no debt, and be able to fund its reduced operations for another 18 months. Latest news is positive, though. In December, Tyrian announced that it had entered an exclusive licensing agreement with Australian-based **SpeeDx Pty Ltd**, which acquired the rights to develop and commercialise Tyrian's molecular test for active tuberculosis. Tyrian will receive up-front and potential milestone payments, as well as a percentage of sub-licensing revenues and potential royalty payments.

The company also reached a deal with US based **NeoClone LLC**, which will manufacture and distribute Tyrian's antibodies targeting TB proteins.

▶ **More information: http://www.tyriandx.com**

Dendrimeric progress

Starpharma is on track for a Phase 3 clinical trial of VivaGel as a treatment for bacterial vaginosis (BV), after it secured a respective agreement by the US **Food and Drugs Administration** (FDA).

While its ASX share value has fallen some 25% since its all time high in July, the recent trend points upward, as Starpharma made steady progress with its dendrimer products over recent months (covered extensively in our previous issue). This includes the application of VivaGel as a coating of condoms and as a topical gel application for the prevention of sexually transmitted viral diseases.

Bacterial vaginosis causing Gardnerella bacteria are clinically detected by the presence of 'clue cells' from the vaginal lining covered in bacteria (as shown in the above photomicrograph).
image: Wikimedia commons

The dendrimer-based antimicrobial agent SPL7013, the active component in VivaGel, was also shown to be effective in patients with bacterial vaginosis. This common condition in women is caused by imbalances in their vaginal microbiota as healthy bacteria, such as *Lactobacillus* species found in yoghurt and cheese, are outgrown by 'harmful' bacteria such as *Gardnerella vaginalis*. In a recent Phase 2 study 74% of patients were 'clinically cured' in the days after treatment with the VivaGel product. This compared to just 22% in the placebo group. Two to three weeks after the treatment the cure rate with VivaGel was still 46% compared to 12% in the placebo group, suggesting a longer lasting effect.

The primary endpoint of the phase 2 trial, the clinical cure of patients assessed by the resolution of symptoms and other standard clinical criteria, will also be the endpoint in the planned two Phase 3 trials. According to Starpharma, these trials will form the basis for a commercial license agreement with a suitable partner.

Starpharma's annual report highlights the broad spectrum of potential applications for its dendrimer technolgy. This includes improvements in the solubility of existing cancer drug Docetaxel, and activity enhancements of agrochemicals such as glyophosate. On the back of the concluded phase 2 trial, the company's operating loss increased in the year to 30 June 2011 by 40% to $8.9 million compared to the previous year, with a net cash burn of $3.9 million. In its September quarterly report, the company reported a cash balance of $17 million.

Fortunes are with Starpharma at the moment. In December, the company was able to raise $35 million to drive its product developments, after a share placement in November raised $32 million, followed by a Share Purchase Plan (SPP) rasing another $3 million. The company announced that its SPP was heavily oversubscribed, by more than 400%.

▶ **More information: www.starpharma.com/news-room/news_archive**

Submitted relief

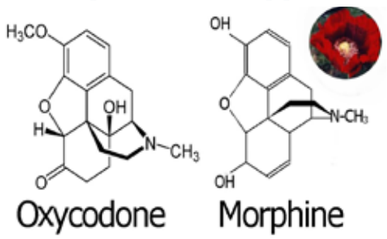
The **US FDA** has accepted **QRxPharma Limited**'s New Drug Application (NDA) for its immediate-release Dual Opioid® pain

therapy MoxDuo IR, stating the application was sufficiently complete, and setting 25 June 2012 as the date for action on the approval. In September, QRx had added clinical data from the drug's phase 3 program to its first submission in July.

Subject to NDA approval, the treatment of moderate to severe pain could be launched in the US as early as 2012. The company also plans to submit a **European Marketing Authorisation Application** (MAA) in 2012.

At the end of December, the company struck a deal with **Actavis Inc**, the fourth largest generic pharmaceutical company in the world, to commercialise the product in the US.

Getting its lead product into the US market will be a major boost for QRxPharma, which has a series of less advanced MoxDuo products still in the pipeline, including formulations for an intravenous application and a continuous release formulation that is applied orally.



These products are based on the synergistic action of the two opioids morphine and oxycodone. As less total opioid is required for the same analgesic effect, patients using MoxDuo products may experience less side effects than with conventional opioid pain relief treatment.

QRxPharma has a significant negative cash flow, and according to its annual report ran an operational loss of $25.6 million in 2011. However, the company's financial situation consolidated after a successful share placement, in which it raised a total of $26.5 million before expenses. QRx reported cash reserves totalling $32 million at 30 September 2011.

▶ **More information: www.qrxpharma.com**

Significant stress relief

The recent roller coaster ride for **Pharmaxis** in its effort to gain European marketing approval for its Bronchitol product ended positively. In June, the **Committee for Medicinal Products for Human Use** (CHMP), which is part of the **European Medicines Agency**, refused to authorise the marketing of Bronchitol as a treatment for cystic fibrosis (CF). But in October Pharmaxis was able to announce that CHMP, after re-examining the application, had recommended authorisation to sell bronchitol in the 27 EU member countries.

Pharmaxis expects that the EC will approve the marketing of Bronchitol in January 2012.

It is a significant win for Pharmaxis. The license sought would cover the use of Bronchitol in CF patients aged 18 and above, which represents about two thirds of all patients who could potentially benefit from the drug. Excluded at this stage are children aged 6 to 17, but the company plans a short term clinical trial for the license to be extended to this age group.

The outcome will also buoy the company's position in its pending New Drug Application (NDA) in the US, for which a pre-NDA meeting was held in December 2010. Back then Pharmaxis had anticipated submitting a full application in the second quarter of 2011.

However, the positive news from the EU was somewhat overshadowed with news at home, where the Australian **Pharmaceutical Benefits Advisory Committee** (PBAC) did not recommend subsidising the use of Bronchitol under the **Pharmaceuticals Benefit Scheme**.

Bronchitol is also in development for the treatment of bronchiectasis, an incurable, chronic lung condition. Pharmaxis is currently conducting a Phase 3 trial for this application of Bronchitol, announcing in December that the trial has reached its specified recruitment target. In the US around 110,000 people receive treatment for the condition, but according to the company the diagnosis rates are increasing and to date there is no targeted medication available for these patients.

In other news, Pharmaxis has completed patient enrolment in a Phase 2 clinical trial of ASM8, a potential treatment for moderate to severe asthma. The company acquired ASM8 with its take over of Canadian-based **Topigen Pharmaceuticals** in February 2010. The drug comprises two RNA-silencing oligonucleotides which target a number of mediators involved in the inflammation and hyper-responsive reactions that occur in the lungs of asthmatics. A first Phase 2 trial found that over a course of four days very low doses of ASM8 were safe and well tolerated, and effective in treating mild to moderate asthma. The drug was found to:

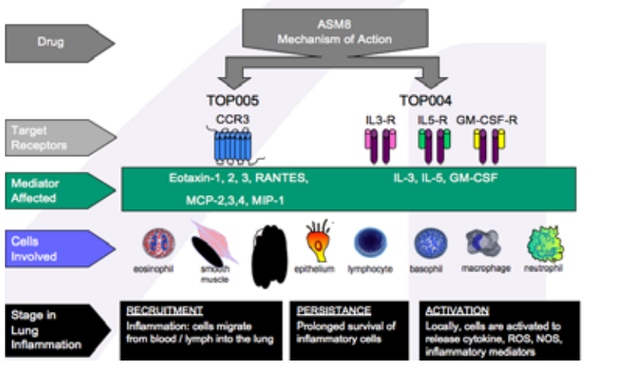


image: pharmaxis

- silence its target genes;
- significantly reduce its target cells, eosinophils, in the sputum of patients; and
- reduce the Early Asthmatic Response (EAR) and the Late Asthmatic Response (LAR) to allergen challenge.

Pharmaxis has already an asthama related product on the market. The lung function challenge test Aridol is sold in Australia, Korea, Europe and, since February 2011, also in the US. Sales of Aridol have been modest, although steadily growing, contributing to the $319,00 revenue ($197,000 gross profit) generated from the sales of goods in the September 2011 quarter. At 30 September 2011, Pharmaxis had cash or cash equivalents totalling $33.5 million, with a reported loss for the year 2010/2011 of $45.5 million, and a net cash outflow over the year of $35.5 million.

▶ **More information: www.pharmaxis.com.au**

Simplified scheme outlining the excitotoxicity theory leading to nerve destruction. The neurotransmitter glutamate released by the nerve cell is bound by postsynaptic receptors and positive ions can enter at the recipient nerve cell. As the cellular voltage increases calcium enters the cell. In cases of overstimulation, such as occuring in some neurodegenerative disorders, high levels of calcium in the cell cause damage and may lead to cell death.

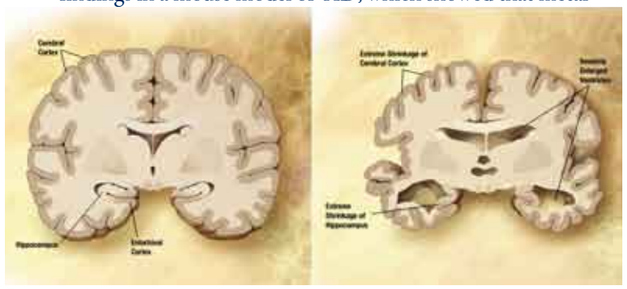
Not forgotten

Researchers associated with **Prana Biotechnology Limited** have received **NHMRC** grants to investigate how the interaction of compounds such as Prana's metal protein attenuating compound PBT2 with metals such as zinc and copper may improve cognitive functions in both normally ageing brains and brains effected by neurodegenerative diseases such as Alzheimer's disease (AD).

The premise behind these studies is that the decline of cognitive function is linked to an imbalance of metal ions in parts of the brain. Thus studies, including by Prana scientists, suggest that a build up of amyloid Abeta protein, which is a characteristic feature in the brain of AD patients, is marked by a trapping of physiological metal ions. As these ions become deficient in the nearby neurons, the pertubed trafficking of these essential neuronal messengers at the synapses then may negatively impact on cognitive abilities.

Recent research on PBT2 suggests that the compound not only prevents the aggregation of Abeta protein-metal complexes outside of brain cells, it then also helps shuffle the metal ions back into neurons.

In March 2011, a team led by ***Dr Paul Adlard*** from **The Mental Health Research Institute** (MHRI) in Melbourne, who is also involved with Prana, published in PLoS One findings in a mouse model of AD, which showed that metal ionophores such as PBT2 can positively impact on the health of neurons. And in September, a paper in the *Journal of Neurochemistry* by researchers including from the **University of Melbourne**, Prana and the MHRI, showed that by translocating zinc and copper ions into neurons, PBT2 induces biochemical responses that support the function of synapses.



Diagrams of a normal brain (left) and a brain from an Alzheimer's patient (right) revealing major shrinkages of sections of the brain.
image: wikipedia, public domain

The results could explain the benefits in cognitive function Prana found in Phase 2a trials of PBT2 in AD patients. The company hopes to consolidate these findings in a 12 months Phase 2 Imaging trial, for which recruitment commenced in December.

Prana also announced data from a German study showing that PBT2 can improve synaptic activity in neurons involved in memory function as it prevents the toxic effects of Abeta oligomer formation.

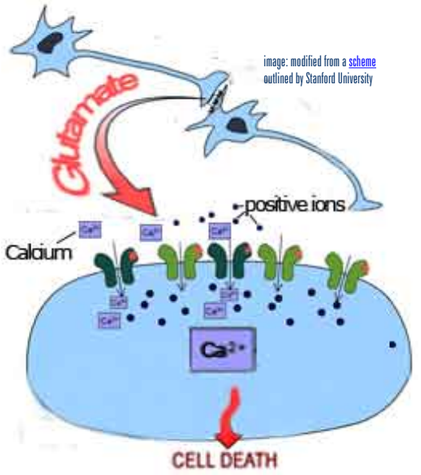


image: modified from a scheme outlined by Stanford University

While Prana's development of PBT2 has focussed on AD, characteristic features of the disease are shared with Huntington's Disease (HD), a genetic, neurodegenerative disorder that often affects young adults. Prana is currently preparing for the recruitment of patients in a respective clinical Phase 2 trial, for which it received approval in early January.

In both AD and also HD, the destruction of nerve cells may be linked to synapses being excessively stimulated by the neurotransmitter glutamate in a process called excitotoxicity.

One of the NHMRC grants was awarded to a team led by ***Associate Professor Kevin Barnham*** from **The Mental Health Research Institute** in Melbourne, who is a co-inventor of PBT2. The project will investigate how cellular copper levels influence exitotoxicity, extending previous research showing that PBT2 can inhibit this process.

The second NHMRC grant was awarded to ***Dr Adlard***'s team to investigate the role of metals in the healthy brain and whether compounds such as PBT2 can also prevent loss of cognitive function associated with normal ageing.

Apart from developing PBT2 for treating AD and HD, Prana has a series of other drugs in the pipeline focussing on neurodegenrative disorders. Thus a **Michael J. Fox Foundation** grant, awarded in August, will support the development of PBT434 as a treatment for Parkinson's Disease.

For the year 2010/2011, Prana reported an operating loss of $6.4 million for the year 2010/2011, with a net operating cash outflow of $4.5 million. As of 30 June 2011, Prana had reserves of $8.8 million cash and cash equivalents.

▶ **More information: www.pranabio.com**

Naturally human

News from **Patrys Limited**'s arsenal of 'natural human' anti-cancer antibodies include a ten year follow-up of a trial conducted with its most advanced product, the PAT-SC1 antibody, in gastric cancer patients.

Of the treated patients, who at the time of surgery showed no evidence of metastases, 55% were still alive after ten years. This compares to a survival rate of 30% in a historic control group of patients who did not receive PAT-SC1.

The company announcement emphasised that patients taking part in the trial had received only a single low dose of the IgM antibody reagent and yet significantly reduced the long-term mortality rate in a cancer indication that is notoriously difficult to treat with usually poor prognosis.

Patrys acquired the PAT-SC1 in 2009 from **Debiovision**

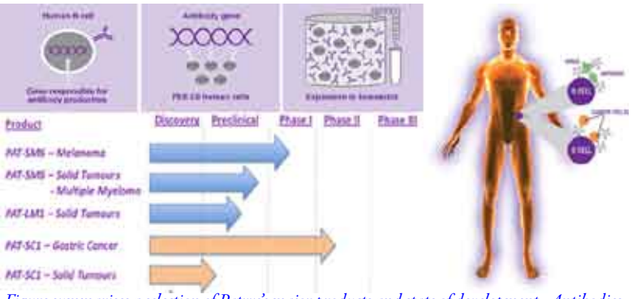


Figure summarises a selection of Patrys's major products and state of development. Antibodies are produced by transfecting antibody genes from selected human B1 cells into the human recombinant cell line PER.C6®, licensed from Crucell N.V.
image: modified images from www.patrys.com

Inc. At present, it is Patrys' most advanced in-house product with completed Phase I and IIa trials. The antibody targets a gastric cancer specific variant of the complement decay-accelerating factor also known as CD55, which belongs to a class of membrane-bound proteins that inhibit the attack of the body's complement system. Elevated levels of CD55 on cancer cells have been found associated with poor patient prognosis.

In March, the company announced that it had achieved commercial scale production yields of PAT-SC1, an important milestone for Patrys, which plans to out-licence the antibody next year.

In October, Patrys reported that it was able to also achieve a successful scale-up and manufacturing of its second in line natural human antibody, PAT-SM6, which is currently in a Phase I safety trial for the treatment of patients with a recurrent form of melanoma confined to the skin.

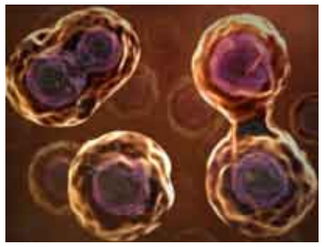
However, targeting a surface protein called GRP78, which is implicated in cancer cell survival, growth and metastasis, the antibody may have potential for a number of cancers.
In September, Patrys reported that, according to new pre-clinical studies, the antibody may also be effective against multiple myeloma, a type of bone marrow cancer arising from plasma cells, and other cancer indications including ovarian cancer and prostate cancer. In the human ovarian cancer model the antibody showed most promising results, being as potent as commercial standard of care treatment, the company said in a statement. It adds to the list of cancer lines against which the antibody showed potent activity, also including metastatic colon, lung, pancreatic and gastric cancers.

For the year 2010-2011, Patrys reported an operating loss of $7.4 million, with a net cash outflow of $5.1 million and reserves of $6.3 million in cash and cash equivalents. With an oversubscribed private placement of shares, completed in December, the company was able boost its financial position with $3.4 million.

▶ **More information: www.patrys.com**

Regenerated strength

Mesoblast Limited had a strong run over the past year, with its share price gaining almost 400% over the past 12 months. The company was strongly boosted after US based **Cephalon, Inc.** bought a 20% stake worth $242 million, and offered US$130 million upfront payment for the rights to commercialise certain Mesoblast products.

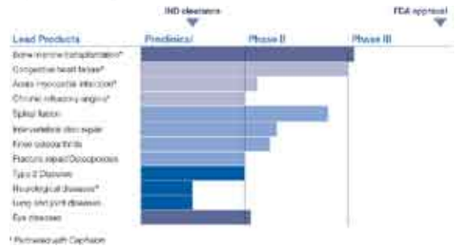


Mesenchymal Precursor Cells

The deal has strengthened the company's cash position, which totalled $263.2 million at 30 June 2011, and led to a profit before tax of $92.2 million.

Mesoblast is developing a broad range of regenerative therapies based on Mesenchymal Precursor Cells (MPC). This includes the treatment of heart conditions, blood vessel diseases of the eyes and legs, bone marrow regeneration after cancer as well as a range of bone, cartilage and

image: Mesoblast Annual Report 2011



musculoskeletal conditions. The most advanced products are aimed at reconstituting bone marrow in cancer patients, with a US Phase 3 trial underway, and a treatment for congestive hearth failure, which is ready to enter the phase 3 clinical stage.

Mesoblast's approach aims to take advantage of the particular clinically relevant features of MPCs including that they do not initiate an immune response. And while MPCs have the potential to differentiate into certain tissue cells, they also stimulate a whole range of regenerative processes.

Cardiovascular conditions, such as congestive heart failure, acute myocardial infarction and chronic refractory angina are conditions targeted by Mesoblast's lead product Revascor™. In September, the company received clearance for a first European Phase 2 trial of the product in patients who suffered a major heart attack. Revascor™ will be injected as patients undergo angioplasty or stent placement procedures, as based on preclinical studies a single intracoronary infusion of MPCs can increase the formation of blood vessels, prevent scar formation and generally improve heart muscle function.

In October, Mesoblast also received clearance for a Phase 2 trial in Singapore to test the use of MPCs for the treatment of wet Age-related Macular Degeneration (AMD). With the trial, Mesoblast takes another step in developing a combination therapy in which MPCs could support current standard-of-care treatment options for the two distinct types of wet AMD, the Asian and North American/European forms.

The regenerative capacity of MPCs may also have potential for the treatment of diabetes type 2. In previous preclinical studies, Mesoblast found that in mice MPCs can support the regeneration of insulin secreting beta cells in the pancreas.

These findings were supported by a study in non-primates with type 2 diabetes. Mesoblast reported in November that a single intravenous injection of its allogeneic Mesenchymal Precursor Cells (MPCs) led to a significant reduction in the fasting sugar blood levels of tested animals. Significantly, the reduction was dose dependent, with the highest doses of the adult stem cells being most effective. In addition, the reduced sugar levels correlated with reduced circulating C-reactive protein, an inflammatory marker predictive of heart attack and cardiac death. Mesoblast plans for its first clinical trial in early 2012.

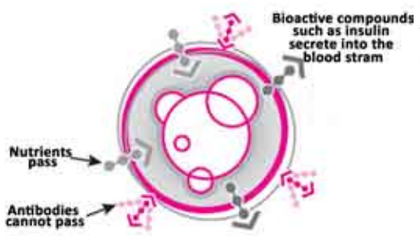
At the end of November the company announced that it had reached agreement with the US FDA on key elements of the Phase 2 trial, and will shortly file an Investigational New Drug (IND) submission to pave the way for patient recruitment.

In September, the company also took steps to secure sufficient supply of MPCs for its long-term commercial needs by entering a strategic manufacturing alliance with the Swiss **Lonza Group**.

▶ **More information: www.mesoblast.com**

When pigs learn to fly

Living Cell Technologies Limited is another maturing ASX listed company which has recently formed significant new strategic partnerships. LCT first parted from an existing one, though, terminating in October its R&D collaboration agreement with **Centocor**, which dated back to 2009 and included a two-year commercial rights option to LCT's encapsulating technology.



Scheme of LCT's IMMUPEL™ technology.
image: LCT

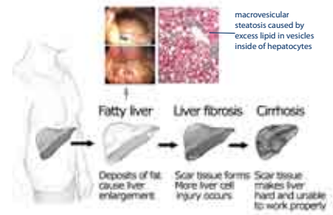
The company then announced that it had established a new joint venture company **Diatranz Otsuka Limited** (DOL) in a 50/50 ownership with Japan's **Otsuka Pharmaceutical Factory, Inc**.

DOL will progress the commercialisation of DIABECELL®, LCT's most advanced product based on its encapsulating IMMUPEL™ technology, through which living cells of various sources are wrapped in an alginate capsule that shelters them from being attacked by antibodies. At the same time the capsule is selectively permeable for nutrients and medically relevant compounds, such as insulin in the case of DIABECELL®.

LCT's contribution to the new venture include DIABECELL® related assets such as patents, trademarks, manufacturing and R&D facilities as well as a special herd of biocertified designated pathogen-free pigs, the source of insulin producing pancreas cells. With DIABECELL® now entering pivotal Phase 3 trials, these were valued at $25 million, matched by a $25 million cash contribution from Otsuka.

Meanwhile, LCT announced that the two of up to eight patients have received implants in its Phase 2 DIABECELL® trial in Argentina. Results from trials in Russia and New Zealand indicated that lower dosages have greater benefit for the patient, and the Argentinian trial will now use fewer insulin producing cells and a different implantation technique.

In Russia, the product has already gained registration as a marketable medical technology, but sales await new legislation regulating xenotransplantation.



Progressive stages of liver damage caused by fatty liver, and, in a progressed stage, nonalcoholic steatohepatitis (NASH), which also features tissue inflammation.
image: adapted from NIH and other sources; creative commons liscence 3.0

Otsuka will also support LCT's other product developments, including NTCELL, which consists of encapsulated choroid plexus cells that have potential for the treatment of a series of neurodegenerative diseases. These include disorders such as Huntington's and Parkinson's but their development has not passed the preclinical stage yet.

For the year 2010-2011, LCT reported a loss of $6.7 million with a cash outflow of $5.7 million. At 30 June 2011 it had reserves of $4.5 million in cash and cash equivalents.

▶ **More information: www.lctglobal.com**

Slippery milky way

Immuron Limited has further progressed in the development of IMM-124E, a potential treatment for NASH (non-alcoholic steatohepatitis), having in November submitted an Investigational New Drug (IND) application to the **US FDA**.

It is the third advanced product of the company, with Travelan™ for the prevention of traveller's diarrhoea now being for sale in Australia, New Zealand and South Africa.

NASH is a chronic inflammatory disorder of the liver, which

is associated with metabolic syndrome. It is a growing health problem in major markets as it is far more prevalent in obese populations, with currently few treatment options.

As with Immuron's other product developments, IMM-124E is based on polyclonal antibodies produced in bovine collostrum, the milk that is first produced a few hours after giving birth. The product is prepared by immunising cattle with lipopolysaccaride (LPS), a bacterial component that stimulates the production of a certain type of antibody, so called immunoglobulin gamma (IgG). Earlier studies, including a recent Phase I/II clinical trial, found that IMM-124E given orally to patients with NASH reduces insulin resistance, excessive amounts of triglycerides and other fats inside liver cells and abnormal liver function. These benefits were found to be mediated by an increased level of regulatory (or suppressor) T-cells, which exert an anti-inflammatory effect. Other immunomodulatory effects were also observed.

The company is now planning for a Phase 2 trial to evaluate safety and efficacy of the product.

However, the year 2010-2011 has been a difficult for Immuron. The company reported lower product sales than in the previous year, in parts due to regulatory delays in the marketing of Travelan in the US, although within Australia sales increased. As the directors note in their annual report, with a loss of $2.6 million, a net cash outflow of nearly $2 million, and reserves of only $750,814 in cash and cash equivalents, the company's marketing and research program will rely on the ability to raise additional capital from direct investment by investors.

▶ **More information: www.immuron.com**

Burning advance

Calzada Limited's subsidiary **PolyNovo Biomaterials Pty Ltd** is progressing in its development of a new treatment of full thickness burns device. PolyNovo is involved in the project as a 80% stakeholder in a joint venture company **NovoSkin**, the other 20% of which are by **University of Adelaide**'s ***Associate Professor John Greenwood***, the 2011 South Australian of the year (health category).

BTM engraftment in pigs.
image: Presentation by A/Professor John Greenwood at the 2011 Ausbiotech conference

The project is developing two separate products, which both utilise PolyNovo's NovoSorb™

- a Biodegradable Temporising Matrix (BTM), which utilises PolyNovo's NovoSorb™ medical grade polymers, and is applied to stabilise the wound and stimulate dermal tissue growth; and
- a Composite Cultured Skin (CCS) from patients own skin, which potentially could abolish the need for skin grafts.

The BTM device was successfully trialled in pigs as a first treatment of full thickness burns, where it led to less wound contraction and less infection than a leading commercial product. And following key safety studies with satisfactory outcome and the ethical approval for a first human study, Calzada is about to commence two pilot human studies of the product, subject to standard pre-trial risk assessments.

Calzada had also positive results in a proof-of-concept animal study on the second stage of the project, the CCS. Designed as a by-layer stynthtic skin formed from the patient's own cells using a NovoSorb scaffold, A/Professor Greenwood was able to implant the product as a viable form of skin without requiring an external source of nutrition, and in a clinically relevant timeframe.

Calzada reported reserves of $3.5 million in cash and cash equivalents at 30 June 2011, after an increased net loss and net cash outflow of $2.9 million, despite slight increases in its revenue stream. One stream of income results from the company's ownership of **Metabolic Pharmaceuticals Pty Ltd** and its AOD9604 compound, a fragment of growth hormone that was previously developed as an oral treatment for obesity, and has been outlicensed to Phosphagenics as a component of a cellulite cosmetic cream. Phosphagenics is also investigating a wide ranging spectrum of other applications related to the potential action of the compound on bone and cartilage, as well as muscle, ligament or tendon mass.

▶ **More information: www.calzada.com.au**

No place to hide

Some 12 years after it was established in 1999 as a spin-out from the **Australian National University**, **Biotron Limited**'s hopes rest on the success of BIT225, a small anti-viral compound that is orally-administered and targets viral reservoirs in immune cells. In its early years, Biotron also pursued a C-Test cancer diagnostic test, but since 2007 the company has focussed its resources mainly on its viral program, with BIT225 the lead product.

The compound was discovered in a screen for inhibitors of the ion channel activity of so called viroporins. These proteins are essential for viral production and replication, and include the Vpu protein of HIV type 1 and p7 of Hep C virus (HCV).

BIT225 was initially selected as the most promising candidate in the HIV drug development program, as it was found to inhibit the virus in its reservoir in monocytes, in which the virus resides largely unaffected by current treatments. Acting synergistically with common anti-retroviral therapies, Biotron hopes that, used in a combination therapy, the drug will interrupt the on-going cycle of infection in the body. Recently BIT225 was also reported to act in the early phase of HIV infections by reducing the initial local infection of dendritic cells, from which the virus disseminates by infecting T-cells in lymph nodes.

The drug was also found to be effective against HCV, and its the HCV program, targeting a globally expanding market, that has now most advanced. Results from a Phase 2a trial in Thailand, presented at an international conference in December, showed that in HCV patients treated with standard-of-care (SOC) together with BIT225, 87% had virus levels below the level of detection three months after the start of the 28 day treatment, compared to 63% of patients who had received SOC only.

Biotron has also commenced a Phase 1b/2a proof-of-concept human trial of BIT225 in HIV positive individuals, with results expected in early 2012.

For the year 2010/2011 the company reported a net loss of $1.9 million, a net cash outflow of around $2.0 million and reserves of around $2.1 million cash and cash equivalents.

▶ **More information: http://biotron.com.au/asx.htm**

Riding high

Tiger snake antivenom and a pharmaceuticals sample case used by Commonwealth Serum Laboratories in early 1900
image: sample collection Museum Victoria

Rise of a player...

CSL Limited is Australia's only truely global player in biotech, uniquely positioned not only because of its total domestic dominance in terms of market capitalisation – with more than $19 billion it accounts for around 80% of the total market capitalisation of the Australian biotechnology sector*. CSL also stands out because of its history, having first gained critical mass and expertise as a Government owned institute established in 1916, the **Commonwealth Serum Laboratories**, before becoming a globally competitive private enterprise. Today it is a very very profitable enterprise, with a net profit of $941 million reported for the year to 30 June 2011, although down 11% from the previous year due to unfavourable currency exchange rates.Floated only in 1994 on the ASX, the company grew rapidly, building on its expertise in blood fractionation, the development of new vaccines, and the production of snake and spider bite antivenoms.

This is not to say that the ride over the past two decades all went smoothly, but the last significant trouble dates almost a decade back, when an oversupply of blood in global markets together with unfavourable exchange rates impacted significantly on the business of its Swiss arm **ZLB Bioplasma AG**.

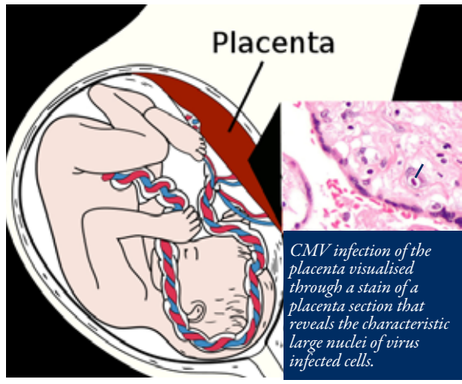
The company's response was expansion, and the strategy has paid off. Following the buy of the German company **Aventis Behring** its market value rose sharply, from a share price of around $5 per share in 2002 to relatively steady $30-40 per share since 2007.

...continuing the ride

CSL outclasses the pack in Australia also in terms of R&D investment, and enjoys the continued support by the Commonwealth, as reflected by a $30 million Government boost of the company's medical R&D capacity in 2010.

In December, the company held an R&D briefing in which it announced a significant increase in R&D investment by $25 million to about $350 million in the coming year. Research and development director ***Dr Andrew Cuthbertson*** said that the global financial uncertainty had not adversely affected investment in R&D, and while watching the developments carefully, the company would intend to grow R&D spending by 7-8% over the next few years.

image: micrograph insert adapted from wikipedia, creative commons



CMV infection of the placenta visualised through a stain of a placenta section that reveals the characteristic large nuclei of virus infected cells.

The company also announced a new partnership with the **US National Institutes of Health** (NIH), to study a potentially new treatment for the prevention of congenital Cytomegalovirus (CMV) infection. The virus, ubiquitous in infants and children, is the most common cause of abnormalities present in newborn babies, and can lead to deafness, blindness, cerebral palsy, mental and physical disabilities, seizures, and even death. The condition is triggered by the mother getting infected for the first time during pregnancy and then passing the virus on to the unborn child.

While to date there is no proven therapeutic prevention for congenital CMV, virus specific antibodies may prevent the

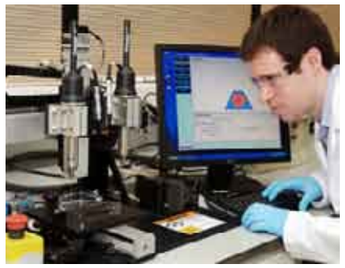
transmission of CMV to the child during pregnancy. The NIH study will test this in a multi-site clinical trial with more than 150,000 women. A primary analysis of the trial is expected in 2016.

According to CSL, its Cytogam® product is currently the only registered CMV immunoglobulin in the US, which its subsidiary ZLB Behring acquired in 2006 from **MedImmune, Inc**. for $120 million in cash. In its main application it is intravenously administered to patients having an organ transplant, who may then potentially become susceptible to CMV infections as drugs suppress their immune system.

▶ **More information: www.csl.com.au; *Research Australia: Shaping Up: Trends and Statistics in Funding Health and Medical Research**

♫ A tissue, a tissue... ♫

A collaboration between US startup **Organovo** and Melbourne's **Invetech** has won the *2011 Engineering Excellence Award for Research & Development/Innovation*. The prize, awarded by Victorian division of **Engineers Australia**, recognises the development of the world's first commercial 3D bio-printer, a flexible technology platform for organisations working on tissue construction and organ replacement.



An Organovo engineer printing blood vessel structures on the 3D bioprinter.
image: Jack Smith

The innovation is based on the US firm's developments, which the Australian partner helped engineer into a commercially viable instrument.

The printer consists of robotically controlled precision heads, one for placing human cells, the other for placing a hydrogel, scaffold, or support matrix. The 3D bio-printer also includes an intuitive software interface for the modelling of a tissue construct. which then is assembled cell-by-cell with the printer. Using the device surgeons could, for example, get access to tissue on demand for various uses.

▶ **More information: www.invetech.com.au**

Little helpers just got bigger

In one of his last actions as Minister for Innovation, ***Senator Kim Carr*** announced in December a significant boost of the **Commercialisation Australia** program. Early Commercialisation Grants are the core product of the scheme, offering matching grants between $50,000 and $2 million to help companies through the early stages of the commercialisation process.

Effective from 7 December 2011, enterpreneurs do not have to repay the Early Stage Commercialisation grants anymore, which they previously were required to pay back as a percentage of sales income generated as a result of the funded project. In addition, while previously companies had to have an annual turnover of less than $20 million to be eligible for the scheme, the limit is now lifted to $50 million. In addition to these major changes, eligible businesses will now be able to apply for an Experienced Executives grant of up to $350,000 – up from $200,000.

In the latest round of the **Commercialisation Australia** program, the Governement announced in November grants worth $3.7 million offered to 9 projects. It raises the number of innovations the program has supported since its launch 2 years ago to 154, with provided funding now totalling $61.6 million.

This round's grants include $2 million awarded to a project by **Whispir Ltd**, one of five ICT projects receiving funding. The **OpenWhispir** project is a cloud-based platform through which organisations can better engage with private and public communities to source information; execute plans and tasks; and build real-time situational awareness of an event as it unfolds.

The funding also reflects of the increasing relevance of cloud computing in Australia(as highlight in our story 'Lets hope it never rains...' in the ICT section).

Three of the 9 funded projects are developing clean technologies, another area of growth in Australia, as was pointed out in the recent *Australian Innovation System Report 2011*, and covered in our lead article in the June-August issue.

Still, back in May Senator Carr declared the biotech industry as the big winner in the program, having received almost 30% of the funding.

▶ **More information: http://minister.innovation.gov.au**

Clean prize

SMAC Technologies has won the **Australian Clean Technologies Ideas Competition** for its air-conditioning system that can reduce energy consumption and greenhouse gas emissions in commercial and industrial buildings by 30% to 85%, as demonstrated in over 40 installations.

The company will now represent Australia in the US at the **Cleantech Open Global Ideas Competition**

▶ **More information: www.cleantechopen.com.au**

NSW Budget

On the back of decreasing GST revenues, forecast to decline by $395 million, the NSW Government handed down its 2011-2012 Budget, which is set to produce an operating deficit of $718 million.

As a major post, the Government intends to spend $62.6 billion on infrastructure over the next four years, which includes $6.3 billion allocated to transport and roads, and around $4.7 billion on health capital works.

Other relevant posts include:

- $1 billion in the **Department of Primary Industries** (DPI) including:
  - –$390 million across the agriculture, fisheries and biosecurity sectors of DPI including funding for science and research, particularly food security;
  - –$190 million to protect valuable agricultural land and continue research and industry development programs;
  - –$120 million investment in biosecurity, which includes funding to control noxious weeds.
- $100 million in support of the State's mining industry, including an additional $5.5 million for the **New Frontiers** exploration initiative launched in 2006, which extends until June 2012. A further $28.6 million support research, development and demonstration of low emissions technologies, as part of the **Coal Innovation NSW Fund**. This includes the ongoing carbon capture and storage demonstration project on the Central Coast, which will build on the **Munmorah Power Station** pilot capture plant developed by **Delta Electricity** and the **CSIRO**.
- $34 million will support a **Clean Energy Supply program**, funding low emissions coal technology, renewable and green business initiatives.
- $221 million to trade and investment, including $130 million in funding to attract industry and develop business to be provided through the **State Investment Attraction Scheme** and the **Regional Industries Investment Fund**. This includes:
  - –$53 million allocated to the **Regional Industries Investment Fund**; $30 million for the **Illawarra Region Innovation and Investment Fund**; and
  - –$30 million for the **Science Leveraging Fund**, which supports the development of research nodes and increasing business innovation.

Munmorah Power Station, and below the Post combustion capture (PCC) pilot plant built by Delta Electricity and CSIRO.
image: air shot by Delta Electricity; image of pilot below by CSIRO

The Government has also announced it will develop **Industry Action Plans** which will outline a long-term vision for industry sectors including Manufacturing, Services, Digital Economy, Education and Research, and Tourism and Events.

Medical Research will receive a boost with an investment of $105.6 million, which includes:

- $32 million for the **Medical Research Support Program** supporting infrastructure and operating costs for 17 medical research institutes across NSW, supplementing the clinical grants they receive from the NHMRC and other sources.
- Over $60 million for capital grants to the **Westmead Millennium Institute**, **Australian Advanced Treatment Centre** at **Prince Of Wales Hospital**, **Neuroscience Research Australia**, and the **Children's Medical Research Institute** at **Westmead**.
- Almost $3 million for the **Spinal Cord Injury and Other Related Neurological Conditions Research Grants Program**.
- Almost $10 million for the **Translational Cancer Research Program**, with grants administered by the **Cancer Institute NSW**.

As previously announced, the NSW Government is in the process of developing a *10-year Health and Medical Research Strategic Plan*, and has established a new **Office for Medical Research** (transitioned from the former **Office for Science and Medical Research**, now **Office for Science and Research**) within the **NSW Department of Health**. The office is funded with $129 million over four years to support research, treatments and health related technologies.

▶ **More information: www.budget.nsw.gov.au/home**

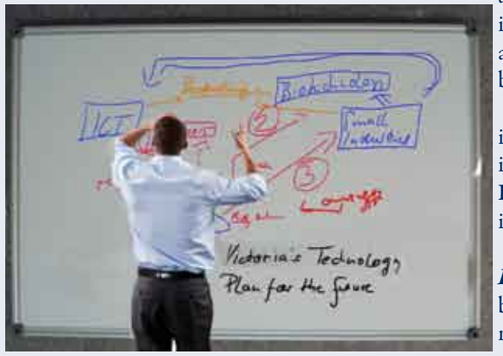
Mega dimensions

Dimension Data Australia, a specialist for ICT services and solutions, has opened a new global service centre at Macquarie Park in Sydney. The $107 million investment will provide 24-hour, seven day a week technical support for companies spanning a range of sectors, including financial services, telecommunications, healthcare, manufacturing, government and education.

▶ **More information: www.nsw.gov.au/news/global-ict-service-centre-officially-opened**

A plan (or three) is all you need

The **Victorian Government** has recently released a suite of technology platforms which together encompass the State's *Technology Plan for the Future*. The initiatives include an $85 million ICT plan, covered in the ICT section of this issue, a $55 million Biotechnology plan and a $10 million Small technologies plan.



By promoting the convergence of these technology areas, Victoria's Technology Plan aims to drive productivity growth across the state's existing industry base, as well as foster new businesses. The initiatives reflect the Government's market-driven approach, based on the assumption that "businesses are best-placed to determine their own requirements".

The biotechnology plan details two 'action' areas:

- Capability Development: initiatives in this area support a skilled workforce, capitalise on the state's R&D base, and pursue international trade and investment opportunities. This includes the development of an 'eResearch agenda'; support for systems biology, and clinical translational research. The Government will work towards maintaining science research infrastructure and capability including the **Australian Synchroton**, the $100 million **Victorian Life Sciences Computation Initiative** (VLSCI), and Victoria's biomedical imaging capability, and support the establishment of the Victorian **AgriBiosciences Centre** and**AgriBio – The Centre for AgriBioscience** (operational in 2012).
- Biotech-enabled innovation: initiatives in this area focus on supporting biotechnology capabilities, improving access to R&D infrastructure and expertise, and enhancing the State's competitiveness and productivity. This includes demand-driven product development, uptake programs, demonstration projects and regulatory reform. New initiatives include a **Health Market Validation Program** (see below), and a new **Industrial Biotechnology Uptake Program**. Further initiatives are designed to link industry to capability, for example through a new **Industrial Biotechnology Demonstration Project**, and improve competitiveness.

Artist impression of the $288 million ArgiBio – Centre for Biosciences in Bundoora, a joint project by the Department of Primary Industries and LaTrobe University, which is to be operational in 2012.
image source: biosciences research centre project

The plan's key component is a $15 million **Health Market Validation Program**, "a competitive grants program that will leverage the power of government-as-customer to support the development of innovative health technology solutions to identified problems facing Victoria's health sector". In addition the plan includes a **Technology Trade and International Partnering Program** (TRIP), which is an element of all three technology plans and will support companies in attending overseas conferences and events.

The delivery of the biotechnology plan will be measured against certain targets set to be achieved by 2015, including to increase both product development activity and the value of biotechnology-related exports by 25%.

The State Government pledges to continue its work in partnership with industry, supported by a series of initiatives, such as the establishment of a new **Victorian Biotechnology Advisory Council** composed of 10-15 industry stakeholders.

The Minister for Technology ***Gordon Rich-Phillips*** announced in December that the council will be chaired by ***Professor Ian Gust***, with a further 12 members appointed for two years.

There will also be a new **Office of the Lead Scientist** to assist the development of innovation and science policy, and a new **Industry Sustainability Working Committe** to support industry addressing issues such as climate change, sustainability and a move to a low carbon economy.

The third element of the Technology Plan for the Future is a $10 million initiative targeting the development and adoption of small technologies. The term defines a convergent technology comprising nanotechnology, biotechnology, ICT, microtechnology and advanced engineering technologies. In future, these technologies could impact on a very broad range of industry sectors by improving the functionality of products and the energy efficiency in manufacturing, and by reducing costs and enabling more efficient use of resources.

Similar to the biotechnology plan, the small technology plan is structured in two 'action' areas which, firstly, promote the growth and capabilities of small technology businesses (Capability Development) and, secondly, promote the integration of these technologies into commercial applications, products and processes (Small technologies enabled innovation).

Key initiatives include the TRIP (see above), and a **Small Technologies Industry Uptake Program** (STIUP), a voucher-based system through which businesses can gain access to facilities, goods, services, advice or expertise to explore, adopt and integrate small technologies.

▶ **More information: www.business.vic.gov.au**

Copper rush SA

BHP Billiton's mining adventure, the **Olympic Dam** expansion, took major steps towards the realisation of one of the world's largest mines, after having been approved by the **Australian**, the **Northern Territory** and the **South Australian Governments**. The development was reviewed in an extensive background article in our May-June edition, including the partial opening of the **Woomera Prohibited Area** (WPA) for mining activities, which may in future lead to another Olympic Dam like mine with similar economic but also environmetal characteristics.

Approximate location of proposed desalination plant and pump station at Port Bonython/Point Lowly
image: modified from Google Earth with data included as outlined in the Supplementary Environmental Impact Statement

Cuttlefish
image source: www.pir.sa.gov.au

While approved by the governments in October, the SA Government still required the finalisation of a revised Indenture Agreement detailing obligations and arrangements governing the initial 40-year life of the expanded mine. A respective legislation, the *Roxby Downs Indenture Bill*, was ratified at the end of November, now allowing BHP to begin initial works on the project.

The operation will see the construction of a new open pit mine with the potential to increase current production of the existing underground mine to approximately 750,000 tonnes a year of refined copper plus associated products – uranium oxide, gold, and silver. However, due to its scale and remoteness, the mine and the growing township Roxby Downs present major infrastructure issues, such as the supply of electricity and water. High-quality water is supplied from the Great Artesian Basin, one of the world's largest groundwater aquifers. In addition, a desalination plant will be built at Port Bonython/Point Lowly in SA's Spencer Gulf region, supplying water to the mine through a 320 kilometre pipeline.

Associate Professor Jochen Kaempf from **Flinders University** (SA) said in an intial reaction that the desalination plant could pollute near-bottom water within a 100-metre distance from the desalination discharge point, which is in proximity to the breeding habitat of cuttlefish. This would pose an increased chance of adult cuttlefish becoming exposed to highly concentrated toxic brine at some point in their lives, he said.

Other remaining environmental concerns relate to the mining of uranium, an unusual byproduct of copper mining, although the radioactivity of waste created is said be very low. However, ***Dr Gavin Mudd***, a senior lecturer at Monash University, expressed his concern in a statement to the **Australian Science Media Centre** that BHP will not be requied to bury the residual waste due to the high cost involved.

▶ **More information: www.bhpbilliton.com**

Grainy days in WA

Western Australian Minister for Agriculture and Food ***Terry Redman*** has opened the first of two facilities established under its $9 million **New Genes for New Environments** project. As outlined in a document by the **Department of Agriculture and Food**, the project will enable the evaluation of the candidate GM traits from both public and private research organisations under contrasting stresses, with the now established facility at Merredin providing low rainfall and high temperature conditions, while a second facility, to be opened at Katanning in 2012, will have conditions with frost and winter waterlogging.

Complementing these two facilities is the **Managed Environment Facility** (MEF), which also opened at the Department's Merredin station in October, but which will focus its research on non-GM crops.

As the DPI document outlines, currently there are only two GM crops approved for grain and fibre production in Australia, an insect and herbicide resistant cotton variety and a herbicide resistant canola variety. However, there is considerable industry interest in developing grains with traits such as drought and salinity tolerance, disease resistance and fertiliser use efficiency.

The state, together with NSW, is already home of a trial by the **CSIRO Food Futures National Research Flagship**, testing genetically modified wheat and barley varieties. And according to Mr Redman, the new facilities have had inquiries from both public and private organisations interested in developing more productive and reliable varieties with better grain quality.

▶ **More information: www.mediastatements.wa.gov.au**

To GM or not to GM...

Western Australia is the nation's largest exporter of grains, valued on average at $3 billion. In 2010, the state became the third in the country to allow farmers to grow genetically modified (GM) canola. However, the debate is continuing as to whether GM crops will boost or threaten WA's grain export performance. A frequently publicised argument by groups opposing GM crop trials and commercial use is that non-GM crops could become contaminated with GM-modified crops and threaten export into markets such as Europe and Japan.

However, at present there are only two States left that hold up a ban of commercial GM crop production – South Australia and Tasmania. But there is considerable pressure for change, as recently highlighted in a number of media reports, according to which **Business SA** chief executive ***Peter Vaughan*** has called for a lift of the ban which he said is holding back the food industry.

This won't happen, though, at least until a review in 2014, according to State Government sources.

Playing it save

The nation's biosecurity is a focus of two initiatives in Queensland and Western Australia.

All in one

In Queensland, a new Biosecurity Bill 2011 is being considered in the State Parliament. According to the State's Minister for Agriculture, Food and Regional Economies, ***Tim Mulherin***, the proposed legislation provides a cohesive, flexible tool to respond to both current and future biosecurity challenges.

The reform brings together the fragmented set of Acts and subordinate legislation that to date regulate the State's biosecurity. Mr Mulherin said in a statement that the bill offered a more proactive approach as people would be required to actively identify and mitigate risks associated with pests, diseases and contaminants.

"It will support local area or industry-level risk management, decision-making and prioritising of biosecurity activities", he said. The bill also proposes stronger penalties for biosecurity-related offences.

▶ **More information: www.cabinet.qld.gov.au**

Stop the boats

In Western Australia, the **State Government** launched its $9.4 million two-year program, as announced in its 2011 Budget, alongside of a Biosecurity Charter. The initiative aims to protect Western Australian aquatic environments from marine pests, which are a globally significant problem. Fisheries Minister ***Norman Moore*** said at the launch that marine pests alone directly cost the global economy more than $1.5 trillion every year.

Invasion of the Northern Pacific sea star, a major aquatic pest
image: CSIRO

Biofouling at the hull of ocean-going vessels is a major entry point for aquatic pests, and will be addressed by the WA **Department of Fisheries** (DF) using cutting edge detection tools and systems, pioneering research and expert personnel. This includes an online risk assessment system to identify vessels at high risk of carrying aquatic pests before entering WA ports.

DF is also developing a database for the detection of alien aquatic pests in freshwater river systems, lakes and dams.

▶ **More information: www.mediastatements.wa.gov.au/Pages/WACabinetMinistersSearch.aspx?ItemId=145662&minister=Moore&admin=Barnett**

QLD grid buster

TRUenergy has announced its intention to build two new gas fired power stations in Queensland, powered with gas from the State's south west gas fields. Together the investments could amount to $3.6 billion.

The company has commenced the development application process for the two stations, which could be developed in stages from as early as 2013, with the initial units sized at around 500MW and a total capacity of up to 1500MW.

TRUenergy's managing director ***Richard McIndoe*** said in a company statement that Queensland is the right state for these developments given that the **Australian Electricity Market Operator** has forecast a shortfall in energy reserves of between 341 megawatt and 779 megawatt by 2013-2014.

▶ **More information: www.truenergy.com.au**

Secure help

The Government's new Energy Security Council will be chaired by **Dr Michael Vertigan**, who is currently director of Aurora Energy Pty Ltd and chair of the Solar Flagships Council. The Energy Security Council, which was established together with the Energy Security Fund as part of the Government's Clean Energy Future plan, is to advise on support measures to address energy security risks. The Council will assess applications for financial assistance from energy market participants to support the implementation of the Clean Energy Future initiative, but also undertake more general functions including contingency planning, assisting with crisis management by providing a forum for co-ordinated action, and considering trends in energy markets which are likely to lead to systemic risks to energy security. The Council will be guided by a Charter of the Council, which the Government announced in September.

Michael Vertigan

Right chemistry

David Black, professor for organic chemistry at the University of New South Wales and the current Secretary General of the International Union of Pure and Applied Chemistry (IUPAC) has been elected Secretary General of the International Council for Science (ICSU) for the next three years. The ICSU is a non-government organisation with a global membership of national scientific bodies, such as academies of science, and International Scientific Unions. It aims to strengthen science globally for the benefit of all humankind and plans and coordinates interdisciplinary research to address major issues of relevance to both science and society.

David Black

Lobbying appointment

Deborah Rathjen

Ausbiotech, Australia's biotechnology industry organisation, has re-appointed Bionomics chief executive **Dr Deborah Rathjen** as chair. Not-for-profit Ausbiotech, which is led by chief executive officer **Dr Anna Lavelle**, represents over 3,000 members and promotes the commercialisation of Australian bioscience in national and international marketplaces.

New fish on the block

The Australian Institute of Marine Science (AIMS) has appointed **John Gunn** as new chief executive officer. He took up the position in November 2011, replacing **Dr Ian Poiner**, who has led the organization for the past seven years. Mr Gunn, a marine scientist with special expertise in fisheries, has previously served as a member of the Oceans Policy Science Advisory Group and other boards and committees.

John Gunn

Healthy leadership

In January, renowned medical researcher **Professor John Mattick** commenced as executive director of the Garvan Institute of Medical Research, one of Australia's largest medical research organisations focussing on cancer, diabetes and obesity, immunology and inflammation and neuroscience. He succeeds **Professor John Shine**, who retired after more than a decade at the helm of the 1963 founded institute. Professor Mattick is a pioneer in the analysis of the human genome sequence and the critical role of specific DNA sequences in the regulation of gene expression during human development and susceptibility to complex diseases such as cancer and diabetes.

John Mattik

Rural deputy

The University of Southern Queensland (USQ) has appointed **Professor Jan Thomas** as USQ's vice-chancellor and president. The current deputy vice-chancellor at the University of Notre Dame succeeds **Professor Bill Lovegrove**, who retired in December after eight years in the position. Professor Thomas had a long and distinguished academic career, with broad organisational responsibilities including in a prior position as deputy vice-chancellor (academic) at Murdoch University. Most recently she was a member of a Goverment expert advisory group focussing on the development of higher education performance indicators. Professor Thomas has also an international reputation in veterinary and biomedical sciences.

Jan Thomas

Auditory hero

One of Australia's foremost scientists, **Professor Graeme Clark**, who pioneered the cochlear implant or bionic ear, will join NICTA as a distinguished researcher. Professor Clark's will lead the development of technologies for new types of hearing implants. The project will involve the study of the auditory neuroanatomy of the first bionic ear patient, who passed away in 2007 and donated his body to science. In November, Professor Clark received the prestigious CSL Florey Medal, which is presented every two years by the Australian Institute of Policy and Science (AIPS).

Graeme Clark

Physical elevation

Australian Academy of Science Fellow **Professor Bruce McKellar** has been elected as the next president of the International Union of Pure and Applied Physics (IUPAP). He will take up his position in 2014, to become the first Australian to lead the organisation. IUPAP was formed in 1922 to represent physics internationally. Australia became a member in 1925. The Union's mission is to assist in the worldwide development of physics, to foster international cooperation in physics, and to help in the application of physics toward solving problems of concern to humanity. Professor McKellar is a theoretical physicist working on elementary particle physics, with a special interest in neutrino physics and the violation of matter-antimatter symmetries. His many awards include the 2007 Massey Medal of the Institute of Physics (UK) and the Australian Institute of Physics, and the 2009 Flinders Medal of the Australian Academy of Science.

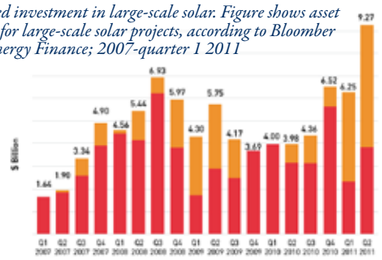
Bruce McKellar

Broadly connected operator

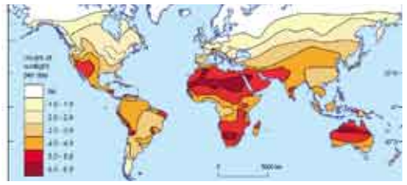
NBN Co has appointed its first chief operating officer. **Ralph Steffen**, a senior telecommunications executive, will have overall responsibility for construction of the NBN as well as deployment planning, network operations and IT. Previously, Mr Steffens was managing director of Service Delivery at BT Group plc, a global telecommunications company headquartered in London. **Dr Stephen Hanly** has been appointed as the inaugural CSIRO-Macquarie University chair in wireless communications. Dr Hanly, who is currently associate professor at the National University of Singapore commented on his appointment that his role would be to strengthen the highly successful collaborations between the CSIRO ICT Centre and the Electronic Engineering Department at Macquarie University in the area of wireless communications.

Stephen Hanly

Increased investment in large-scale solar. Figure shows asset finance for large-scale solar projects, according to Bloomber New Energy Finance; 2007-quarter 1 2011



Hours of sunlight per day across the globe, according to Geoscience Australia, Australian Energy Resource Assessment.
image: Clean Energy Council, Large-Scale Solar Policy Roadmap



Road to the sun

The **Clean Energy Council** has released a policy roadmap for the development of large-scale solar projects in Australia, describing the sector as still in its infancy, despite having some of the world's best solar resources, and in relative proximity to energy intensive industries. There is also great potential to integrate coal and gas power plants with large-scale solar projects, such as the **Kogan Creek Solar Boost** project in Queensland (see below). And Australia has substantial research expertise with a highly skilled workforce. Yet, currently there are few large-scale projects constructed in Australia, including:

- Stage 1 of **Solar Heat&Power**'s 1 MW demonstration plant at the **Liddel Power Station** in NSW;
- Two 'Big Dishes" constructed in a joint project with **Wizard Power** at the **Australian National University;**
- The 0.5 MW Wizard Power demonstration plant north of Whyalla, SA, a $14.5 million project which includes 4 Big Dish units in a pre-commercial demonstration of energy storage, that will be capable of handling intermittent solar input for the delivery of energy on demand;

Other projects on the way include:

- The **Uterne Solar Park** in Alice Springs by **SunPower Corporation**, a 1 MW solar power station, which is built as part of the Government's Solar Cities program and, once commissioned, will be the largest tracking solar plant in Australia.
- The 1.22 MW St Lucia campus solar project at the **University of Queensland**, developed by **Ingenero,** will be the largest flat panel photovoltaic array in Australia.
- The $104.7 million **Kogan Creek Solar Boost** project by **CS Energy** will involve installing a 44 MW solar thermal addition to the Kogan Creek Power station to become the largest solar integration with a coal-fired power station in the world.

The major barrier for the development of large-scale solar projects remains the cost of such developments, which includes both the upfront capital hurdle as well as the long-term revenue stream required to finance deployment. However, on-the ground expertise could significantly drive down project costs in the future by up to 50% according to estimates by the **US Department of Energy**, and a number of policy measures have been developed internationally to help get solar projects off the ground. This includes loan guarantees, grant programs, feed-in tariffs and tax incentives. In the US the capacity of large-scale solar projects is estimated to increase from 419 MW in 2007 to over 16 GW in 2020, driven by financial support from state and federal governments. The *American Recovery and Reinvestment Act 2009* provides $80 billion for clean energy research, development and deployment, including a $6 billion expansion of an **Innovative Technologies Loan Guarantee Program**. In Germany and Spain, growth of renewables including large-scale solar projects are driven by generous feed-in tariffs (FiT) alongside other subsidies, such as in Germany a low interest loan for renewable energy projects, clear policy objectives with targets set over several years, and regular reviews of the levels of support required.

In India, a $19 billion **Indian Solar Mission** was announced in 2009 targeting increased grid connected photovoltaic solar power from currently 1-2 GW to 20 GW by 2022, including through a renewable energy purchase obligation for certain utilities.

In Australia, grant programs have been the major mechanism of support, including the $1.5 billion **Solar Flagships** program, which according to the CEC plays a crucial role in developing the sector. Recently, two projects were offered funding under Round One of the progam:

- A 150 MW photovoltaic system proposed near Moree in NSW by the **Moree Solar Farm** joint venture, which is led by **BP Solar** and involves **Pacific Hydro** and **Fotowatio Renewable Ventures**. The project was offered $350 million in funding.
- A 250 MW solar thermal gas hybrid power plant near Chinchilla in Queensland, which was proposed by the **Solar Dawn** consortium led by **Areva Solar** and involving **CS Energy** and **Wind Prospect CWP**.

However, the CEC says that in addition to developing a longer term vision for large-scale solar projects, the Government should provide funds to support a pipeline of solar projects across the various types of solar technologies and targeting various size ranges. An ongoing rollout of solar projects would benefit the industry, improve the understanding of investors and allow transparent assessments of cost reductions with each type of technology and scale.

In order to support a revenue stream, the CEC recommends considering FiT mechanisms for large-scale project, which are so far largely restricted to small-scale operations in Australia.

According to the roadmap, uncertainties in the current policy framework are a major barrier for solar investments, although a carbon price and the **Renewable Energy Target** (RET) together with the establishment of the **Australian Renewable Energy Agency** (ARENA) and the **Clean Energy Finance Corporation** (CEFC) will provide a more stable investment environment.

▶ **More information: http://minister.ret.gov.au/MediaCentre/Speeches/Pages/LaunchSolarPolicyRoadmap.aspx**

Carbonic state

A new Victorian based **Centre for Geological Carbon Storage** will be established by a collaboration between the **Cooperative Research Centre for Greenhouse Gas Technologies** (CO2CRC), the **Victorian Government** and the **University of Melbourne**. The centre will focus on R&D but also on high level education in CCS-related disciplines, with the objective of building capacity in CCS skills in Australia.

Victoria is currently home to the country's only operational geological carbon storage project, the Otway Project run by the CO2CRC. The State is also one of the more prospective areas in Australia for CCS because of its high CO_2 emissions from brown coal and its suitable storage geology in Bass Strait, a statement by the CO2CRC said.

▶ **More information: www.co2crc.com.au/dls/media/11/CentreforGeologicalCarbonStorage.pdf**

Crude insecurity

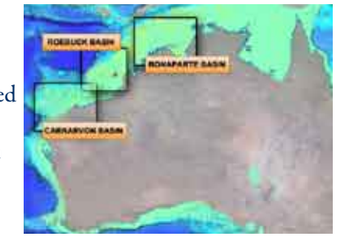
While Australia is one of only three net energy-exporting nations within the OECD, and our exports of liquefied natural gas (LNG) are set for growth, the nation needs to address a rising trade deficit in petroleum products.

However, most of Australia's petroleum resources are located offshore, and new exploration for petroleum are met with considerable safety concerns, heightened by the **Deepwater Horizon** desaster, the largest offshore oil spill in US history, and the 2009 incident at **PTTEP Australasia**'s Montara Wellhead Platform 250 kilometres off the Western Australian coast.

The **Australian Government** has reacted to this with a proposed **National Offshore Petroleum Safety and Environmental Management Authority** (NOPSEMA) which is to strengthen the regulation of offshore activities from1 January 2012. Related legislation, the *Offshore Petroleum and Greenhouse Gas Storage Amendment (National Regulator) Bill 2011,* passed the Senate in September. But while federal Minister for Resources and Energy ***Martin Ferguson*** thanked the **Western Australian Government** for their constructive input, the State Government remains sceptical that the new regulator is "ready for business".

Montara Montara Wellhead Platform incident in 2009
images: NOPSEMA

Still, the Australian Government continues to pursue a two way strategy, strengthening regulatory control by the Commonwealth of offshore activities while investing strongly in new exploration. In November, Mr Ferguson announced nine new offshore petroleum exploration permits worth $310 million, which were awarded in the second round of the **2010 Offshore Petroleum Exploration Acreage Release**. Emphasising that Australia needs to strengthen its energy security, Mr Ferguson said that costs for net imports of crude oil, refined products and LPG could increase from $16 billion currently to up to $30 billion by 2015 [Australia is, however, a net exporter of LPG].



Crude oil production has significantly declined since 2000, as the offshore fields in the Victorian Gippsland Basin lost their dominant production role and were only partially replaced by numerous smaller fields, most of which are located in offshore Western Australia. The WA Carnarvon Basin now accounts for 72% of Australia's production of crude oil, condensate and LPG, while the share from the Gippsland Basin reduced to 24%.

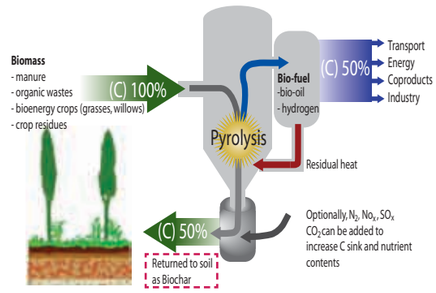
The new offshore permits, which include frontier areas, are also mostly located within the Carnarvon Basin(5), with the remaining being in the adjacent Roebuck (3) and Bonaparte (1) Basins. They were awarded to **Woodside**, **Shell**, **Mitsui E&P**, **Cottesloe Oil and Gas**, **Strike Energy**, **WHL Energy and Santos**.

▶ **More information: http://minister.ret.gov.au**

Biochar still in the game

It was once proposed by then opposition leader ***Malcolm Turnbull*** as a key component of effective policy to reduce carbon emissions in Australia: Biochar, a char made by burning organic materials, such as wood or crop waste in a low oxygen environment. Added to soil it could sequester carbon and improve soil health.

In March 2009, we dedicated our lead story to biochar technology, also summarising a major report by the **CSIRO** (Biochar, climate change and soil: A review to guide future research) which indicated that the technology had a fair way to go before its potential could be realised. Thus, the CSIRO report pointed out that estimates suggesting biochar could globally sequester around 1 billion tonnes of carbon per year within 30 years were based on studies which in many cases were conceptually or geographically limited, and often constrained by limited experimental data.



While biochar is not in the public's eye as much today, its potential is still very much alive. A **Biochar Capacity Building Program (BCBP)** is a key component of the Government's $45.6 million Carbon Farming Initiative.

In November, the **Australian Government** announced $2 million in competitive research grants provided through the BCBP to further explore the technology, and to support the development of biochar offset methodologies to be used by land managers participating in the CFI.

▶ More information: www.maff.gov.au/media_office/media_releases/media_releases/2011/november/biochar

When its bursting at the seams

While promising vast riches for state and federal economies, the mining of coal seam gas (CSG) has vocal critics, and Australian governments scramble for the right strategy to deal with it.

In NSW a parliamentary inquiry into coal seam gas is in its final stages, as written submissions ended in September and a final public hearing took place in Sydney in December. The concerns voiced are not just angry farmers or environmental activists, but also experts such as ***Dr Stuart Khan***, a senior lecturer from the **University of New South Wales**. According to a statement by the university, he told the inquiry that national risk assessment guidelines should be set on the impact of drilling on aquifers, as poorly planned exploration and extraction activities can pose considerable risks to both groundwater and surface water systems. He further said that regulators and policy makers in NSW are faced "with a severe lack of guidance, support, knowledge and experience for assessing and overseeing the safe management of CSG activities in this state."

Sound advice could help

At a federal level, the **Australian Government** has outlined a new science-based framework for the approval of CSG projects, acknowledging that to date the quality of independent advice on how CSG projects would impact on underground water has been limited by the scope of the *Environment Protection and Biodiversity Conservation Act 1999*. Under the new rules, announced in November, a new independent advisory committee will consider the impact on underground water more generally, and it will be mandatory to disclose the information to the public.

The new **Independent Expert Scientific Committee** will be funded with $150 million and advise and oversee research on water issues related to coal seam gas and large coal mining projects. The committee will also commission and fund water resource assessments for priority regions.

A new **National Partnership Agreement** between Commonwealth and states reached through COAG will require that CSG project assessments and approvals take into account the committee's advice. Incentive payments of up to $50 million will be available to the states to deliver this outcome.

The framework will apply to future licenses and the states will remain the prime regulators.

▶ More information: www.pm.gov.au

Wild protection

On a state level, the **Queensland Government** also moved towards greater recognition of environmental assets by protecting Queensland's part of the Lake Eyre Basin from large dams and unsustainable industrial development.

The Lake Eyre Basin is Australia's largest river system, extending over 1.2 million square kilometre, of which 500,000 square kilometres are in Queensland, where it is divided into the Georgina/Diamantina Catchment and the Cooper Creek Catchment. According to Queensland's Environment Minister ***Vicky Darling***, the river system does not have major weirs or dams in Queensland but contains globally unique and largely intact ecosystems with extensive floodplains and wetland habitats.

Lake Eyre Basin
image: Wikipedia, creative common license

The State Government announced in December that it intends to declare all three catchments as 'Wild Rivers', which will impose buffer zones from watercourses for development within the most sensitive and valuable areas. The protection will include:

- preventing open cut mines, large dams, irrigation and gas and petroleum production in areas known as High Preservation Areas (3.6% of the Queensland Lake Eyre Basin);
- preventing open cut mines, large dams and irrigation in areas known as Special Floodplain Management Areas (6.8% of the Queensland Lake Eyre Basin);
- requiring gas and petroleum production and exploration to be 200 metres away from watercourses in the Special Floodplain Management Area; and
- strict conditions on limited gas and petroleum activities in the Special Floodplain Management Area.

The announcement drew praise from environmental groups and criticism from industry lobby groups, including from groups representing primary producers. The **AgForce** representing Queensland's rural producers said that Wild Rivers declarations place an unnecessary layer of regulation over primary producers and fail to recognise the good land management practices of both traditional owners and rural landholders.

▶ More information: www.cabinet.qld.gov.au

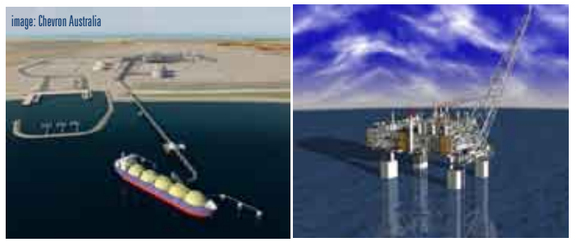
Fluid investment

The $29 billion **Wheatstone** LNG project by the Australian subsidiaries of **Chevron** (operator) and venture partners **Apache**, **Kuwait Foreign Petroleum Exploration Company** and **Shell** has officially commenced after a Final Investment Decision was announced in September. The decision to go ahead with Western Australia's fourth largest LNG project came after a **State Development Agreement** was reached in early September, and earlier environmental approvals at the state and federal level.

The project will initially consist of two LNG processing trains, which together will produce up to 8.9 million tonnes per annum (mtpa) of LNG from 2016, with the option of expansion to 25 mtpa.

A unique feature of the project is that the foundation infrastructure will act as a hub that will also process third party gas located offshore in Western Australia.

image: Chevron Australia



Chevron is also involved in two other LNG projects in WA. These include the established $27 billion **North-West Shelf** project, which produces 17 mtpa LNG, or 9% of the world's LNG, and the **Gorgon Project**, the world's largest natural gas project and the largest single resource natural gas project in Australia's history. The fourth committed LNG project is the Pluto LNG project led by **Woodside**.

Together the four projects will increase WA's LNG capacity to 45 mtpa, or 25% of current world production levels.

▶ More information: www.chevronaustralia.com

Energetic Japanese

In December, the venture partners in the **Ichthys LNG Project**, Japan's **INPEX** (operator) and French firm **Total**, reached a major LNG deal with five Japanese power companies. According to INPEX, the deal means that the total volume of 8.4 mtpa LNG expected from the project is now sold, with 70% to be delivered to Japan.

The deal is the strongest indication yet that a final investment decision on the project is likely in the near future, Resources and Energy Minister ***Martin Ferguson*** commented on the *Sales and Purchase Agreement*, under which LNG will be supplied for 15 years commencing from 2017.

The project goes back a decade when a substantial gas and condensate field was discovered in the Browse Basin, off the north-west coast of Western Australia and some 800 kilometres from Darwin. The most recent estimates point to a resource of 12.8 trillion cubic feet of gas and 527 million barrels of condensate, to be produced over an operational life of more than 40 years.

The gas will be transported to a proposed processing plant in Darwin, from where the LNG is then exported to overseas destinations.

According to Mr Ferguson, the project could generate $70 billion in export revenue, further strengthening Australia's position as an exporter of LNG.

In 2010-11, Australia exported 20 mtpa, at an export value of $10.5 billion. And there is $140 billion worth of LNG projects under construction, which combined with the Ichthys project could quadruple Australia's existing export capacity.

If going ahead, the Ichthys project will be Japan's biggest single financial investment in Australia, and will also be the first Japanese-operated LNG project. In addition to the 8.4 mtpa LNG, it will also have capacity for about 1.6 mtpa LPG, and 100,000 barrels of condensate a day.

▶ More information: www.inpex.com.au

Freshening up

In 2009, the **Australian Government** announced a **National Centre of Excellence in Desalination Australia** (NCEDA), which it tasked to manage national funding for desalination projects totalling $20 million over five years. The **Western Australian Government** provided a further $3 million towards the establishment of the centre. It was launched at **Murdoch University** in early 2010 with the support of a consortium of 13 universities and the CSIRO.

NCEDA was set up as an integral component of the national Water for the Future initiative and was then complemented by the $20 million **Australian Centre of Excellence in Water Recycling** in Brisbane. The centre has since developed an Australian Desalination Research Roadmap, which details Australia's water needs and gaps in desalination technology, and also provides a guide for the centre's investments. The supported research includes the use of nanotechnology, solar power, developing solutions to increase the recycling of desal membranes, and monitoring of marine life.

So far 22 research projects have received funding, and in September an additional $3.8 million was offered to 11 projects. This announcement coincided with NCEDA's launch of the nation's first dedicated **Desal Research Facility**, which will enable scientists to work together with industry in developing desalination technologies from bench to pilot scale. In addition, a Desal Discovery Centre was opened to engage the broader community in NCEDA's activities.

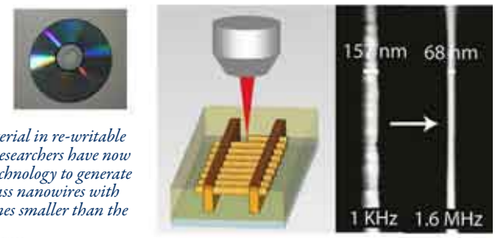
▶ More information: http://desalination.edu.au

Enlightened chips

Australia has a strong position in photonics research, and one potential application in hot pursuit is the development of a photonic chip, which promises vast improvements in information processing. The photonic chip could also address a major bottleneck in the global information flow through the internet as electronic routers are still required to connect optical fibre cables, slowing down the data transfer considerably and accounting for significant energy costs.

Since its establishment in 2003 under the **ARC Centres of Excellence** program, the **Centre for Ultra-high bandwidth Devices for Optical Systems** (CUDOS) has been at the forefront in the development of photonic chips with functionality similar to electronic transistors.

In March 2011, the partnership of seven universities relaunched CUDOS at its **University of Sydney** headquarters, after the ARC extended the project with $23.8 million to 2017. The funding is a recognition of the significant progress the centre has made during its first phase, reaching a significant milestone in 2009, when CUDOS and European partners demonstrated a photonic chip able to switch data at speeds close to a terrabit per second.



Chalcogenide glass, which contains one or more chalcogenide elements, has been widely used, such as amorphous material in re-writable CDs. Swinburne researchers have now used direct laser technology to generate in chalcogenide glass nanowires with a resolution 12 times smaller than the wavelength.
images: top – Wikipedia; right – CUDOS

However, producing the chip relies on the fabrication of extremely small materials, still a major challenge. The centre has now taken a significant step towards achieving this goal. As described in a recent paper in *Nano Letters**, CUDOS's researchers at **Swinburne University** were for the first time able to engineer nanowires using chalcogenide glass, a material that is widely used in electronics and the imaging industry.

It is also highly interesting for photonics research because of the unique properties of chalcogenide glass that makes it extremely attractive for optical signal processing. Thus, it shows a strong optical 'non-linearity', which means that its optical density changes according to the applied light intensity.

As lead author and PhD candidate at **Swinburne University**, ***Elisa Nicoletti*** put it, "If you pump high density light into an optic fibre made of non-linear material, you can actually change its properties, and therefore change the way other light moves along it". And by contrast to the nonlinear optical properties of silicon, which are quite slow in responding, chalcegonide's response time is ultrafast, a key property for ultrafast frequency conversion and optical switching.

This important quality the researchers have now been able to retain in a wire less than10 millionth of a metre thick.

▶ More information: www.swinburne.edu.au; Nicoletti et al (2011) Nano Letters, 11, 4218-4221

Phase recognition

Fibre-optic communication systems have revolutionised our telecommunication systems, but the interface between the light based transmission of a signal through an optical fibre and the electronic-based receiving end, such as computers, presents significant challenges. Until some years ago receivers of information sent through optical signals were only reading the intensity of a signal. But in order to meet ever-increasing bandwidth demands, so called coherent optical communication systems have experienced a renaissance, as they allow the capture of information encoded in the phase of light, thus potentially providing much higher spectral efficiencies.

However, the complexity of the receivers that are required in coherent systems presents a problem. According to ***A/Professor David Moss*** from the **University of Sydney**, who is also a senior researcher with CUDOS, the ability to monitor and characterise these signals has, until now, been restricted to optical laboratories. The 2011 Eureka Prize finalist in the category *Innovations in Computer Science* led an international team which has developed a device that could meet the need for energy efficient and ultrafast measurement of both light intensity and phase profiles.

Published in *Nature Photonics**, the researchers based their new chip on a technology known as SPIDER (Spectral Phase Interferometry for Direct Electric-Field Reconstruction). They demonstrate that this optical oscilloscope is capable of phase and amplitude measurement of terahertz-bandwidth optical pulse, which the authors say is a key milestone in achieving full characterisation of ultrafast optical waveforms on a chip.

Applications such as telecommunications, high-precision broadband sensing and spectroscopy, metrology, molecular fingerprinting, optical clocks, and even attosecond physics, are all set for a major speed upgrade, A/Professor Moss said in a university statement. The device should also be achievable in silicon, it was even fabricated using the same methods as silicon chips, and thus could be ideal for a wide range of applications.

According to A/Professor Moss, with the 'SPIDER chip all parts of the internet, including silicon routing chips, will have the capacity to measure the information encoding phase of light.

▶ More information: http://sydney.edu.au/news; Pasquazi et al (2011) Nature Photonics; 5: 618-623

Off the brakes

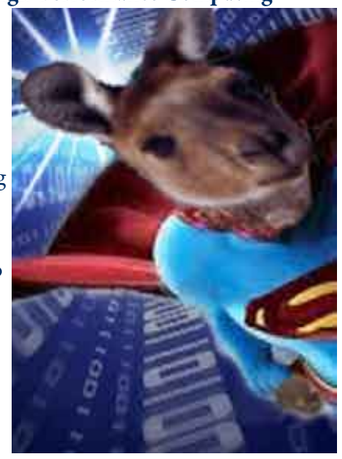
The **University of Wollongong** (UOW) has announced a new program called **iAccelerate**, which it says could potentially attract $70 million in investment in the Illawarra region and become an 'essential cog' in the region's innovation ecosystem.

Its objectives are intricately linked to the **National Broadband Network** (NBN), providing a 3500m^2 purpose built high tech building connected to the projct, with a key objective being to 'marry' IT graduates out of UOW with the NBN rollout. A further aim sated on its website is to double the number of successful start-ups in the region.

▶ More information: http://media.uow.edu.au/releases/UOW112227.html

Nothing less than super suits

In our last edition, we had broadly summarised recent efforts in lifting Australia's supercomputing capacity, such as investments in a **GPU Supercomputer for Theoretical Astrophysics Research** at **Swinburne University**, and also progress in establishing the **Pawsey High-Performance Computing Centre for SKA Science** with the launch of the **iVEC@Murdoch** supercomputer.



In September, Australia's supercomputing capabilities were further boosted with the **iVEC@UWA** supercomputer, also called Fornax, purchased by the **University of Western Australia**. The system will consist of over 1000 CPU cores, 96 GPUs, half a petabyte of general disk storage and more than another half petabyte of fast storage closer to the CPUs.

iVEC is a joint venture by the CSIRO and four universities, tasked with establishing and managing the $80 million **Pawsey Centre**, which is funded through the **Super Science Initiative** and State Government contributions.

▶ More information: www.news.uwa.edu.au

High tech spinning wheel

Image: Deakin University

A new **Deakin University** high-tech infrastructure is designed to spin users at "gut wrenching G-forces while only seven metres off the ground", according to ***Professor Saeid Nahavandi***, the director of the university's **Centre for Intelligent Systems Research** (CISR).

The 'next-generation' **Universal Motion Simulator** (UMS) will not only be used to give pilots the full experience of flying a military jet, but also provide a platform for simulating land based vehicles including tanks and other armoured vehicles, trucks, race cars and motorbikes.

Equipped with a robotic arm that can move at high speed, exerting forces of up to 6 G in any direction, the UMS also integrates so called haptics technology, which provides a sense of touch and feel to virtual or remote objects. Controlling the device through a joystick or steering wheel, users also experience a high resolution 3D display of a training environment. And while pilot's undergo the training, their physical and mental responses can be monitored through electroencephalogram and electrocardiogram.

▶ More information: www.deakin.edu.au/news

Let's hope it never rains...

In October, former Innovation Minister ***Senator Kim Carr*** launched in October a report prepared by **Lateral Economics** for **Macquarie Telecom** (MacTel) on the challenges and opportunities cloud computing presents for Australia.

Many may not know that they do, but already 71% of firms use some form of cloud services, a 31% increase in the space of two years, underscoring the opportunities that the technology hold for firms and private consumers alike. This includes services such as **Gmail**, **Dropbox** and **Apple**'s **iCloud**.

Will Australia "aspire to its usual back office role" – or seize the moment of opportunity?

The potential for cloud computing services in Australia report identifies intriguing opportunities and challenges as cloud services increasingly are a co-product between private service provider and government regulators. This can impose sovereign risk such as through the US Patriot Act, which provides the **US Government** with the right to access everything from any

cloud infrastructure within its jurisdiction. Comparing it with the success of financial services from tax havens and countries with a combination of competitive efficiency and export-oriented regulation, the report sees opportunites for Australia. Supportive regulation served Swiss banks well, and government regulations could help local cloud service providers attract overseas clients.

Australia's governance – 'intangible infrastructure' – is a major asset, the report says. And the NBN will provide important tangible infrastructure, although the capacity of Australia's backhaul may be challenged. However, there is Australia's tyranny of distance, although there are two sides also to this coin. Being dependent on undersea cabling, there are capacity, congestion and latency issues. While latency could be a barrier for the export of services, it also could be a benefit by protecting local suppliers while providing an incentive to build capacity.

Senator Carr said at the launch that the identified issues around risk management, sovereignty, data security, privacy and service quality need to be thoroughly debated. "A local cloud capability will give us a say in these issues."

Government's should set ground rules on issues such as privacy, the report says, but industry self-regulation could be effective in handling issues such as standardisation of contract terms and security practices. Accordingly, MacTel, which is a member of the Government's **IT Industry Innovation Council** (ITIIC), and a number of other firms (**Fujitsu**, **VMware** and **Infoplex**) have already voluntarily signed up to a set of industry standards that protect privacy and security to ensure consumer confidence.

▶ More information: www.ict-industry-reports.com; http://minister.innovation.gov/Carr

Virtual Victoria

The **Victorian Government** has unveiled an $85 million plan for its growing ICT sector. The plan is one element of a suite of three major initiatives under the State's *Technology Plan for the Future*, with further elements addressing biotechnology and small technologies (covered in more detail in our 'States' section). At its core the ICT plan includes an $11 million **Digital Futures Fund** supporting collaborative projects in the ICT sector with other partners. It also includes:

- a **Technology Trade and International Partnering Program** (TRIP), which will assist companies in attending overseas ICT trade fairs and participate in trade missions.;
- an $18 million **Broadband Enabled-Innovation Program**, which will support projects targeting service delivery in business, government and the community through the use of high-capacity broadband; and
- a $2 million suite of ICT skills initiatives.

▶ More information: http://www.mmv.vic.gov.au

Digital digging with IBM...

The **IBM ICT R&D Laboratory** announced in October 2010 was launched at the **University of Melbourne**, further strengthening the nation's ICT research capacity. The initiative will focus on areas including:

- Smarter natural resource management in key areas related to resource discovery, production, supply chain and operations, and applied to resources such as oil and gas, minerals, water and food.
- Smarter natural disaster management with a focus on expanding and integrating current expertise in areas such as real-time event (stream) processing, weather modelling, traffic management and mobility analytics to assist in the planning and management of evacuation, communication and emergency response.
- Extending ongoing collaborations with the University of Melbourne in computational life sciences to a broader set of topics in healthcare and life science analytics.

The over $100 million investment, including $22 million in government funding, adds a global commercial partner to a field which in Australia is still dominated by publicly funded research organisations, including the **National ICT Australia** (NICTA), **CSIRO**'s **ICT Centre**, the **Australian Synchrotron**, and a number of Cooperative Research Centres (CRCs).

image sourced from Melbourne School of Information

...as ICT takes over...

The IBM laboratory is positioning Victoria as a hub for ICT R&D in Australia, with the additional benefit of Melbourne having been selected as home to the **NBN Co** headquarters. In November, NBN Co opened its new $32 million operations centre, comprising the **Network Service and Operations Centre** and the **National Test Facility**. NBN Co will use the facilities to manage the NBN day-to-day operations, while telephone and internet service providers will be able to test products and equipment. In addition, NBN Co opened two facilities directed at consumer experience and education.

As is readily pointed out by Victoria's investment promotion agency **Invest Victoria**, the state is also increasingly attracting private sector investment in research. The agency's website mentions IBM's **Asia-Pacific Software Solutions** centre, **Ericsson's R&D Centre**, **Computershare**'s global headquarters, **R&D and Operations Centre**; **Fujitsu** software development operations; **NEC**'s global **R&D Centre**, and **Tata's Software Support Centre**. Recently several companies joined the list including:

- **VanceInfo Technologies Australia**, a Chinese ICT service and outsourcing company, opened its headquarters in September.
- **Zendesk**, a provider of cloud-based helpdesk software, opened its Asia-Pacific headquarters; as did
- **The Attachmate Group Inc**, a global software company, whose ICT applications have had major impact in areas such as operations management, open source, end user computing and collaboration, and cloud computing;
- **Data#3 Limited**, a company dealing with software licensing, asset management, and network optimisation solutions, as well as data centre hardware, opened a new Integration Centre in Melbourne.

...and there is more...

In September, Melbourne University also opened the State's first **Broadband Application Laboratory** at its **Institute for a Broadband-Enabled Society** (IBES). The new facility is designed to help businesses translate their ideas into new products and services that exploit Australia's increasing broadband capacity.

▶ More information: www.premier.vic.gov.au/media-centre

Less strings attached

New data by the **Australian Bureau of Statistics** confirm that more Australians are subscribing to internet services, and their is a growing preference amongst Australian internet users for faster but also mobile connections.

As of June 2011, there were 10.9 million internet subscribers in Australia, growing by 14.8% over the year. Of these, 95% subscribed to broadband, with 87% of connections offered at download speeds of 1.5 Mbps or greater. However, fewer Australians use standard DSL services, typically delivered with wired telephone services, with the largest growth in numbers seen in mobile wireless connections, even excluding the use of mobile handsets.

According to the ABS **Internet Activity Survey** (IAS) mobile wireless internet connections are now more common than DSL connections, accounting for 44% and 41% of all connections, respectively. However, it is the number of mobile handset internet subscribers that is growing most rapidly, increasing by 18.1% from December 2010, and by more than 42% over the year. Astounding also is the increase in downloaded data volume, increasing more than 4 fold from 717 Terabytes (TB) in the three months to June 2010 compared to 3695 TB in the same period to June 2011.

▶ More information: www.abs.gov.au

Lead 1, 24-33; Nationals 2; S&T 14; Uni 34; Innovation watch 36; States 45; People 49; Rural & resources 50; ICT 54