

**The Energy and Minerals Institute at  
The University of Western Australia**

**Submission in regard to**

**An Inquiry into the Economic Implications of Floating  
Liquefied Natural Gas Operations**

**Being undertaken by the Economic and Industry Standing  
Committee of the Parliament of Western Australia**

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### **The context in which we operate**

“Western Australia is ideally positioned to become a global centre of excellence in research, design and development for offshore engineering and floating systems, based on strong industry and international research collaborations” Professor Paul Johnson, Vice-Chancellor, UWA, 2013<sup>1</sup>

The five largest LNG importers in the Asia-Pacific, Japan, South Korea, Taiwan, China and India, account for almost 60% of global LNG demand<sup>2</sup>. This robust demand within Australia’s region provides Australia and Western Australia in particular the opportunity to be best placed to meet Asia’s long-term demand. However, this demand will push technological developments far beyond what has been achieved in the past as suppliers seek to monetise stranded assets.

Whilst there is potential for Australia to lead future supplies<sup>3</sup>, there have been recent international developments creating a more competitive market for Australian LNG, with Qatar directing LNG into the Asia region and the North American shale boom supporting domestic gas supply, thereby reducing American purchases of international gas supplies. There is also an increasing use of short-term trading on spot-markets to complement long-term sales.

In addition to international pressures and world markets, more than 80% of Australia’s gas reserves exist in deep, remote, offshore areas. The ability to realise the full potential of these assets relies on the development of economically viable solutions. With these technologically demanding developments, comes immense engineering and design challenges to which, in part, The University of Western Australia (UWA) has responded, and now has over twenty years of experience supporting education, research and consultancy services to the oil and gas sector. This expertise and underpinning knowledge, infrastructure and training is most concentrated in UWA’s Centre for Offshore Foundation Systems (COFS), the School of

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<sup>1</sup> [www.miningoilgas.com.au](http://www.miningoilgas.com.au) special feature world-class engineering expertise developed for North West Shelf gas

<sup>2</sup> <http://www.ey.com/GL/en/Industries/Oil---Gas/Global-LNG--New-pricing-ahead---LNG-demand-growth>

<sup>3</sup> <http://www.bakerinstitute.org/programs/energy-forum/research/the-changing-geopolitics-of-natural-gas-the-rise-of-unconventional-gas-and-its-implications-for-global-natural-gas-markets-geopolitical-relations-and-u.s.-energy-security>

Mechanical and Chemical Engineering, the School of Environmental Systems Engineering (SESE) and the School of Civil and Resource Engineering (Civil) within the Faculty of Engineering, Computing and Mathematical Sciences (FECM). These departments have been at the forefront of the developments. In particular, as a niche market supplier, COFS provides solutions globally for offshore foundation requirements through high-quality sophisticated modelling and experimental facilities. The Centre is one of the world's largest teams of academic researchers and consulting engineers in offshore geomechanics. Strategically aligned with Advanced Geomechanics<sup>4</sup>, academia and industry COFS has created a symbiotic relationship and reputation that is world-renowned.

### **Universities and industry: partners in economic development**

Much research has been undertaken to understand the symbiotic relationship between industry, academia and government that can drive a successful knowledge-based economy. Success similar to the Silicon Valley<sup>5</sup> is elusive but researchers agree that it is the willingness of people in each sector to strategically collaborate, effectively cooperate and compete in key areas to create new markets that make knowledge hubs and economies prosper.

By and large, the university sector and the technology sector run in parallel much of the time, only occasionally crossing over the permeable membrane<sup>6</sup> when a symbiotic relationship is achieved. In this submission, we offer a number of local examples that have provided technology solutions locally and internationally through university-industry collaborations.

In recognition that both parallel sectors have extensive knowledge, the UK has recently announced “knowledge exchange hubs”<sup>7</sup> in an effort to provide a space where the two sectors can come together more frequently in a collaborative and competitive environment. This helps to support a diversity of skills, mutual inspiration and a level of understanding across the challenges. Whilst the UK example focuses on the creative economy and academia, the concept still applies.

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<sup>4</sup> <http://www.ag.com.au/>

<sup>5</sup> <http://www.technologyreview.com/news/516506/silicon-valley-cant-be-copied/>

<sup>6</sup> <http://www2.druid.dk/conferences/viewpaper.php?id=5790&cf=32>

<sup>7</sup> <http://www.ahrc.ac.uk/Funding-Opportunities/Knowledge-exchange-and-partnerships/Pages/Knowledge-exchange-and-partnerships.aspx>

Perth has all the prerequisites identified by researchers as necessary to be a successful, innovative, knowledge hub<sup>8</sup> in the energy sector<sup>9</sup>. With a first-mover advantage offered by the first floating liquefied natural gas (FLNG) facility operating in our zone, there is an opportunity to build more high-tech solutions and train even more highly-skilled engineers to respond to the new challenges of this evolutionary development.

UWA welcomes the Federal Government's recent announcement of an Oil and Gas Industry Innovation Partnership (OGIIP). Whilst the level of financial support is modest and highly leveraged, major and minor oil and gas companies, service providers, engineering companies and small manufacturing companies have self-identified and declared their interest and need to work together to create an environment that encourages innovation and thereby improve productivity.

The OGIPP will facilitate collaboration, improve the competitiveness of the oil and gas sector, build capabilities and skills for export growth and keep WA and the nation at the forefront of oil and gas technology developments. More importantly, it is expected to create an innovation hub or exchange to unlock talent, new technology and new business ideas focussed on high impact areas in the oil and gas sector. UWA plays an important role building capability and skills for the knowledge hub and future skills for export growth. In addition, the close relationship built between UWA and industry in the oil and gas sector has enabled parts of the university to integrate with the needs of industry. The OGIPP will provide additional opportunities to enhance UWA's industry and SME engagement across the entire value-chain.

UWA also welcomes the announcement of the Commonwealth Scientific and Industrial Research Organisation (CSIRO)/Australian Institute of Marine Science (AIMS) National Floating Systems Research Centre (NFSRC). This Centre will draw together existing expertise and infrastructure from academia, industry and government to support future offshore deep-water developments. Although led through CSIRO, core capability in the NFSRC will build on the longstanding expertise resident at UWA. This is also exemplified

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<sup>8</sup> <http://www.technologyreview.com/news/516506/silicon-valley-cant-be-copied/>

<sup>9</sup> [http://www.committeeforperth.com.au/pdf/FactBaseBulletins/factbase\\_Bulletin\\_31\\_August\\_2013.pdf](http://www.committeeforperth.com.au/pdf/FactBaseBulletins/factbase_Bulletin_31_August_2013.pdf)

by the subsea pipelines collaboration cluster supported through CSIRO's collaboration fund and building on a significant WA-base<sup>10</sup>.

## **The limitations of this submission**

This submission does not attempt to provide solutions or pass comment on how the State of Western Australia can capitalise on energy developments, or list all of the various opportunities for research and industry collaboration in Western Australia. Neither is it a study of small business opportunities or spin-offs from research organisations, or a full study of employment opportunities that have arisen through these developments. That information is best sourced from individual institutions and is outside of the scope of this submission.

This submission has instead focussed upon existing examples of how symbiotic relationships currently exist between research institutions and industry and how this incubates highly-skilled individuals to produce high-tech solutions via permeable academic-industry boundaries. International knowledge hubs all experience the same symbiotic developments; however knowledge hubs are created when there is a critical mass of companies and research organisations working together. Once initiated, these hubs attract and retain expertise, growing domestic markets and eventually contributing greater exports of commodities, technical solutions and expertise.

In the university context, these relationships are highly valued. The generation and the use of knowledge form a "knowledge value chain". Activity ranges from fundamental research, applied research, consultancies and testing. Research groups able to work across the "knowledge value chain", are able to work closely with industry partners as the knowledge is translated from academic understanding into engineering application. The depth of co-existence within these successful relationships has not been explored in this submission.

## **Local Value Creation: Case Study**

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"We compete in an industry in which technology is constantly evolving, so the benefits of being a first-mover are significant." Peter Coleman, CEO Woodside, 2012<sup>11</sup>

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<sup>10</sup> [http://www.cofs.uwa.edu.au/\\_\\_data/assets/pdf\\_file/0018/2343510/FINAL-Subsea-Pipeline-Cluster-Report-56pp.pdf](http://www.cofs.uwa.edu.au/__data/assets/pdf_file/0018/2343510/FINAL-Subsea-Pipeline-Cluster-Report-56pp.pdf)

## **Centre for Offshore Foundation Systems (COFS)**

The difficulties experienced by oil and gas companies on the North West Shelf (NWS) in the 1980s and 1990s provided local research and engineering design opportunities. The proximity of the developments underpinned the uniqueness of the situation. Borne out of these challenges, Advanced Geomechanics (est. 1994) and COFS (est. 1997) were established to Over time, COFS has developed one of the most sophisticated research and modeling facilities in offshore geomechanics and engineering in the world.

A team of over 40 internationally recognised researchers, consulting engineers and technical staff work together to solve some of the key engineering challenges of today and tomorrow. Their work on the mechanics of seabed sediments, offshore foundations systems, pipeline and deep water offshore engineering and geohazards provides pivotal support to both the local and global engineering communities.

Initially funded under the Australian Research Council's (ARC) Special Research Centres program and supported as a node of the ARC Centre of Excellence (CoE) for Geotechnical Science and Engineering (CGSE), in partnership with the Lloyd's Register Foundation and the State Government of Western Australia through the CoE in Science and Innovation program.

The diagram below demonstrates the impact of one research area within COFS.

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<sup>11</sup> <http://www.woodside.com.au/investors-media/announcements/documents/14.05.2012%20woodside%20ceo%20and%20managing%20director%20address%20appea%202012.pdf>

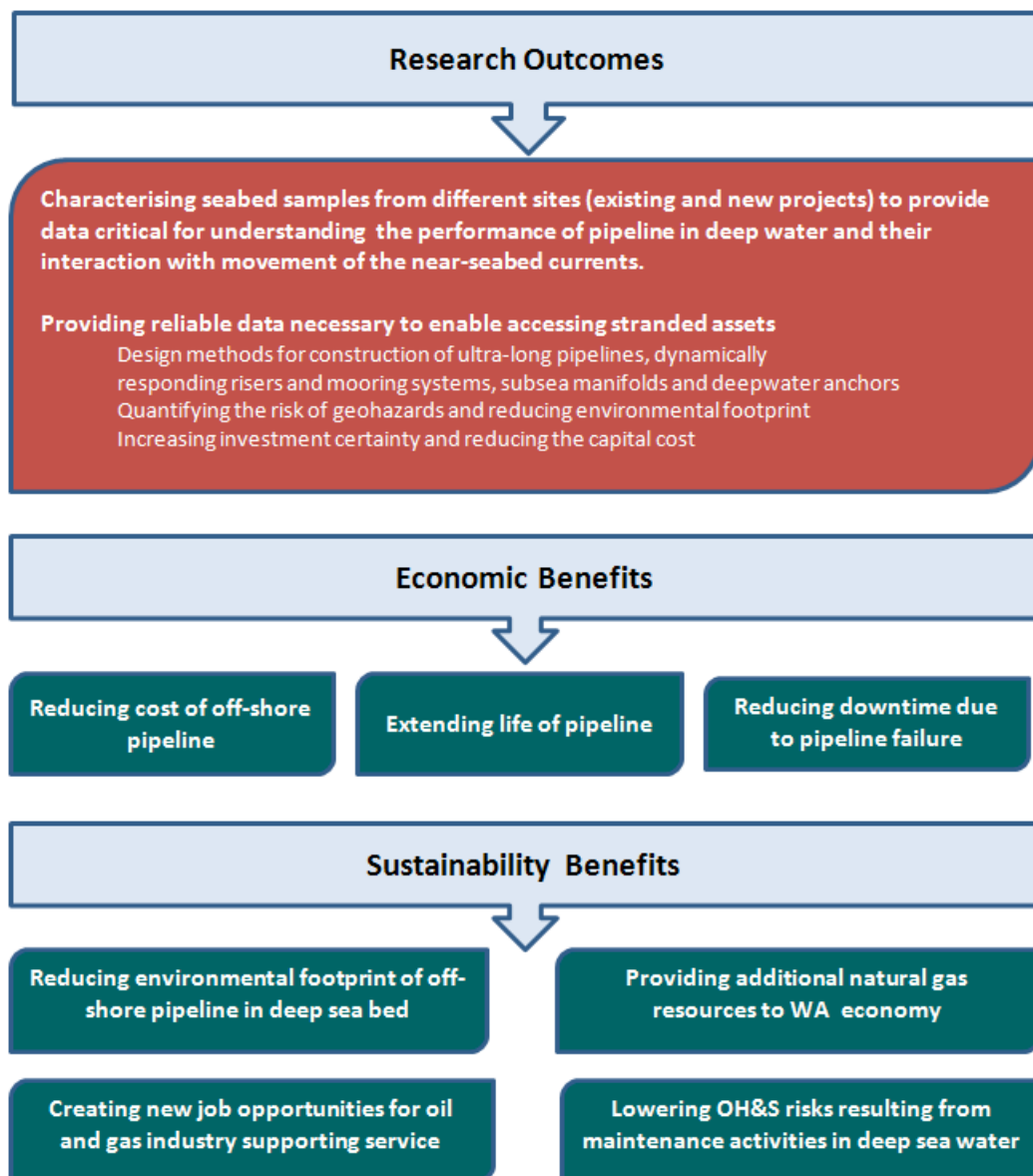


Figure 1 Research to Economic Impact for Deep Water Infrastructure <sup>12</sup>

Research shows that first-movers maximise their advantage when capability or product-market position is achieved (in our case knowledge) and they cooperate with competitors to create value and compete to appropriate it<sup>13</sup>. The relationship developed over time between COFS and Advanced Geomechanics is a good example of how first-movers are able to achieve maximum market share with a competitor. It is essential to understand that first-movers benefit from activating and accumulating knowledge ahead of new entrants. The research and technical services offered at UWA today have evolved as oil and gas developments have moved along the technology curve spurred on by the need for more gas

<sup>12</sup> RMDSTEM WA:ERA Impact Assessment, 30 September 2010

<sup>13</sup> <http://psbm.org/Ebooks/Strategic%20Innovation%20New%20Game%20Strategies%20for%20Competitive%20Advantage.pdf>



supplies and economically viable developments. Staying ahead of the “knowledge curve” by specialising in well-defined, niche activity has ensured COFS first-mover advantage.

### **Science and innovation: engineering and design and industry collaboration**

“We have a highly sophisticated and innovative support and services industry in Western Australia” Professor Paul Johnson, Vice-Chancellor, UWA 2013<sup>14</sup>

The same challenging conditions experienced on the NWS in the 1980’s will apply as the first FLNG development is launched in 2016. Whilst current proposed solutions for FLNG are adaptations of technologies currently applied in offshore production and onshore facilities, the combination of adapted technologies still has to be proven in the field. Understanding the unique and demanding set of challenges that have to be overcome to move LNG production to an offshore environment<sup>15</sup> and the challenge of bringing them together into one facility in harsh climatic environments will present technology challenges to which UWA in part can address.

In 2013, the Faculty of Engineering continues to build on industry and international linkages. A selection of examples is noted below; additional examples of academia-industry interactions providing economic benefit can be found in COFS Annual Reports<sup>16</sup> and industry sources.

- Researchers within the group were able to provide advice to Keppel Offshore and Marine Technology (Singapore) on the capacity of skirted spudcans under combined loading and to evaluate the potential of suction caissons to support self-installing platforms in shallow waters.
- Through preliminary testing of OMNI-Max anchors in calcareous sediments, it was seen that these anchors might perform better than other standard anchor types. A joint-industry project between COFS, Delmar Systems, Woodside Energy and ExxonMobil is underway using the centrifuge facilities. New instrumentation has been developed and used to test five anchors in four different soils.

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<sup>14</sup> [www.miningoilgas.com.au](http://www.miningoilgas.com.au) special feature world-class engineering expertise developed for North West Shelf gas

<sup>15</sup> <http://www.laohamutuk.org/Oil/Sunrise/PotenFLNGBreakthrough.pdf>

<sup>16</sup> <http://www.cofs.uwa.edu.au/about/annual-report>

- Working with Woodside, Civil Engineering and COFS researchers were able to build a research and testing facility that circulates water to simulate tropical cyclone waves and current conditions. The facility supports the Woodside STABLEpipe joint industry project looking at wave forces on pipelines. The research has already yielded a benefit-to-cost ratio greater than 10:1<sup>17</sup>
- Working with Woodside on the impact of tidal motions and deep internal waves on off-shore infrastructure, to enable the setting of efficient design criteria resulted in considerable cost savings on current and future projects. The research to savings straight leverage ratio was nearly 5:1 at the time of the project.

In order to understand the collective economic impact of research-industry interaction, UWA, Curtin University and CSIRO commissioned RMDSTEM in 2010 to undertake a selective review of some of the oil and gas research projects. A conservative risk-adjusted present value impact<sup>18</sup> for Western Australia industry attributed to these projects was \$354M to \$624M over the next two decades based on the intensity of LNG infrastructure, production efficiencies and unlocking new gas reserves.

## Talent Pipeline

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Universities contribute to economic development in the oil & gas sector primarily through (a) the provision of graduates with the education necessary to commence careers within profitable industries, and (b) the development through research of new knowledge and technologies that increase the capacity, capability and efficiency of industry operations. Particularly in world-leading universities, these two contributions act to reinforce one another: world-class research leads to investment by global companies in the University, which enables the University to deliver graduates with even better educations and technical knowledge, who serve industry better and who appreciate the need for research investment.

The University of Western Australia is an excellent example of this cycle, particularly over the last 20-30 years as demonstrated by the growth in scale of its industry partnerships within the oil and gas sector and by its significant increase in international ranking. As the

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<sup>17</sup> <http://www.woodside.com.au/our-approach/documents/otube%20fact%20sheet%202012.pdf>

<sup>18</sup> RMDSTEM WA:ERA Impact Assessment, 30 September 2010

University's quality rises, so do the broader economic and social benefits it delivers to the Western Australian community.

As well as training PhD students, the work undertaken in the Faculty of Engineering has a direct impact on the content and nature of undergraduate programs. The educational benefits include:

- inclusion into the undergraduate program; and
- opportunities for students to work with industry on industry motivated and funded individual research projects.

The future workforce will be informed and influenced by world-class research outcomes and research projects.

Furthermore, industry partners contribute to the talent pipeline by supporting scholarships, prizes, honours and masters research projects, vacation work and industry placements. The intertwined mutually beneficial support provides the best outcomes for students and industry alike. A recent Committee for Perth report highlighted the close connection between the resources sector and the universities as they collectively foster knowledge generation within the sectors<sup>19</sup>.

UWA provides an extensive range of courses<sup>20</sup> across the Faculties to both students and industry that support the oil and gas sector in Western Australia. In particular the Centre for Mining, Energy and Natural Resources Law has been educating law graduates and supporting professional development for industry lawyers since 1990. The Centre undertakes research and consultancy on legal issues arising from the mining, energy and natural resources sectors of the Western Australian economy.

## International Collaboration

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UWA prides itself on the ability to collaborate internationally and is committed to working with prominent research organisations around the world to provide and share leading-edge knowledge. Recently ranked 91st in the research Shanghai Jiao Tong University Index

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<sup>19</sup> Perth as a global minerals and energy resources hub

<http://www.committeeforperth.com.au/pdf/FactBaseBulletins/perth%20as%20global%20minerals%20and%20energy%20resources%20hub%20-%20november%202012.pdf>

<sup>20</sup> <http://www.emi.uwa.edu.au/courses>

Ranking, UWA understands the advantages of global connectivity. To better understand the value and connectivity of academic institutional relationships, research in 2008 undertaken by Professor Markwell provides the essence of international collaboration<sup>21</sup>.

International collaboration does not only extend through research connections. Perth's corporate landscape has changed with many of the world's resource companies opting to operate from Perth. This close connection improves the likelihood of deeper corporate and academic understanding and capability. For example, Chevron, Shell and Woodside have their Australian headquarters in Perth and all have funded Professorial positions at UWA. The rotation of personnel through these international organisations enables UWA researchers to connect and maintain relationships beyond Australia's borders.

Researchers across the Faculty of Engineering support international oil and gas developments in Asia, Africa and the Gulf of Mexico. These are demonstrated in the map below<sup>22</sup>.

Five members of COFS' current staff are members of either the American Petroleum Institute (API) or International Standards Organisation (ISO) committees responsible for developing international design guidelines for the oil and gas industry. The value and influence of these international activities cannot be underestimated as the information flow back to Western Australia provides high quality knowledge.

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<sup>21</sup> [http://www.uwa.edu.au/university/governance/executive/education-archive/speech\\_on\\_world\\_class\\_universities](http://www.uwa.edu.au/university/governance/executive/education-archive/speech_on_world_class_universities)

<sup>22</sup> <http://www.cofs.uwa.edu.au/about/annual-report>

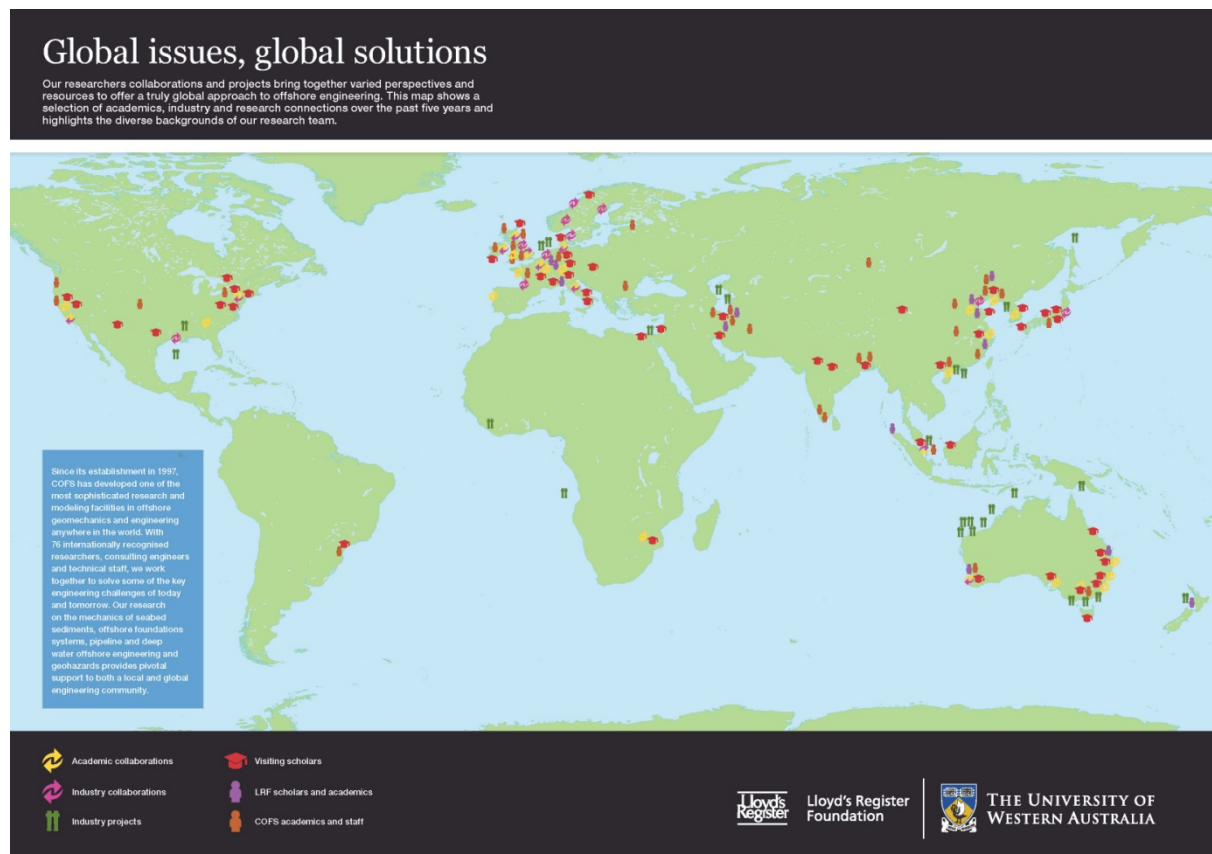


Figure 2 Global issues, global solutions

## Conclusion

This submission attempts to provide an understanding to the Committee of the contribution UWA can make to this emerging activity. With over twenty years of expertise supporting the oil and gas sector, nationally and internationally, UWA provides research, technical services and educates highly-skilled engineers.

Knowledge hubs world-wide are synonymous with leading university activity. As Perth emerges as a knowledge hub supporting offshore, deep water developments, UWA, as a top 100 university will continue to contribute and support the hub and Perth's recognised expertise in engineering and design and Western Australia's economic future



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Safe, sustainable value  
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ACHIEVE INTERNATIONAL EXCELLENCE



# Western Australia a world-leader in gas

As the world is challenged to reduce carbon emissions to save our environment - governments, scientists, industry and community are working together to find cleaner energy supplies for the world's transition to a lower carbon economy.

Energy users the world over see that natural gas is relatively inexpensive, provided it can be transported efficiently. The International Energy Agency (IEA) predicts that the world is entering a 'golden age of gas' where affordable energy will be provided to millions of people who lack access to it now.

Australia has world class resources of natural gas. LNG is a lower emission alternative to more traditional fossil fuels, such as coal and oil.

Nearly all of Australia's conventional gas resources are located in North West Australia, in three main basins: Carnarvon, Browse and Bonaparte. Based on current known conventional reserves, Australia's gas resources can provide a secure energy supply for the next half-century.

The Australian Government claims gas 'is projected to be the fastest growing fossil fuel over the period to 2030'. Currently there is more than \$200 billion invested in natural gas projects in Australia.

Western Australia's export capacity of LNG will almost treble to 44.5 million tonnes per annum by 2016 to meet Asia's growing demand - mainly from Japan, South Korea and China, with India an emerging market. As Western Australia is in close proximity to LNG markets, it is increasingly positioning itself as a world leader in the supply of clean, high-quality natural gas.

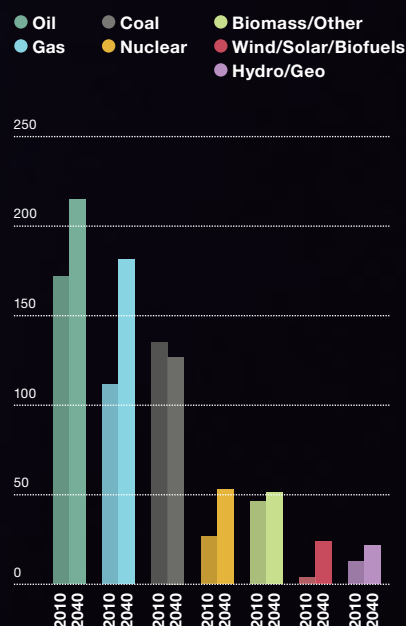
Western Australia is the largest gas producing State in Australia and currently has two operating LNG facilities - the North West Shelf Project and Pluto LNG. There are five more projects under construction - Gorgon, Prelude, Wheatstone, Greater Western Flank Phase 1 and North Rankin Redevelopment Project and there are several prospective projects.

## The golden age of gas

Global energy demand will increase by 30 per cent from 2010 to 2040 as economic output more than doubles and prosperity expands across a world whose population will grow to nearly 9 billion people.

Oil, gas and coal will continue to be the most widely used fuels and have the scale needed to meet global demand making up about 80 per cent of total energy consumption in 2040. Natural gas will grow fast enough to overtake coal in the number two position behind oil. Demand for natural gas will rise by more than 60 per cent through 2040. Much of this growth will come from electric utilities and other consumers shifting away from coal in order to reduce CO<sub>2</sub> emissions.

### Global energy demand by fuel type (Quadrillion BTUs)



Sourced: '2012 The Outlook for Energy: A View to 2040' by ExxonMobil Corporation.



## Industry's partner of choice

Western Australia's energy and minerals industries are very high-tech, knowledge-rich and sophisticated. The University of Western Australia is repeatedly selected to partner with industry based on our strengths in engineering, law, environmental science, agriculture, medicine and other disciplines. Together industry and UWA are consistently developing innovative solutions for the resources sector.

### UWA – member of group of eight

The University is a member of the Group of Eight, a coalition of leading research-intensive, comprehensive Australian universities, and is a member of the Worldwide Universities Network of 16 member universities from across four continents.

### Global Partners

Recognised by industry for its outstanding research capability, UWA has been selected to join the global programs of both Chevron and Rio Tinto. Rio Tinto recently announced a \$3 million investment in UWA as the first partner in its Global Education Partnerships Programme. This Programme will establish a worldwide network of leading universities to generate and foster an appropriate expertise base

for the resources industries. In 2011 Chevron invested \$5.7 million in Gas Process Engineering at UWA. This is part of an ongoing commitment to the company's prestigious global University Partnership Program, which also includes Stanford University, Massachusetts Institute of Technology and Texas A&M University.

### Professorial Chairs

Several University Chairs are funded by industry. For example, the Chevron Chair in Gas Process Engineering, Professor Eric May, Woodside-Chevron Chair in Petroleum Geoscience and CO<sub>2</sub> Sequestration, Professor David Lumley, Woodside Professor in Leadership and Management, Professor David Day and BHP Billiton Chair in the Business of Resources, at UWA's Business School, Professor Peter Hartley.

Harnessing the talent in UWA's Centre for Offshore Foundation Systems and greater Faculty of Engineering, Mathematical and Computing Sciences - Shell and The University of Western Australia entered an agreement in 2011 to assist with research on the effects of the ocean environment on offshore gas operations. The agreement involves an appointment of the Shell EMI Chair, two (UWA) research assistant professors and two PhD students to conduct the studies.

The new professorial Chair in metocean and subsea engineering and offshore foundations will improve collaboration between UWA's research capability and Shell's global metocean and offshore engineering groups.

### Linkage Project Success

UWA is in the top tier of Australian universities in terms of number and success rate in Linkage Project grants. The University attracts funding from the Australian Research Council for projects that support research and development, which are collaborative between academics and partners from outside the University.

### WA:ERA

The WA Energy Research Alliance is a collaboration between UWA, CSIRO and Curtin University together with valued industry partners including Woodside, Chevron and more recently CCG Veritas. WA:ERA aims to build research capacity focused on opportunities relating to the oil and gas industry. It continues to provide direct support to its industry alliance partners and has developed a major research program addressing CO<sub>2</sub> geosequestration.





# Dynamic research unlocks resources

The value of Australia's energy resources is now recognised on a global scale and Australia is leading the innovation drive to safer, sustainable energy for the world.

Leading research in this State, The University of Western Australia (UWA), has a dedicated team of inter-disciplinary researchers who are developing powerful new technologies to drive global change in the widespread use of LNG.

Our scientists through UWA's Energy and Minerals Institute, collaborate with industry and government providing invaluable insights into current practice and industry needs, triggering new technical developments, enhancing capabilities of the facilities, and fuelling academic research with new ideas and concepts.

Western Australia shares the same time zone as 60 per cent of the world's population and the nations that promise the greatest economic growth of the 21st Century. The Energy and Minerals Institute promotes activities that support the priorities of our State, National and International Governments to meet safety, environmental and sustainability and technical innovation targets.

Our teams are dedicated to finding new ways to explore and extract new resources, they investigate environmentally sustainable practices and safety standards, and explore the cultural and social benefits that the gas revolution promises to bring.

# UWA's LNG expertise

UWA key scientists are making valuable breakthroughs for the entire LNG value-chain by leading research using world-class research infrastructure at the University. The following pages highlight a selection of UWA scientists leading research that delivers safe, sustainable value from our energy resources.



## Winthrop Professor Eric May

His research has developed breakthrough techniques for measuring gas properties under extreme conditions - providing critical data to advance the computer models used to design and optimise gas processing plants.

- UWA Centre for Energy – Deputy Director
- Chevron Chair in Gas Processing

[eric.may@uwa.edu.au](mailto:eric.may@uwa.edu.au)



## Winthrop Professor Dongke Zhang FTSE

He has conducted extensive research into fuel processing and conversion, and combustion science and technology, with a specific focus on coal, natural gas and bio-energy.

- UWA Centre for Energy – Director

[dongke.zhang@uwa.edu.au](mailto:dongke.zhang@uwa.edu.au)

## Winthrop Professor David Lumley

An international expert in time-lapse imaging of sub-surface fluid flow, including hydrocarbon recovery, and environmental and global-climate processes such as groundwater containment flow and CO<sub>2</sub> injection and storage.

- Centre for Petroleum Geoscience & CO<sub>2</sub> Sequestration – Director
- Woodside Chevron Chair in Petroleum Geoscience

[david.lumley@uwa.edu.au](mailto:david.lumley@uwa.edu.au)



### Winthrop Professor Mark Cassidy

Leads a team investigating offshore geotechnics and engineering, predominantly developing wave-structure-soil interaction models for the analysis of oil and gas platforms, mobile drilling rigs and pipelines. His work supports safe future offshore infrastructure development and engineering.

- Centre for Offshore Foundation Systems – Director
- UWA Oceans Institute – Deputy Director

mark.cassidy@uwa.edu.au

### Professor David White

His research has focussed on the mechanics of soils, foundations and pipelines, primarily for the offshore industry. He has led experimental and numerical studies into geotechnical mechanisms at micro- and macro-scale which have been used to understand the behaviour of piles, foundations, pipelines and submarine slides. Simple design methods have been devised, which are widely used in engineering practice.

- Shell EMI Professorial Chair in Offshore Engineering

david.white@uwa.edu.au

### Winthrop Professor Paul Flatau

Research responds to the rapidly evolving needs of business, government, the third sector and the emerging framework of social investment and the developing challenges of corporate responsibility and sustainability.

- Centre for Social Impact – Director
- Chair of Social Investment and Impact

paul.flatau@uwa.edu.au

### Winthrop Professor Tim Ackland

His leading research in occupational biomechanics and ergonomics support workplace injury prevention and optimisation of human performance in industry.

- UWA Health and Rehabilitation Program – Director
- School of Sport Science, Exercise and Health – Head of School

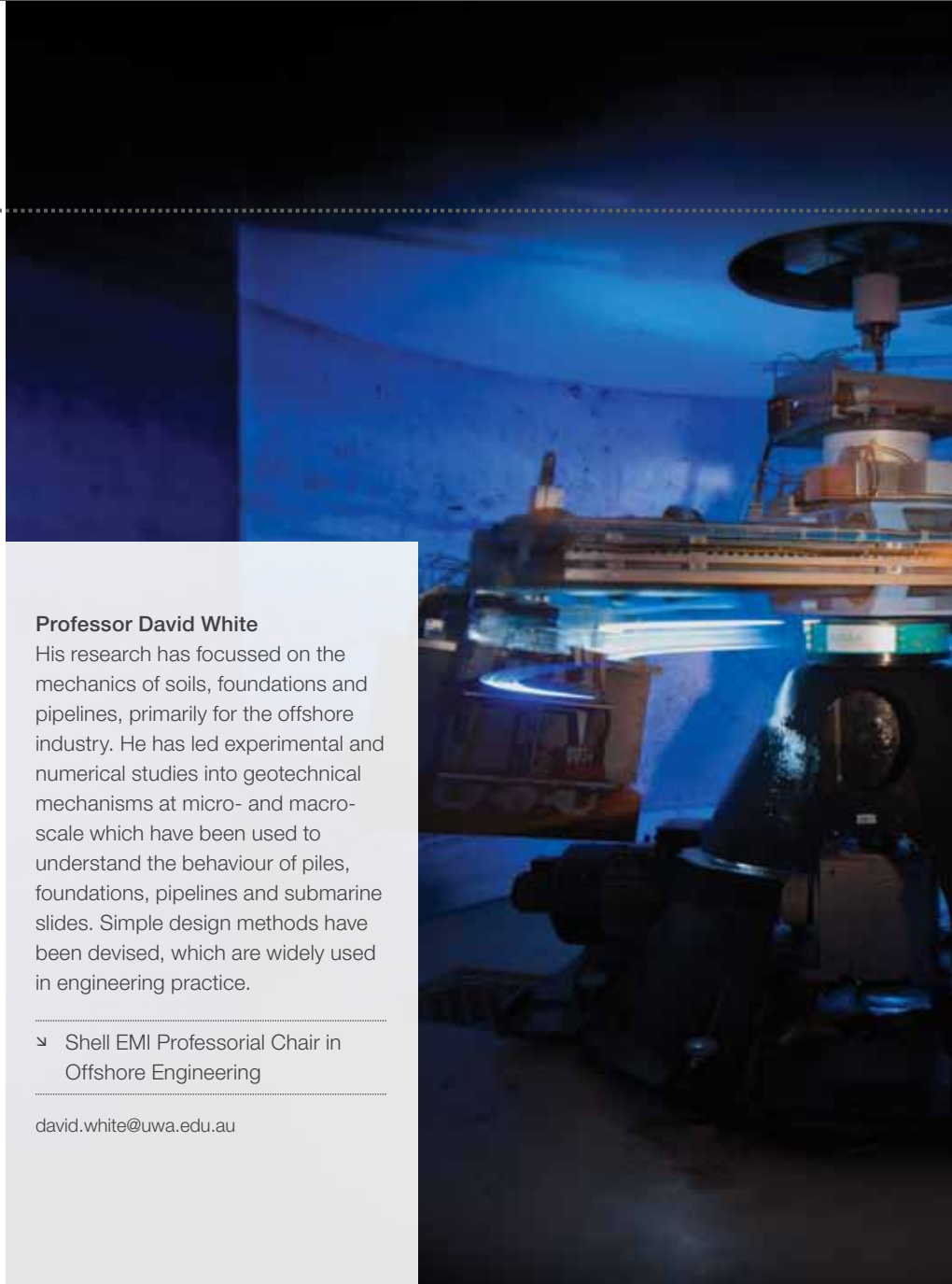
tim.ackland@uwa.edu.au

### Winthrop Professor Liang Cheng

His research is focussed on gas projects in collaboration with industry and the school offers consultancy services in many areas, including geotechnical, structural, hydraulic and resource engineering.

- School of Civil and Resource Engineering – Head of School

liang.cheng@uwa.edu.au





#### **Professor Melinda Hodkiewicz**

Melinda manages research projects in the areas of prognostics, asset data quality and life cycle costing with infrastructure, local government and the resources sector.

- School of Mechanical and Chemical Engineering

[melinda.hodkiewicz@uwa.edu.au](mailto:melinda.hodkiewicz@uwa.edu.au)

#### **Winthrop Professor John Chandler**

Co-leads a team working on collaborative projects, conferences, seminars and workshops conducted in cooperation with the public and private sectors. The Centre stimulates education and research issues around governance, safety and regulation.

- Centre for Mining, Energy and Natural Resources Law – Co-Director

[john.chandler@uwa.edu.au](mailto:john.chandler@uwa.edu.au)



#### **Winthrop Professor Mark Randolph**

His research team has contributed significantly to our knowledge of North West Shelf seabed conditions, with particular insights gained from using the innovative world-class centrifuge facility – unique in Australia.

- Centre for Offshore Foundation Systems
- Academic Staff (Civil & Resource Engineering)
- Royal Society Fellow

[mark.randolph@uwa.edu.au](mailto:mark.randolph@uwa.edu.au)

#### **Winthrop Professor Charitha Pattiaratchi**

His research is assisting industry to monitor and manage environmental and safety risks through UWA's Australian National Facility for Ocean Gliders. The gliders are capable of collecting data and monitoring the health of coastal ecosystems.

- Head of School of Environmental Systems Engineering
- UWA Oceans Institute

[chari.pattiaratchi@uwa.edu.au](mailto:chari.pattiaratchi@uwa.edu.au)

### Professor Matthew Tonts

His research expertise lies in the analysis of how local and regional economic and social systems adjust to external pressures like the growth of infrastructure in rapidly growing areas. This includes quantitative and qualitative analyses of the economic, demographic and social structures and dynamics of localities and regions, as well as considerations of policy and planning frameworks.

- Centre for Regional Development  
– Director/Professorial Fellow
- School of Earth and Environment  
– Head of School

matthew.tonts@uwa.edu.au

### Professor Jessica Meeuwig

Her main expertise is in marine and fisheries conservation and quantitative modelling. Her work includes investigating how marine sanctuaries generate ecological and economic benefits.

- UWA Oceans Institute  
– Research Professor
- School of Animal Biology  
– Research Professor
- Centre for Marine Futures  
– Director, Research Professor

jessica.meeuwig@uwa.edu.au



### Winthrop Professor Hui Tong Chua

His research areas include: Chemicals, fuel and energy – studying the processes by which raw materials become products and their environmental and economic impact; Materials – researching the design of sensor and actuator systems as well as intelligent or smart metals; Mechatronics – researching the integration of the technologies of mechanics and electronics; petroleum – seeking ways to improve the recovery and safe transportation of oil and gas.

- School of Mechanical and Chemical Engineering

huitong.chua@uwa.edu.au

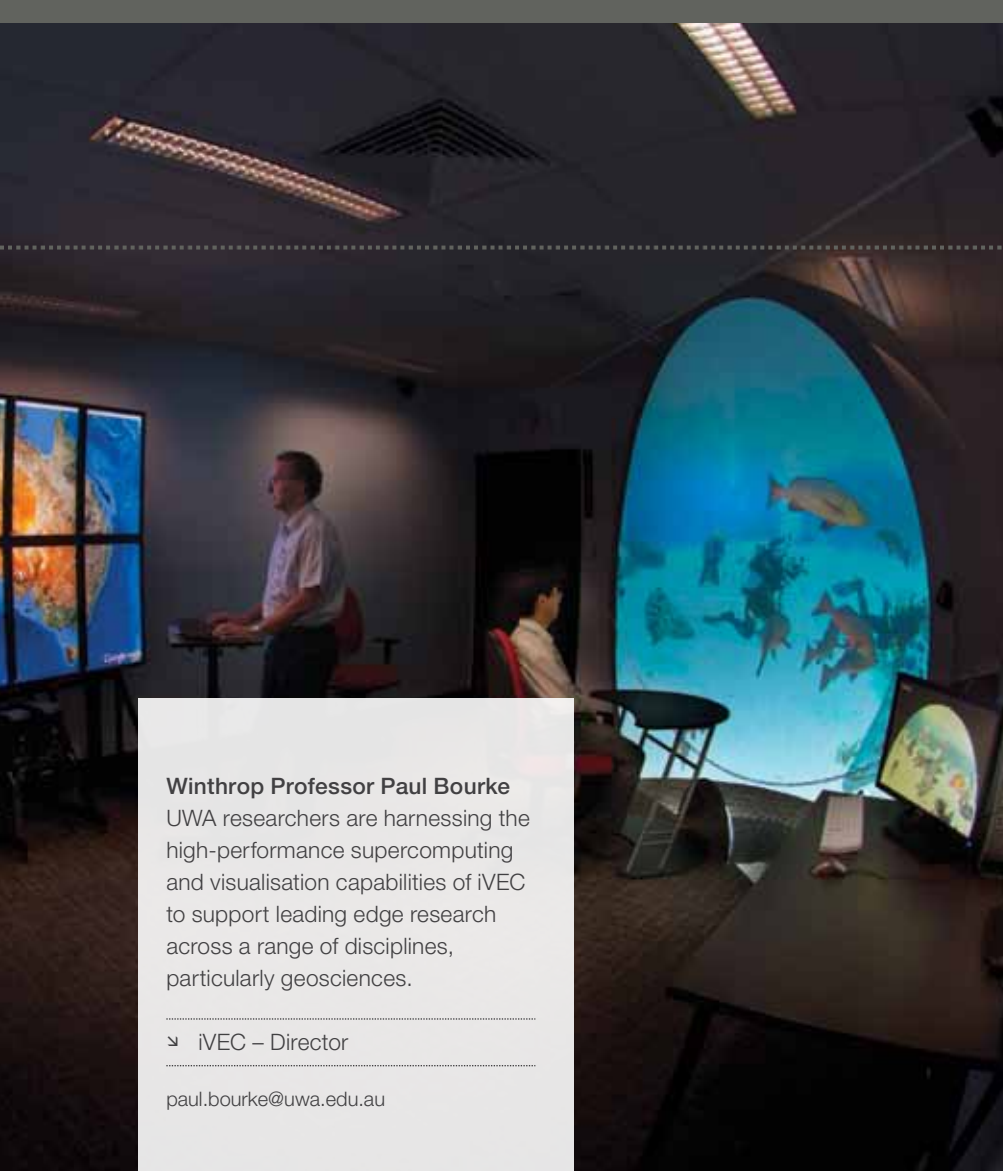
### Winthrop Professor Peter Eastwood

Research in sleep science can help optimise shift scheduling, improve sleep quality when off-shift and support the development of best practice in safety and productivity for the workforce.

- Centre of Sleep Science – Director
- School of Anatomy, Physiology and Human Biology

peter.eastwood@uwa.edu.au





### Winthrop Professor Paul Bourke

UWA researchers are harnessing the high-performance supercomputing and visualisation capabilities of iVEC to support leading edge research across a range of disciplines, particularly geosciences.

➤ iVEC – Director

paul.bourke@uwa.edu.au

### Winthrop Professor Peter Hartley

Leading economist Professor Hartley will provide leadership and foster excellence in the UWA Business School's teaching and research activities and community engagement with the resources sector.

Professor Hartley is the President of the US Association for Energy Economics and widely acknowledged as a world renowned expert in natural resource economics – particularly in the energy sector.

In addition to his new appointment, Professor Hartley will also retain his existing Rice University position in Texas as the George and Cynthia Mitchell Professor and James A. Baker III Institute for Public Policy Scholar.

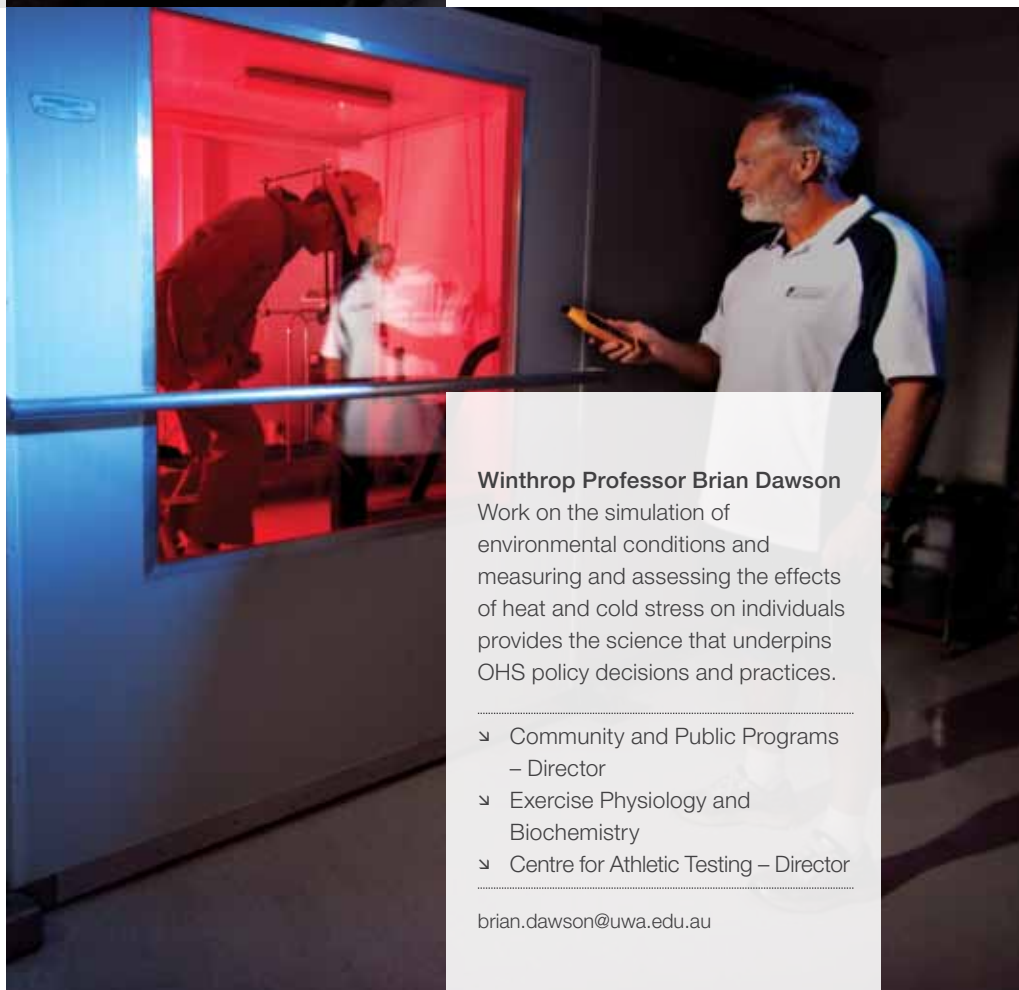
➤ BHP Billiton Chair in the Business of Resources at the University of Western Australia's Business School

### Dr Jo McDonald

UWA's Centre for Rock Art Studies integrates research and scholarship on rock art in the North West and aims to deepen our understanding of Indigenous knowledge. The analysis of rock art can give insights into the relationship between people, their environment, ideas and attitudes.

➤ Centre for Rock Art Research and Management – Rio Tinto Chair of Rock Art Studies, Director

jo.mcdonald@uwa.edu.au



### Winthrop Professor Brian Dawson

Work on the simulation of environmental conditions and measuring and assessing the effects of heat and cold stress on individuals provides the science that underpins OHS policy decisions and practices.

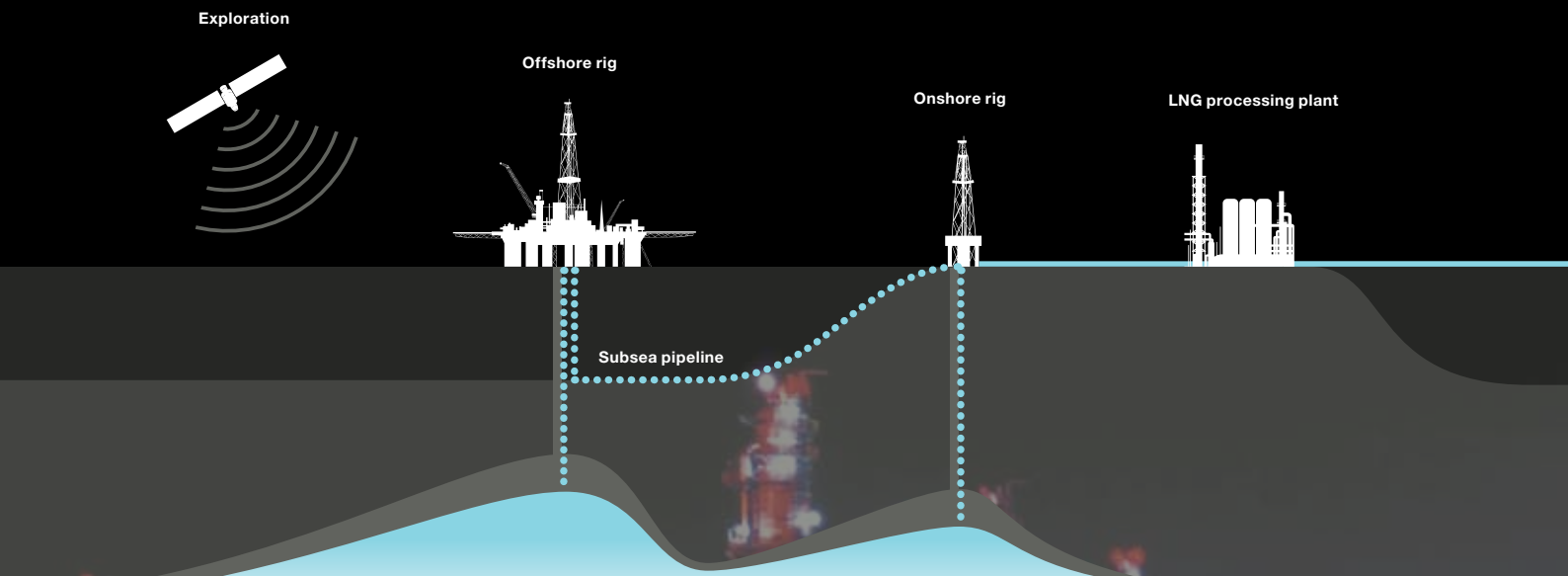
➤ Community and Public Programs – Director  
 ➤ Exercise Physiology and Biochemistry  
 ➤ Centre for Athletic Testing – Director

brian.dawson@uwa.edu.au

# Liquefied Natural Gas

Liquefied natural gas is gas that has been cooled to liquid form, reducing its volume and making it easier to transport. LNG is clear, odourless and non-toxic. LNG is produced by cooling natural gas (predominantly methane) to around  $-162^{\circ}\text{C}$  in large refrigeration units (known as trains). It is condensed into a colourless, odourless liquid which can then be transported or stored in cryogenic vessels.

## The LNG Cycle









THE UNIVERSITY OF  
WESTERN AUSTRALIA  
*Achieve International Excellence*

ENERGY AND MINERALS INSTITUTE

# Energy and Minerals Institute Impact 2012



ACHIEVE INTERNATIONAL EXCELLENCE



“For 100 years, UWA has delivered on its foundation principle ‘to advance prosperity and welfare of the people’ and today is a valued and trusted organisation with an impressive track record of achievement. The EMI is the gateway to a one billion dollar innovation business - rich in talent and world-class infrastructure - and located in one of the world’s leading resource economies.”

**Professor Paul Johnson**  
UWA Vice-Chancellor







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## Our Vision

To advance knowledge and create solutions that deliver safe, enduring value for the world from its energy and mineral resources.

## Our Mission

To enhance and connect UWA's talent and capability across the energy and minerals value chain, build multi-disciplinary networks, and strengthen partnerships with industry and external stakeholders.





# Chairman's Message



The energy and minerals sector is the driving force powering Australia's economy. It is supported here in Western Australia by the UWA Energy and Minerals Institute – based within one of the world's best universities.

Operating in a dynamic, challenging and changing global environment, we are an outwardly focused organisation with a vision to advance knowledge and create solutions that deliver safe, enduring value for the world from its energy and mineral resources.

Our strategic and collaborative approach helps unite the collective strengths and capabilities of global businesses, governments and universities - building talent, capacity and partnerships that address the complex challenges and needs of industry and society.

I would like to congratulate Tim and his exceptional team, who are working with and through others in a multi-disciplinary, multi-sector framework at local, national and international levels. They play an important role in advancing this University and in securing Australia's prosperity – for now and future generations.

I would also like to acknowledge UWA entering its centenary year and recent recognition in the top 100 research universities in the world. The Energy and Minerals Institute is a cornerstone, strategic activity that will ensure that UWA continues to rank among the world's best.

## **Greg Gailey**

Chairman, Board of Trustees  
UWA Energy and Minerals Institute

# Director's Summary



I am proud to provide the first impact report on the achievements of the UWA Energy and Minerals Institute (EMI).

To achieve our mission, the EMI has built a rich and diverse connection with local, national and international networks, and helped facilitate multi-disciplinary alliances and high-performing collaborations that create value and inspire innovation. Our work both within the University and with industry has enriched research and education at UWA and abroad, created new investment and alliances, built national and international talent and capacity, and strengthened partnerships between business and this University.

There are many highlights in this report which demonstrate the broad reach of our growing operations and the depth of our impact. We recently welcomed to our team the new International Mining for Development Centre (IM4DC), and we lead the UWA node of the new \$48 million National Geosequestration Laboratory, a collaboration with CSIRO and WA:ERA.

Other new initiatives include facilitating the establishment of a UWA research and education facility in the Pilbara, and a Perth office for UWA and the IM4DC to strengthen our collaborations with the energy and minerals sector.

We continue to build our global alliances. The EMI represents UWA in the Australian Centre for Natural Gas Management, which is building ever-stronger engagement with China's LNG sector. We are also responsible for the International Energy Centre at UWA, and for the management of UWA's growing collaboration with Korean universities.

The EMI has successfully led multi-million dollar negotiations for a number of partnerships, such as those with Rio Tinto, Chevron and Shell. These partnerships help build UWA's world-class research and infrastructure, education capability and pipeline of talent, which ultimately benefits the resources and other sectors in the community.

The EMI also leads the In The Zone conference, a unique forum for dialogue on issues of strategic relevance to our region. This renowned event also advances the reputation of UWA, now one of the top 100 universities in the world.

I would like to thank our Board of Trustees and the dynamic team of professionals at EMI. I would also like to thank our Vice-Chancellor Professor Paul Johnson for his support and leadership, the many world-class researchers and academics across UWA, and our highly valued resource industry partners that invest in and collaborate with us as we advance towards being one of the world's top 50 universities by 2050.

We welcome feedback on this report. More information is available on our website at [www.emi.uwa.edu.au](http://www.emi.uwa.edu.au).

**Tim Shanahan**

Director

UWA Energy and Minerals Institute



A large, multi-story stone building with a series of tall, narrow arched windows on the upper floors and a row of smaller arched windows on the lower floors. The building is set against a blue sky with scattered white clouds.

**UWA Crawley Campus**  
35 Stirling Highway

UWA is an innovation powerhouse, with over 1,500 inquiring minds and 2,000 higher degree research students, tackling today's challenges and delivering tomorrow's solutions.

A photograph of a historic stone building in a city center at night. The building has classical architectural features, including columns and arched windows, and is illuminated with warm yellow lights. Modern glass skyscrapers are visible in the background.

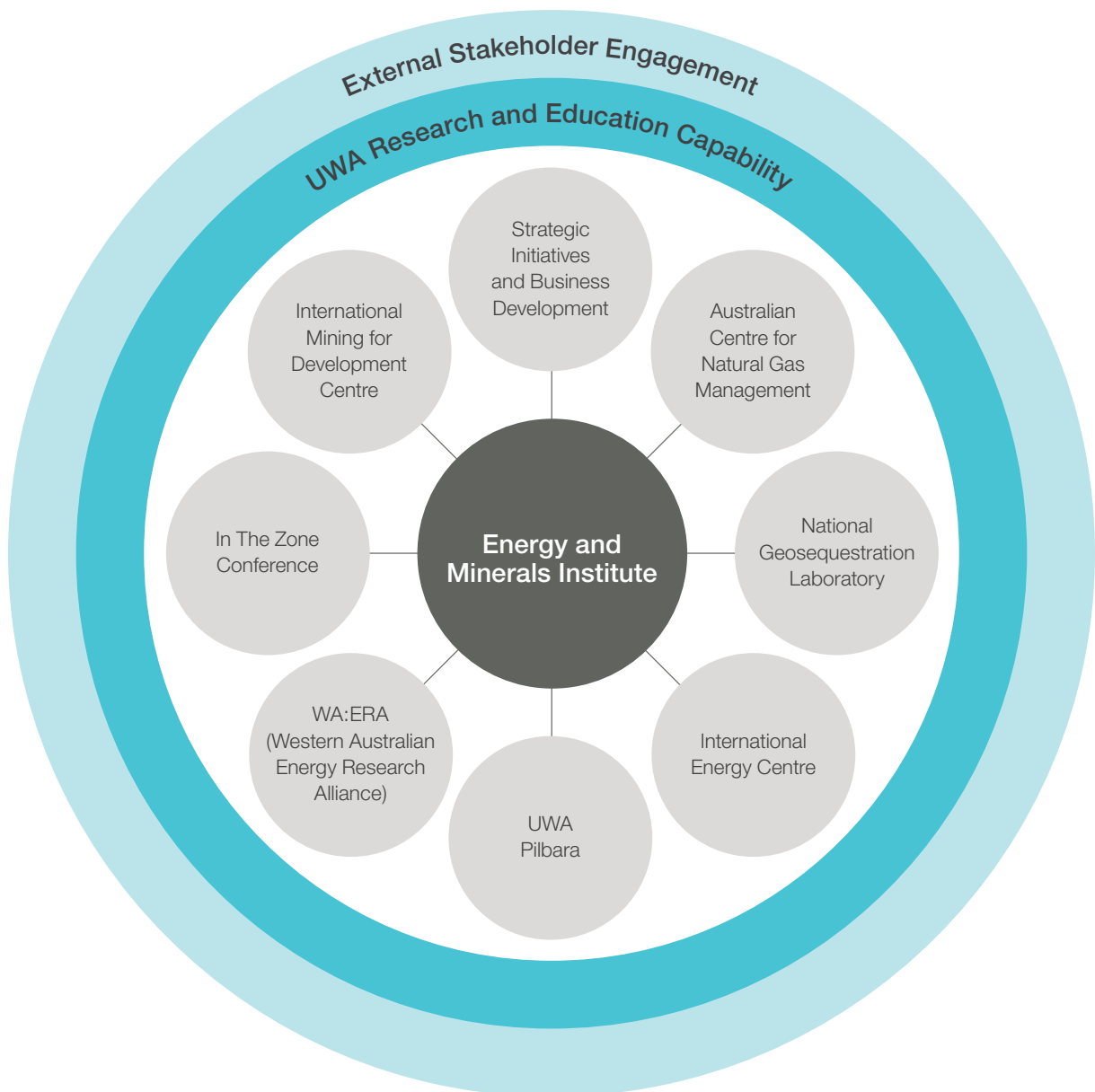
**Perth CBD Office**  
133 St Georges Terrace



# Our Structure

## Energy and Minerals Institute Board of Trustees

<b>Greig Gailey</b>	Chairman of the UWA Energy and Minerals Institute Board of Trustees
<b>Professor Paul Johnson</b>	Vice-Chancellor, The University of Western Australia
<b>Tim Shanahan PSM</b>	Director, Energy and Minerals Institute, The University of Western Australia
<b>Ann Pickard</b>	Country Chair Australia / Executive Vice President Upstream, Shell Development (Australia) Pty Ltd
<b>Greg Lilleyman</b>	President – Pilbara Operations, Iron Ore, Rio Tinto
<b>Glenn Kellow</b>	President, Aluminium and Nickel, BHP Billiton
<b>Professor Robyn Owens</b>	Deputy Vice-Chancellor (Research), The University of Western Australia
<b>Dr Alex Wonhas</b>	Director, Energy Transformed Flagship, CSIRO
<b>Dr Richard C Smith AO, PSM</b>	Australia's Special Envoy for Afghanistan and Pakistan



# Our People



**Tim Shanahan**  
EMI Director

Leading one of the University's key strategic priority areas, Tim's role unites the high level of energy and minerals education and research associated activities across UWA. He also builds the EMI's collaborative structures and networks with business, governments and other universities - locally, nationally and internationally.

Tim's leadership and depth of knowledge in the energy and minerals sector is also helping transform approaches to solving problems and developing solutions - building innovation, investment and partnerships that create value for the University, the resources sector, our partners, the community and other stakeholders.

“  
Our team is focused on promoting, coordinating and facilitating successful research and education outcomes for the University and the resource sector, whilst continually developing exciting collaborative opportunities with others that elevate UWA's global performance and reputation, and help create solutions that benefit both industry and society.  
”

Tel: (08) 6488 4608  
Email: [tim.shanahan@uwa.edu.au](mailto:tim.shanahan@uwa.edu.au)



**Mark Stickells**  
EMI Deputy Director

Mark's focus is on the delivery of major EMI strategic initiatives, financial management, and marketing and promoting the EMI - both internally and externally. He plays a major role in liaising with multidisciplinary networks across UWA, nationally and internationally to create opportunities for collaboration and partnership with other institutions and organisations.

Mark's extensive experience in joint-venture R&D management, funding and partnerships provides EMI with the expertise to negotiate and implement major projects and create value for UWA and industry.

“  
It's an exciting time at EMI as we develop new ways to work with our partners and support UWA's significant talent and capability to tackle the major energy, resource and environmental challenges of our time.  
”

Tel: (08) 6488 5326  
Email: [mark.stickells@uwa.edu.au](mailto:mark.stickells@uwa.edu.au)



**Ian Satchwell**  
IM4DC Director

Ian is Director of the International Mining for Development Centre (IM4DC), a joint venture between UWA and The University of Queensland, funded by the Australian Government through AusAID. Ian works closely with UWA's world leaders in mining research and education, partners, governments and others to facilitate the provision of practical advisory, education and training services to developing nations.

“

IM4DC is helping developing countries use their natural resources to grow their economies and provide social benefits to their people. It's very rewarding and I'm proud to be involved.

”

Tel: (08) 6488 4608  
Email: [ian.satchwell@im4dc.org](mailto:ian.satchwell@im4dc.org)

**Dr Jim Limerick**  
Project Director

Jim has worked with the EMI to advance UWA's engagement with the energy and minerals sector. He has 30 years' experience in both private and government organisations associated with the resource industry. From 1999-2008 Jim was Director General of the Department of Industry and Resources. In 2008 he was awarded the Australian Public Service Medal for outstanding public service to Western Australia's mineral and resource industries.



**Kymette Peck**  
Business Development  
Manager (Minerals)

Kymette facilitates and builds valuable relationships and research and education networks, collaborations and partnerships between UWA, governments, funding bodies, and resource sector industries. She works closely with UWA's research and development community, particularly in minerals-related disciplines. Kymette facilitates international exchanges and liaises with overseas governments on a range of research and education opportunities.

“

The EMI as a gateway to industry has opened up huge opportunities for UWA and I really enjoy being part of that.

”

Tel: (08) 6488 7183  
Email: [kymette.peck@uwa.edu.au](mailto:kymette.peck@uwa.edu.au)



**Jill Stajduhar**  
Business Development  
Manager (Energy)

Jill holds a number of key roles within EMI that facilitate the development of valuable research and education networks, collaborations, projects and partnerships with national and international companies and institutions across the energy portfolio. Jill was appointed to the role of Western Australian Energy Research Alliance Manager in 2008, and Australian Centre for Natural Gas Management Manager in 2010. She was also the foundation Deputy Director (Operations and Business Development) for the International Mining for Development Centre and she continues to support UWA's relationship with the IM4DC and its stakeholders.

“

My role provides an opportunity to bring the depth and breadth of UWA knowledge and expertise to challenges faced by industry, government and the general community.

”

Tel: (08) 6488 4745  
Email: [jill.stajduhar@uwa.edu.au](mailto:jill.stajduhar@uwa.edu.au)



**Ben Killigrew**  
Pilbara Project Director

Ben leads the UWA Pilbara project, an initiative to further strengthen our research and executive education presence in a region that accounts for much of Australia's energy and minerals wealth. Ben's role includes project funding, feasibility analysis and stakeholder engagement with UWA, government, industry and community. The project seeks to enhance economic diversification and educational outcomes for the Pilbara.

“

The Pilbara is critical to the nation's economy and it's exciting to support UWA in playing a more significant role in driving innovation and productivity growth for the region's industry, communities and environment.

”

Tel: (08) 6488 2188  
Email: [ben.killigrew@uwa.edu.au](mailto:ben.killigrew@uwa.edu.au)



**Shaheen Hughes**  
In The Zone Director

Shaheen leads EMI's In the Zone conference, Western Australia's premier forum for dialogue on issues of regional significance. She brings topics of contemporary interest together with engaging speakers to present about strategic issues to our region's most senior thought-leaders. Shaheen works closely with national and international institutions, UWA and others, encouraging understanding about what being part of the Asian century means for our future.

“

There are fantastic opportunities for cross-cultural learning, diplomacy and trade and I really enjoy thinking about the endless possibilities associated with this initiative.

”

Tel: 0418 753 383  
Email: [shaheen.hughes@uwa.edu.au](mailto:shaheen.hughes@uwa.edu.au)



**Nicola Holman**  
Communications &  
Marketing Coordinator

Nicola is responsible for all EMI branding and communications from website, media and event management, to writing e-newsletters, speeches, advertising and other material. She also manages a broad range of important internal and external stakeholder communications, and contributes her expertise to a number of working parties that advance the role of both the EMI and the University.

“

It is very inspiring to be part of the EMI team and it's a great privilege to work alongside some of the greatest minds in the resources sector.

”

Tel: (08) 6488 7586  
Email: [nicola.holman@uwa.edu.au](mailto:nicola.holman@uwa.edu.au)



**Shari Owen**  
Executive Assistant  
to EMI Director

Shari provides high-level executive support to the EMI Director and assists with a range of activities and events. She supports other team members across EMI functions and liaises extensively with stakeholders within UWA and in the resource sector. Shari also provides assistance to the EMI Board.

“

I enjoy the autonomy of my role and the changes that the Institute strives to deliver for the University.

”

Tel: (08) 6488 4608  
Email: shari.owen@uwa.edu.au



**Vicki White**  
Administrative Officer

Vicki provides administrative support to the EMI team as well as the joint venture with Curtin University on the Australian Centre for Natural Gas Management program. She joined EMI in 2012 following seven years of experience in the not-for-profit sector in Personal Assistant and Executive Assistant roles.

“

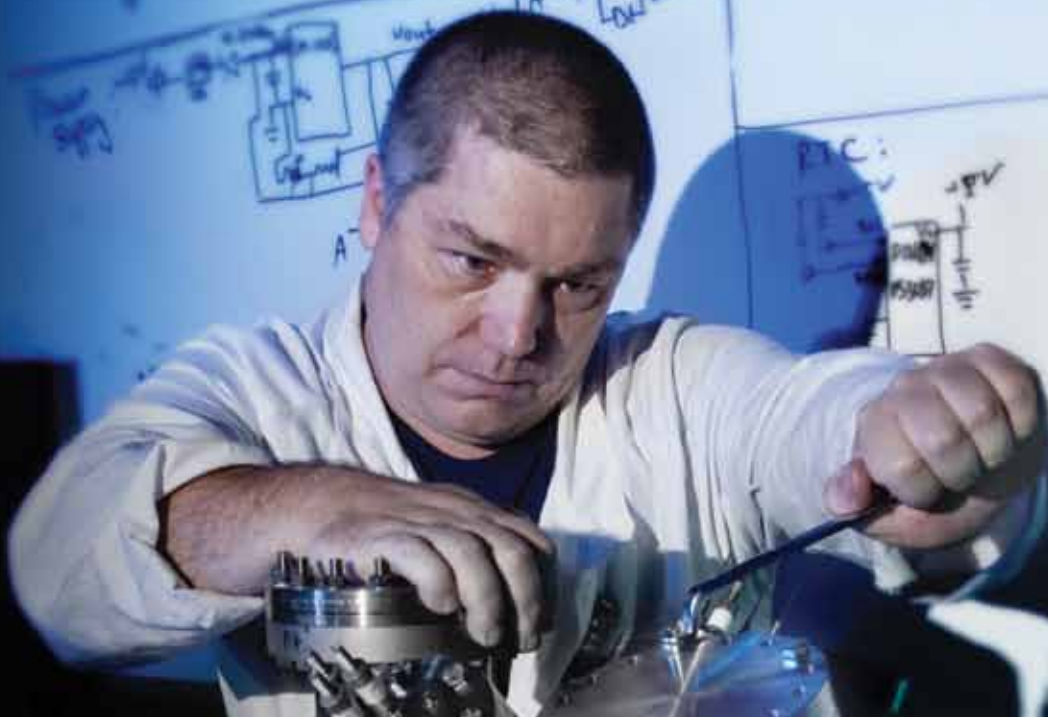
I enjoy the variety in my role that allows me to apply my various skills in the day to day support to the EMI team. I also enjoy the interactions within the University and with our stakeholders.

”

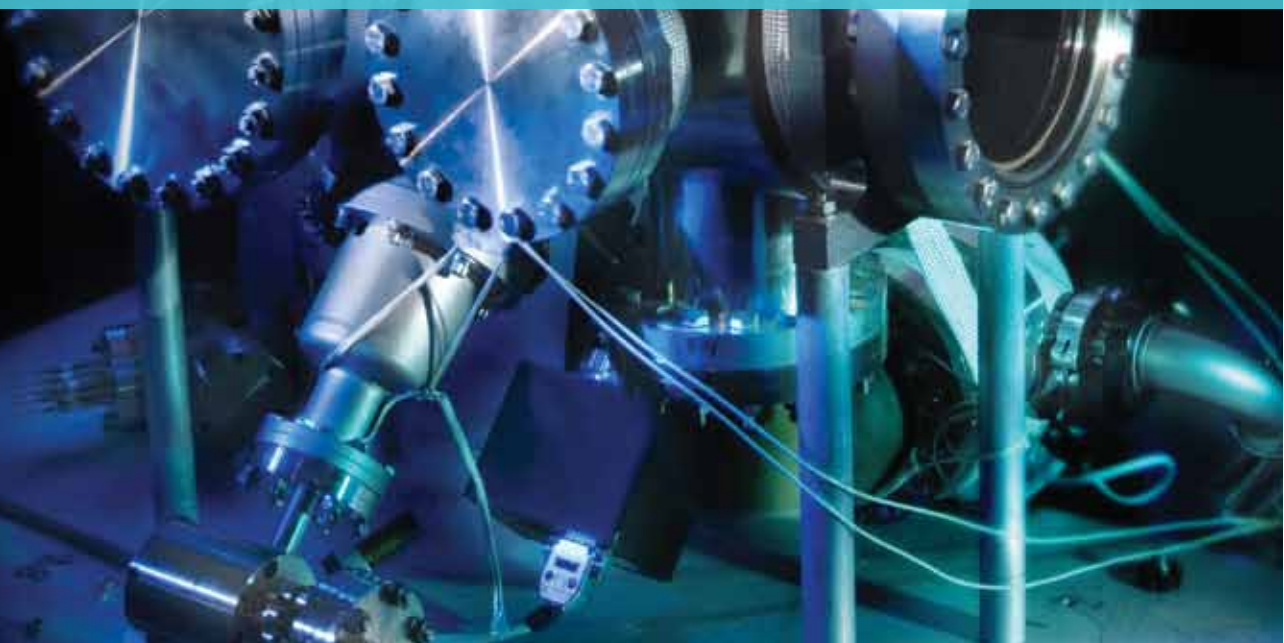
Tel: (08) 6488 8529  
Email: vicki.white@uwa.edu.au

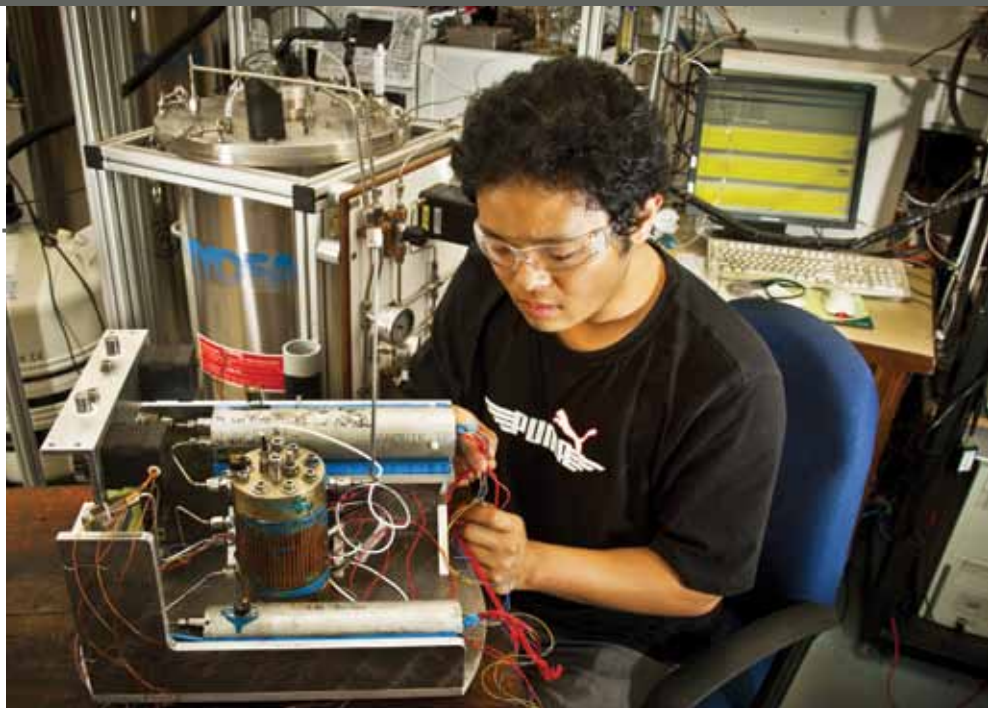


# Highlights



Enriching education  
and research





### EMI negotiates \$3 million partnership with Rio Tinto

**UWA became the first partner of Rio Tinto's Global Education Partnerships Program in 2012. Rio Tinto's \$3 million investment, negotiated by the EMI on behalf of UWA, will foster skills for the future and build education capability.**

The program will establish a worldwide network of leading universities to generate and foster an appropriate expertise base for the resources industry. Supporting a joint focus on building a supply of diverse talent, the scholarship framework also aims to encourage more female, international and Indigenous students into key study areas.

**"This partnership will focus on building career and learning opportunities and will establish a capacity of sustainable skills for the future benefit of the industry and the broader community," said Executive Director Rio Tinto, Sam Walsh AO.**



### Chevron invests in UWA engineering

**Chevron invested more than \$5.7 million to establish an endowment that supports a Professorial Chair in Gas Process Engineering in perpetuity at UWA. This investment, negotiated by the EMI in 2011, builds on our successful partnership with Chevron, which selected UWA to join its prestigious Global University Partnership Program in 2008.**

Chevron's foresight will lead to a legacy of sustained, high-quality academic and industry-oriented outcomes that will further enhance Western Australia's reputation as a world energy hub," said Chevron Chair in Gas Process Engineering, Winthrop Professor Eric May.

With further investment from UWA, the partnership is delivering outcomes such as industry-run workshops, seminars, prizes and scholarships, new major laboratory teaching equipment, and PhD student training.

"In addition, in the area of gas processing research we have secured more than \$8 million in funding for new projects and facilities, completed five major research projects for local industry, and presented many of the results widely by hosting and attending major international scientific and engineering conferences."



## Shell partnership strengthens offshore foundations

In collaboration with Shell, UWA will further strengthen education and research in Western Australia with a new Shell EMI Professorial Chair in Offshore Foundations and Metocean Engineering.

**Negotiated by the EMI in 2011, this investment will improve research collaboration and techniques for forecasting metocean conditions and associated impacts on offshore oil and gas operations. It will also develop education in metocean and subsea engineering, and improve the employment readiness of UWA graduates in this field.**

Shell and UWA's Centre for Energy are also developing a new breed of engineering graduates to lead the search, recovery and production of oil and gas into the future. Thirty two students completed for the first time in 2012 the internationally renowned Shell 'Introduction to Upstream Business' course.

"This is an outstanding opportunity for UWA students studying oil and gas, petroleum and process engineering to learn from the best in the industry," said Winthrop Professor Eric May, who leads the initiative. "With Western Australia's resources sector thriving, there are many opportunities for UWA students to apply this knowledge."

**"We see this as an important opportunity to contribute to research that will benefit the whole offshore industry, and better equip Western Australia to fulfil its potential as a global energy hub," said Shell Australia Country Chair, Ann Pickard.**





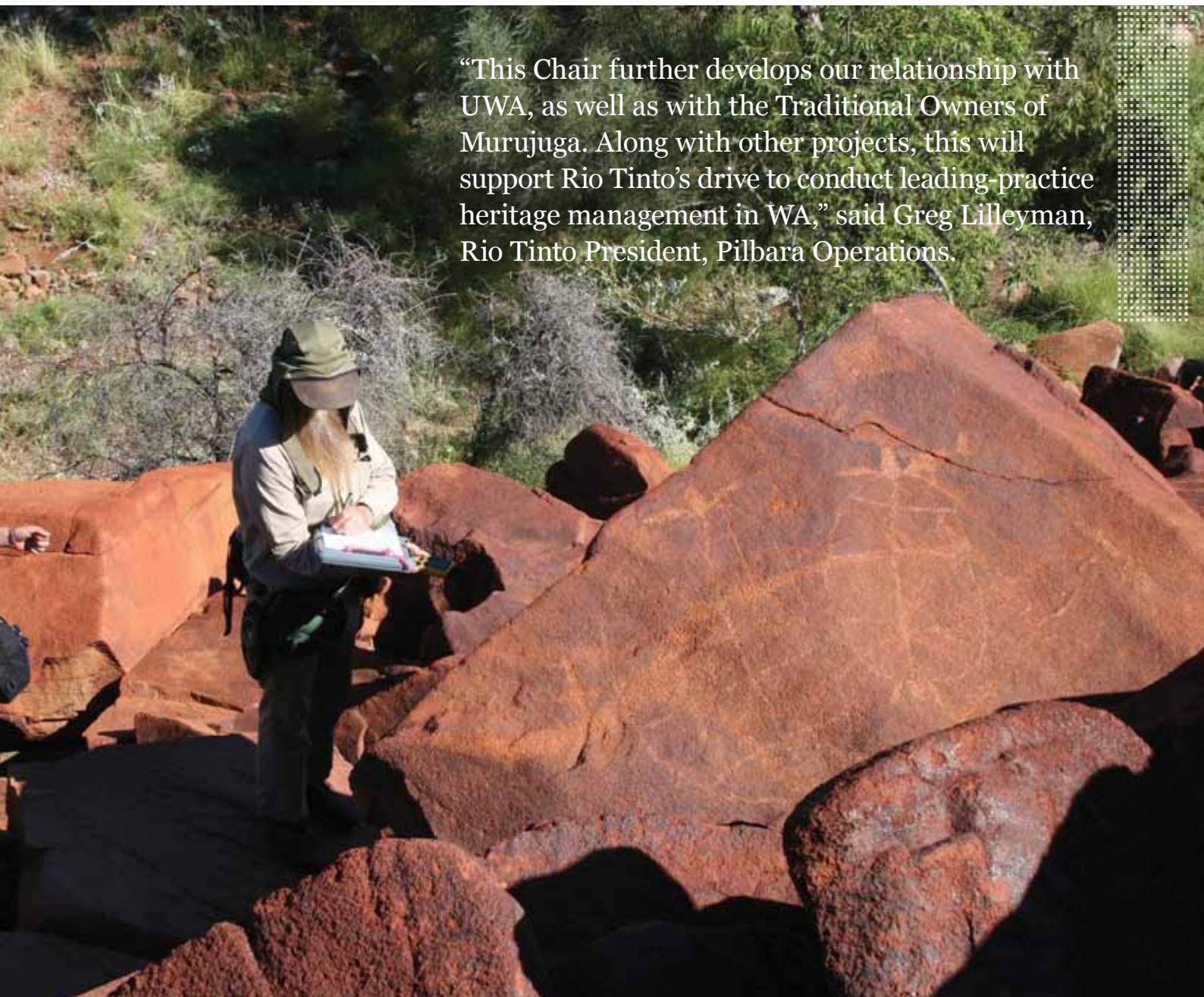


### **Rio Tinto invests in rock art research**

**Leading international mining group Rio Tinto has partnered with UWA and invested more than \$1 million over six years to create the Rio Tinto Chair in Rock Art Studies. The investment will research, catalogue and promote tens of thousands of Indigenous rock art treasures in Western Australia's remote Pilbara region.**

The primary focus of the research will be one of the world's richest collections of Indigenous rock art at the National Heritage-listed Dampier Archipelago, about 1,250 kilometres north of Perth.

Rio Tinto's investment builds on existing strengths at UWA's Centre for Rock Art Research and Management. The interdisciplinary Centre was launched with support from the EMI and brings together experts from the disciplines of archaeology, chemistry, Indigenous studies and fine arts.



“This Chair further develops our relationship with UWA, as well as with the Traditional Owners of Murujuga. Along with other projects, this will support Rio Tinto’s drive to conduct leading-practice heritage management in WA,” said Greg Lilleyman, Rio Tinto President, Pilbara Operations.



## Developing high-tech graduates with industry

The UWA Woodside-Chevron Chair in Petroleum Geoscience and CO<sub>2</sub> Sequestration is a joint partnership aimed at developing high-tech geoscience graduates who will meet the State's need to be increasingly competitive in the international petroleum industry.

Winthrop Professor David Lumley is addressing industry and government's need for enhanced tertiary education in petroleum geology and geophysics. He leads the Centre in Petroleum Geoscience and CO<sub>2</sub> Sequestration, building world-class capability that enhances UWA's existing strengths in an area crucial to our State's development. It currently supports approximately 35 PhD, Masters and Honours students.

With support from the EMI, the Centre continues to develop strong links with industry and government.

## Woodside and UWA lead the way

Woodside invested in the UWA Business School in 2008 with the appointment of Professor David Day to the Woodside Chair in Leadership and Management. Its investment fosters leadership and excellence in the Business School's teaching, research and community engagement areas, and particularly in leadership and management.

“The future of the resources industry depends on continued improvement in both business and technical skills, which requires strong links between the business and university sectors,” said former Woodside CEO, Don Voelte.

“Woodside is leading the way, and I encourage others who value the importance of education to come forward and invest in this State's future.”





## BHP Billiton invests in business excellence

UWA's Business School has built a partnership with BHP Billiton over 10 years and fostered leadership and excellence in teaching, research and community engagement.

The EMI supports the appointment of leading economist Professor Peter Hartley, President of the US Association for Energy Economics, to the new role of BHP Billiton Chair in the Business of Resources, commencing in May 2013.

"We are proud to support this appointment, which represents a significant milestone in our partnership with UWA," said Julius Matthys, Vice President of External Affairs for BHP Billiton WA.



## EMI creates opportunities for COFS and Korea

**The EMI facilitated the development of stronger industry ties between the Centre for Offshore Foundation Systems (COFS) and Korea with a visit to UWA and the Pilbara by a group of Korean academics and oil and gas executives. The 2012 visit resulted in a commitment to further cooperation and research projects that will deliver mutual benefits.**

"Our relationship with UWA offers invaluable opportunities for Korean students to come and gain relevant experience in a vibrant and dynamic environment at the centre of WA's resources hub," said Korea Maritime University Professor Seung Jae Lee.

COFS also visited the Korea Advanced Institute of Science and Technology (KAIST) resulting in research collaborations and PhD student exchanges with the KAIST Ocean Technology Centre.

COFS conducts world-class research in the mechanics of seabed sediments, offshore geohazards, and in offshore foundation and engineering systems. Its expert team also services the offshore petroleum and renewable energy industries at both a national and international level.





## Building talent and capacity



## EMI establishes the IM4DC at UWA

The International Mining for Development Centre (IM4DC) is a \$31 million Federal government initiative funded through AusAID, announced by the Prime Minister in October 2011 at UWA.

**The IM4DC is a joint venture between UWA and The University of Queensland and is managed within the EMI. The Centre assists developing nations to establish and maintain sustainable mining sectors, improve governance and accountability, and strengthen economic outcomes through better education and capacity building.**

It also assists in bringing developing countries the expertise they need to build a socially and environmentally sustainable mining sector that provides economic and social benefits to their people. This includes practical advisory, education and training services across the breadth of mining-related issues.

Over 1,000 people from developing nations will participate in 40 education courses and workshops by mid 2013.

**“This initiative will draw on expertise from across government, industry and academia in Australia to help more than 30 developing countries in Africa, the Asia-Pacific and Latin America address mining-related challenges,” said Prime Minister Julia Gillard.**



---

### EMI collaborates in \$48 million carbon storage initiative

The National Geosequestration Laboratory (NGL) is a \$48.4 million collaborative initiative between UWA, CSIRO and Curtin University, and through WA:ERA supports a research partnership with the South West Collie Hub CCS Flagship. The UWA node of the NGL is led by the EMI.

The NGL is a national research and development facility established in 2012 to develop innovative solutions to minimise risk and uncertainty regarding long term geological storage of carbon dioxide. It will develop and deploy critical research and development to help enable commercial scale carbon storage in Australia.

“Universities play an important role in carbon storage research, development and demonstration, and working together with our partners in industry and government we can help provide certainty, objective data and the analysis needed to provide confidence in this key approach to reducing emissions,” said EMI Director, Tim Shanahan.

UWA's share of the Federal Government's investment includes funding to build a multi-million dollar CO<sub>2</sub> laboratory at UWA and several million dollars of new specialist research equipment for UWA and the Australian Resources Research Centre.

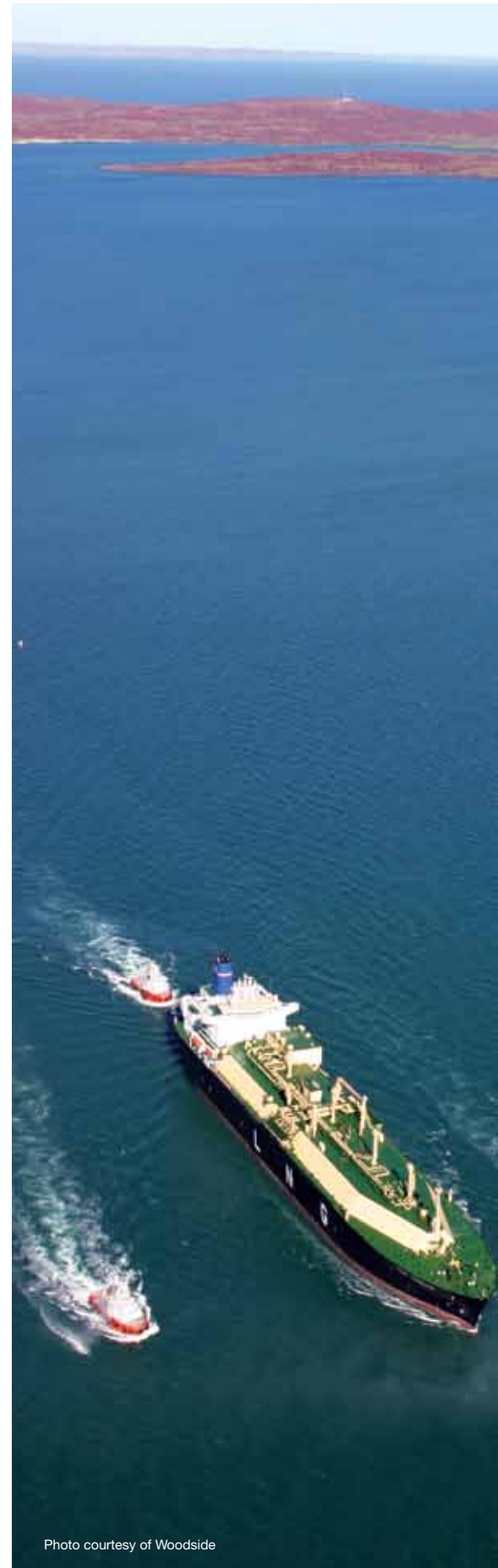


Photo courtesy of Woodside





Advancing oil and gas research capacity

The EMI manages UWA’s engagement with the WA Energy Research Alliance (WA:ERA), a joint venture between UWA, CSIRO and Curtin University that builds research capacity in the oil and gas industry.

The EMI has worked closely with WA:ERA over recent years to sustain key relationships with existing industry partners that include Chevron, Woodside Energy and CGG Veritas. We also work to develop and advance new alliances with other companies in the oil and gas industry.

In addition, the new \$48.4 million National Geosequestration Laboratory (NGL), established to conduct research into the geological storage of carbon dioxide, was secured through the WA:ERA alliance.

UWA in the Pilbara

Led by the University’s Pilbara Taskforce, the EMI is facilitating the establishment of a UWA research and education facility in the Pilbara to support this vital region.

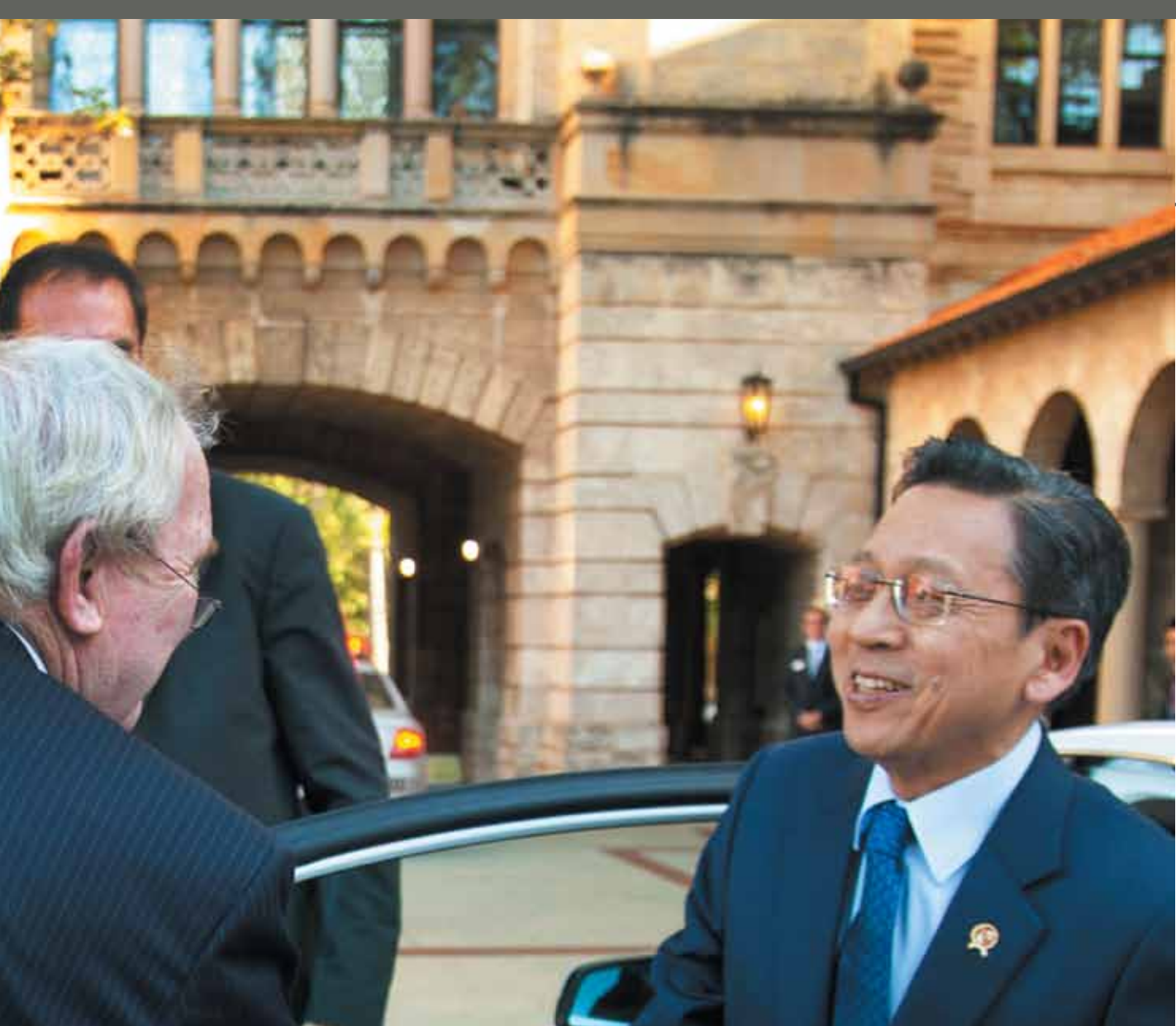
The EMI will promote UWA’s presence in the region and provide a pathway for leading expertise to deliver education, research and policy support - contributing to issues of local, national and international significance such as biodiversity, rock art and regional development. With feasibility study funding from the Royalties for Regions initiative, UWA’s presence will also support the Pilbara Cities vision to develop the region’s economic and social diversity.

By investing in intellectual and infrastructure capital, UWA can support regional skill and professional development, help improve productivity, promote environmental excellence, and enrich the Pilbara through research and education.



Photo courtesy of LandCorp





## Creating collaborations and alliances



## EMI promotes world-class education and training

The International Energy Centre (IEC) is a strategic network of three leading Australian Universities and major industry partner Xstrata Coal. The IEC is an industry leader in the delivery of world-class postgraduate education and training, innovative solutions and expert advice to support a low carbon future.

The EMI is responsible for the University's participation in the IEC. The IEC is dedicated to being the trusted catalyst to enable industry, government and individuals to transition towards a low carbon environment.

The IEC offers the Master of Energy Studies – Carbon Management, which equips future government, research, industry and community leaders with the skills and expertise to address energy challenges and devise solutions for a sustainable future.



## Building engagement with China's LNG sector

**The EMI represents UWA in the Australian Centre for Natural Gas Management. The Centre is a partnership with Curtin University funded by the Australia-China Natural Gas Technology Fund that has delivered leading-edge training programs to over 130 Chinese LNG managers and executives from more than 10 natural gas companies in China.**

In 2011, the EMI negotiated an extension to the UWA-Curtin agreement, ensuring the Centre continues operations to 2014. The Centre will also focus on creating an opportunity pipeline to further develop customized training programs.

"This initiative is building UWA's profile and engagement with the LNG sector in China, and contributing to its international reputation as a leader in LNG expertise," said EMI Director, Tim Shanahan.





### Korean universities collaborate with UWA

Ten Korean universities are collaborating with UWA and Curtin University to assist in training engineers in the energy and mineral sectors. The agreement covers education and research, student and academic exchanges, cooperative research projects, and an executive development program.

The EMI manages the collaboration on behalf of UWA. The collaboration aligns with UWA's mission to advance, transmit and sustain knowledge for the benefit of international and national communities, and the State of Western Australia.

"We are providing our Korean visitors with an integrated and rich experience involving practical training in the resources sector, combined with cultural training and the opportunity to develop English language skills through the professional environment," says EMI Director Tim Shanahan.



## In The Zone

The EMI leads and manages the In The Zone conference series on behalf of UWA, which established the initiative in 2009 as Western Australia's premier forum for dialogue on issues of regional significance.

In The Zone brings together the region's most influential government, business and community leaders to engage on issues relevant to policy, trade, and diplomatic and investment relationships that are critical in this Asian Century.

Across business and the community, UWA is in a position to harness the benefits of sharing ideas, innovation, technology and research across a multi-dimensional cultural and commercial landscape.



**THE ZONE** /zōn/ ~noun  
THE TIME ZONE SHARED BY  
PERTH, 60 PER CENT OF THE  
WORLD'S POPULATION, AND THE  
NATIONS THAT PROMISE THE  
GREATEST ECONOMIC GROWTH OF  
THE TWENTY-FIRST CENTURY.



“There is a much bigger role for Western Australia as we acknowledge the importance of aligning our thinking with the prominence of the Asian and the Indian Ocean regions, seeking to optimise our relevance and influence within the zone’s political landscape,” said the UWA Chancellor Dr Michael Chaney AO.



# Meet some of UWA's leaders in energy and minerals research

The EMI works closely with many UWA world leaders and experts in a range of fields across key areas of energy and minerals research and education, some of whom are featured here. We also collaborate with other key strategic research Institutes at UWA, such as The Oceans Institute and The Institute of Agriculture. To meet more UWA talent visit us at [www.uwa.edu.au/faculties](http://www.uwa.edu.au/faculties)



**Gas Process Engineering**  
Winthrop Professor  
Eric May

Eric is the Chevron Chair in Gas Process Engineering. His research has developed breakthrough techniques for measuring gas properties under extreme conditions – providing critical data to advance the computer models used to design and optimise gas processing plants. Eric leads a team in natural gas research, covering areas of LNG production, CO<sub>2</sub> sequestration and gas processing, including the development of alternative methods for removing CO<sub>2</sub> and nitrogen from natural gas.



**Energy Conversion Technologies**  
Winthrop Professor  
Dongke Zhang FTSE

Dongke is Director of the Centre for Energy. He has conducted extensive research into fuel processing and conversion, and combustion science and technology, with a specific focus on coal, natural gas and biomass energy, and also on mine explosives, mine rehabilitation and mine water utilisation. His work in bioenergy includes thermochemical conversion of biomass to hydrogen and synthetic petroleum, transesterification of vegetable oil to biodiesel, bioethanol and biobutanol, and biochar and chemicals.



**Offshore Foundation Systems**  
Winthrop Professor  
Mark Cassidy

Mark is Director of the Centre for Offshore Foundation Systems and leads a research team investigating offshore geotechnics and engineering, predominantly developing wave-structure-soil interaction models for the analysis of oil and gas platforms, mobile drilling rigs and pipelines. His research contributes to our understanding of Australia's sub-sea soils, and supports safe future offshore infrastructure development and engineering.



**Energy Geoscience**  
Winthrop Professor  
David Lumley

David is Woodside-Chevron Chair and Director of the Centre for Petroleum Geoscience and CO<sub>2</sub> Sequestration. He is an internationally respected expert in 3D and 4D time-lapse seismic imaging of the earth's subsurface, including hydrocarbon exploration and recovery, and CO<sub>2</sub> injection and storage (geosequestration). The Centre builds on existing strengths at UWA in geology and geophysics, from large-scale plate tectonic and sedimentary basin processes, to pore-scale geological and rock physics phenomena.



**Coral Reefs & Climate Change**  
Winthrop Professor  
Malcolm McCulloch

Premier's Research Fellow, Professor McCulloch is working on applying isotopic and trace element geochemical methods to better understand the impacts of climatic and anthropogenic processes on the Earth's environment. He leads the new Advanced Geochemical Facility for Indian Ocean Research, studying environmental change affecting coral reef systems, and supporting the sustainable development of the Indian Ocean region.



**Plant Science**  
**Winthrop Professor**  
**Steven Smith**

Professor Smith was part of the founding team of the ARC Centre of Excellence in Plant Energy. He is Director of the Centre of Excellence in Plant Metabolomics that carries out fundamental research in plant metabolic biology. The Centre's goal is to develop strategies to select or tailor plants for improved performance under environmental extremes, and for improved production of food, materials or bio-energy.



**Geothermal Energy**  
**Winthrop Professor**  
**Klaus**  
**Regenauer-Lieb**

Premier's Fellow Professor Regenauer-Lieb is an eminent, internationally recognised scientist who leads UWA's geothermal research effort. He is at the forefront of mathematical geophysics and computational geodynamics, which holds the key to locating new mineral deposits. Combining geology with geodynamics, his work involves looking back four billion years to understand where the Earth's deposits of various valuable minerals were formed. This allows exploration companies to intelligently predict locations for mineral exploration.



**Ecosystems**  
**Research**  
**Dr Pauline Grierson**

Pauline is Director of the WA Biogeochemistry Centre and leads the Ecosystems Research Group. She has extensive experience in the application of stable isotope methods to examine ecosystem processes, particularly in assessing ecological water requirements of semi-arid ecosystems. Much of her research is focussed in the north-west, where rainfall is predicted to increase due to climate change and where management of water resources is crucial for mining companies.



**Asset Management**  
**Professor**  
**Melinda Hodkiewicz**

Melinda is the head of the Engineering Asset Management Program at UWA, Chair of the Standards Australia committee, and member of the ISO committee responsible for development of an ISO Standard for asset management. She is responsible for UWA's Business & Engineering Asset Management Masters program, the AIM-UWA Alliance 'Asset Management for Managers' Executive course, and works with a number of global and national organisations on professional development for Asset Managers. Melinda collaborates with government and industry on research projects, particularly in the areas of prognostics, asset data quality, life-cycle costing and safety.



**Leadership**  
**& Safety**  
**Winthrop Professor**  
**Mark Griffin**

Mark is Co-Director of the Accelerated Learning Laboratory. His research seeks to understand how organizational contexts shape, and are shaped by, individual performance and well-being. Current projects investigate leadership, safety, performance management and work stress. Mark has extensive experience managing large leadership and safety projects across Australia, Europe, and the USA.



**Leadership & Management**  
**Winthrop Professor**  
**David Day**

David is the Woodside Chair in Leadership and Management at the UWA Business School. His core research interests are in leadership and leadership development, and he is a leading author and editor on the subject of leadership. David is a Fellow of the American Psychological Association and the Society for Industrial and Organizational Psychology. He works with a diverse range of large organisations on projects related to leadership and leadership development. David was awarded the 2010 Walter F. Ulmer Research Award from the Centre for Creative Leadership for outstanding, career-long contributions to applied leadership research.



**Rock Art**  
**Professor**  
**Jo McDonald**

Jo has been recording Australian rock art for more than 30 years. She is the Director of the UWA Centre for Rock Art Research and Management and holds the endowed Rio Tinto Chair in Rock Art Studies. She was Principal Investigator on the Canning Stock Route Project (rock art and Jukurrpa) and is now an ARC Future Fellow, comparing patterns in Australian desert rock art with that found in rock art of the American Great Basin.



**Exploration  
Targeting**  
Professor  
Campbell McCuaig

Campbell is the Director of the Centre for Exploration Targeting, a joint venture between The University of Western Australia, Curtin University and the minerals industry that is focused on advancing the science of exploration targeting. His leadership has resulted in a world-recognised sustainable research centre with research outcomes that are impacting on exploration industry practice, and is being recognised globally at the highest academic levels.



**Regional  
Development**  
Professor  
Matthew Tonts

Matthew is Professor of Geography, Director of the Centre for Regional Development and Head of the School of Earth and Environment. His research interests focus on the role of resource industries in regional economic development, the dynamics of regional labour markets, and indicators of socio-economic wellbeing. In addition to work on regional development in Australia, he has worked on similar issues in Africa, Canada, China, Europe and the United States.



**Energy &  
Minerals Law**  
Professor  
John Chandler

John is Co-Director of the UWA Centre for Mining, Energy and Natural Resources Law, where he established the Graduate Diploma in Energy Law. He has specialised in energy law over the past 15 years and has more than 30 years' experience in large commercial legal firms, advising on many of Western Australia's biggest resource projects. John has significant experience acting for international oil, gas and mining companies. His latest project is a course on Corporate Governance for Resource Companies, which is being offered in February 2013.



**Social Impact  
Winthrop Professor**  
Paul Flatau

Paul is the Chair in Social Investment and Impact at UWA's Business School and Director of the Centre for Social Impact (UWA). Paul's work in recent years has involved close contact with the resources sector but also with not-for-profit organisations and government partners. Paul manages the CSI (UWA) research, teaching and community engagement programs and he is project director of a large array of research projects, including studies concerned with social impact assessment in the resources sector.



**Marine Science**  
Professor  
Jessica Meeuwig

Jessica is a Conservation Fellow of the Zoological Society of London and Director of the UWA Centre for Marine Futures. Her main expertise is in marine and fisheries conservation and quantitative modelling. Jessica's research includes investigating the displacement of humpback whales as a result of coastal development, researching how sharks and fish use underwater banks and canyons, and how marine sanctuaries generate ecological and economic benefits.

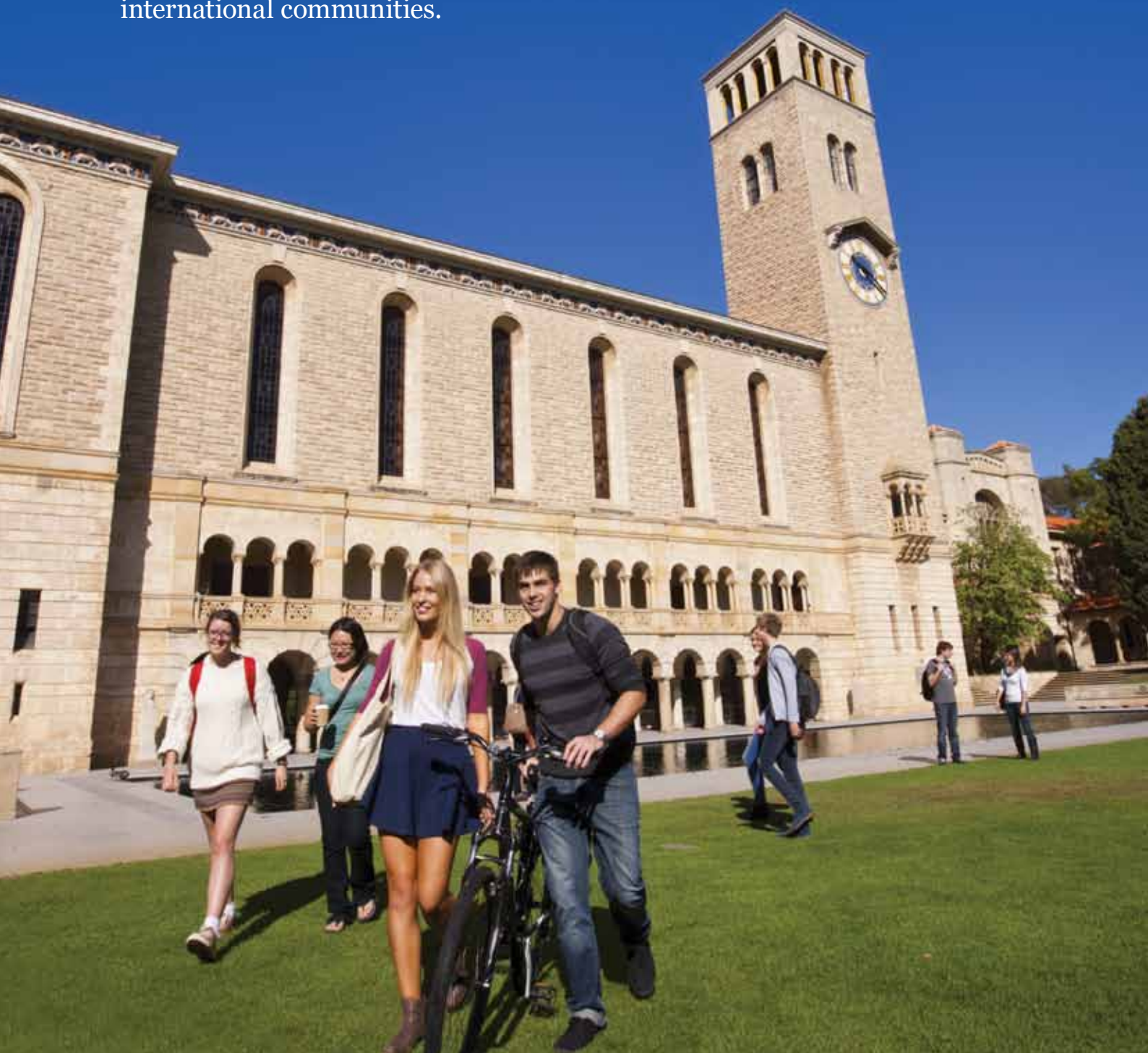


**Sleep Science**  
Winthrop Professor  
Peter Eastwood

Peter is the inaugural Director of UWA's Centre for Sleep Research. Peter's research group investigates the pathophysiology of upper airway dysfunction in individuals with sleep-disordered breathing. His research has led to the development of novel techniques and unique capabilities to image the human upper airway, the application of general anaesthesia to examine upper airway function, and the use of nerve stimulation to treat sleep apnoea.

# The University of Western Australia is one of the world's best.

Our mission is to advance, transmit and sustain knowledge and understanding through the conduct of teaching, research and scholarship at the highest international standards for the benefit of the Western Australian, Australian and international communities.





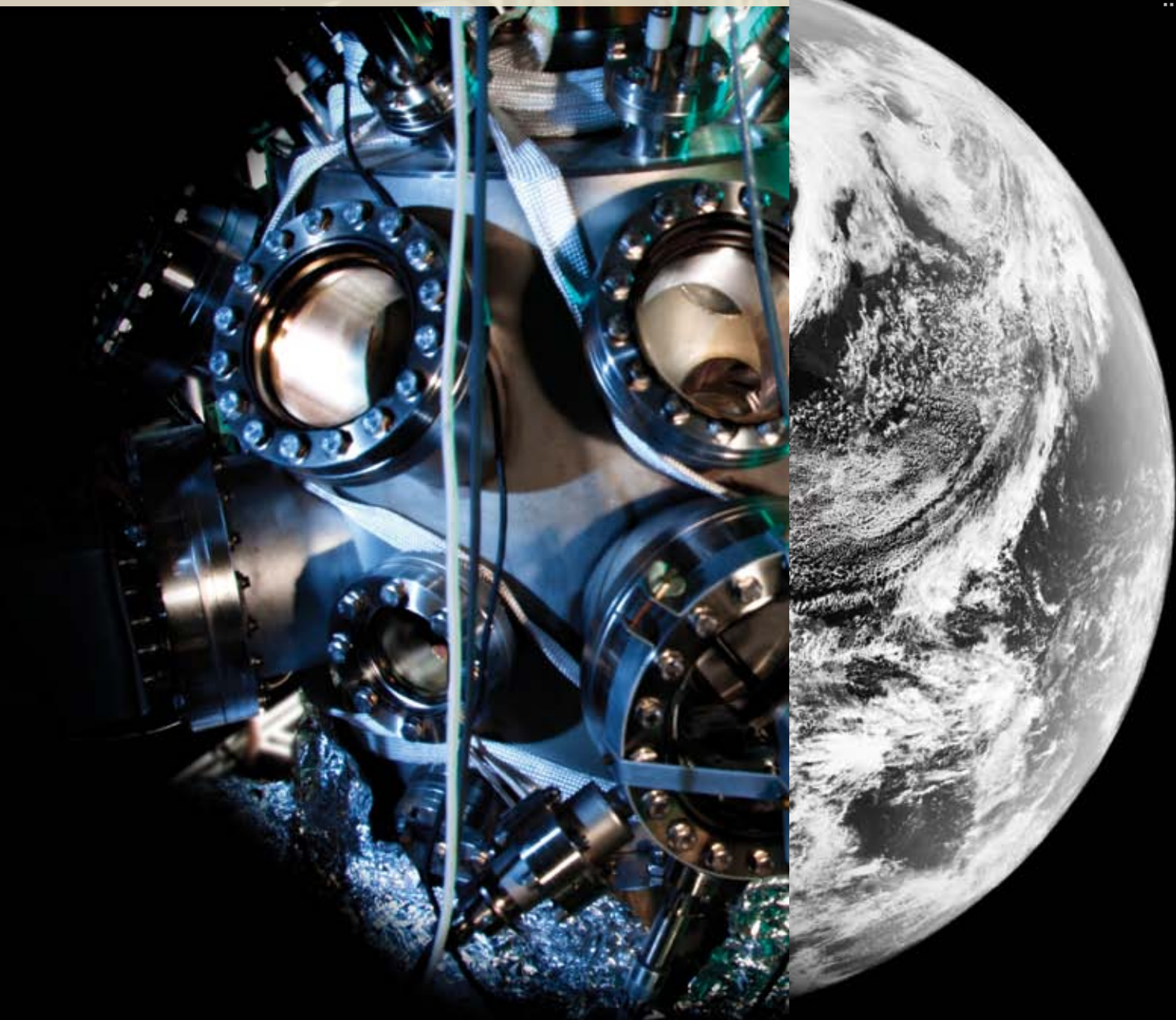


THE UNIVERSITY OF  
WESTERN AUSTRALIA  
*Achieve International Excellence*

ENERGY AND MINERALS INSTITUTE

# World-Class Infrastructure for Energy and Minerals Research

Creating innovative  
solutions for  
resource challenges



ACHIEVE INTERNATIONAL EXCELLENCE

# World-Class Infrastructure for Energy and Minerals Research

Creating innovative solutions with brilliant minds and state-of-the-art facilities



Behind every leading economy, there is a leading University. The University of Western Australia is well positioned to provide the intelligence resources needed to drive the minerals and energy sector. We embody the education, research and community engagement needed to gain the maximum benefit from the sector and secure the nation's future.

At UWA we nurture and promote a culture of innovation, education and high ambitions, and we have the intellectual capacity to apply creative thinking to the technological challenges facing industries.

Our University accounts for the great majority of competitive research activity, and the majority of scientific publications, in Western Australia.


Together with industry, UWA can create a world-class innovation hub here in Western Australia – tackling solutions that address pipeline stability and deep-water engineering, CO<sub>2</sub> sequestration, mineral exploration, soil science, harnessing alternative energy, environmental impact - and the myriad associated human resources issues such as occupational health and safety, sleep science and leadership development.

This period of unparalleled economic advantage has given industry and our University a great opportunity to challenge and change society for the better.

**Professor Paul Johnson**  
Vice Chancellor







iVEC@UWA supercomputing facilities are powering UWA's energy and minerals research

The energy and minerals sector is the driving force powering Australia's economy, attracting unprecedented global investment and creating substantial economic and social opportunities for the nation. The sector is also facing significant challenges in its quest to explore and extract resources, optimise infrastructure investment, and effectively manage a range of complex issues including human resources, environment and safety – all within a sustainable development framework.

**At The University of Western Australia, our researchers are harnessing the powerful capability of our world-class research facilities, and delivering innovative solutions that meet these challenges. From high-performance, multi-million dollar infrastructure, to unique experimental technology, our facilities support cutting-edge research across the depth and breadth of resource related issues.**

The UWA Energy and Minerals Institute (EMI) is the gateway for industry to engage with our world-class research



and facilities. Through engagement and collaboration, EMI facilitates the University's energy and minerals research partnerships - addressing industry needs by bringing together the right expertise.

Within these pages is a snapshot of our state-of-the-art facilities and how they are advancing the frontiers of knowledge and technology in the energy and minerals sector.

More information on our facilities is available on our website at [www.emi.uwa.edu.au](http://www.emi.uwa.edu.au).

**Tim Shanahan**  
Director, UWA Energy and Minerals Institute

# Advancing seabed science for offshore engineering

## Deep Water Engineering

Capable of reproducing the behaviour of complex seabed sediments, UWA's world-class centrifuge facilities support industry with geotechnical design for structures such as pipelines, anchors, foundations and jacket foundations.



*Photograph courtesy of Woodside*

The facility supports leading research into offshore foundation systems, including the mechanics of seabed sediments, geo-hazards and seabed mobility, and pipeline and deep water offshore engineering.

**“In the past decade, the facility has deepened our understanding of the North West Shelf seabed and we are developing new benchmarks for deep-water engineering and exploration in the region,” says Professor Christophe Gaudin at the Centre for Offshore Foundation Systems.**

COFS was established in 1997 by Professor Mark Randolph to better understand Australian subsea soils and develop adequate foundation solutions. Backed by internationally recognised academics and strong technical expertise, the Centre is the only one of its kind in Australia and the only testing and modelling facility in the southern hemisphere to have both a beam and drum centrifuge.

The Centre has developed extensive links with industry and provides technical capability to exploration and petroleum companies around the world in all aspects of safe and economic foundation design and operation.





## Pipeline Stability on the NW Shelf

Unique in the world, the giant O-Tube simulator creates cyclonic conditions in a controlled experimental environment, demonstrating how seabed sediment and pipelines interact during storms. The facility supports industry to improve pipeline designs - promoting safety, reducing risks such as pollution, and optimising infrastructure investment.

High costs for stabilising pipelines connecting Australia's North West Shelf gas fields to shore, prompted development of the facility.

"Using observations from O-Tube simulations, we're developing new analyses for processes that control pipeline stability. A multi-disciplinary approach combining hydrodynamics, geotechnics and sediment transport is being used to help improve future pipeline designs," said Winthrop Professor Liang Cheng.

A collaboration between industry and UWA, the facility has the potential to change global industry design standards for pipeline structure and stability.

## Offshore Soil Science

Providing the science that supports safe and stable future offshore infrastructure development and engineering, UWA's multi-million dollar soil characterisation facility contributes to our understanding of Australian soils under cyclonic conditions.

**The facility uses innovative x-ray and bending element technology to determine the strength and stiffness of soils, enabling characterisation of the seabed in any particular location.**

"Oil and gas reservoirs are going into deeper waters and more remote environments. It's exciting to be developing new engineering methods to allow platforms and pipelines to be designed for these challenges," said Winthrop Professor Mark Cassidy.



# LNG innovations



## Cleaner Gas

New processes to remove carbon dioxide and nitrogen from LNG reserves to deliver 'clean' gas are being investigated at UWA in a study using unique instrumentation.

The custom-built cryogenic pressure swing adsorption apparatus can study carbon dioxide and nitrogen removal at temperatures ranging from cryogenic to ambient, and at pressures of 0.001 to 5000 kPa.

"Research outcomes will be used to improve the design of LNG production trains and treat contaminated gas reserves," said Winthrop Professor Eric May, Chevron Chair in Gas Process Engineering.







### Safer Passage for LNG

Experimental research using a unique hexapod apparatus aims to identify new ways to improve the safe storage and transport of liquefied LNG across the world's oceans.

"In rough seas, sloshing of stored liquids in partially-filled LNG tankers can cause damage to the surrounding wall insulation, with implications for safety and asset integrity," says Winthrop Professor Eric May.

"We use a hexapod and other instrumentation to study the physics of liquid sloshing in tanks, and in particular the effects of 2D and 3D geometries. We can then assess the influence of various design and operational parameters on sloshing and identify new ways to improve LNG storage and transportation."





# Building a safe, high performance workforce

## Technology for Productivity

With a focus on workplace injury prevention, UWA's state-of-the-art occupational biomechanics facilities include 3D motion capture, dynamometry and electromyography equipment to assess the impacts and performance of a wide range of workplace tasks.

These facilities provide industry with scientific data to identify high-risk workplace activities, support decision making regarding OSH risk mitigation strategies and policies, and help reduce the likelihood of workplace compensation claims.

"We can simulate the biomechanics of any movement – from subtle vibrations to dynamic full-body actions – and predict the likely impact on the muscle and body in the short and long term," says Winthrop Professor Tim Ackland, a world-leader in occupational biomechanics.



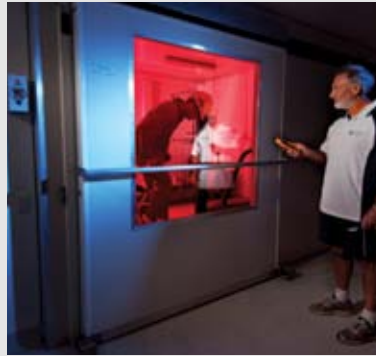
## Sleep Science Aids Performance

Monitoring, analysing and diagnosing sleep disorders and assessing their affects on workplace safety and productivity is an aim of research being conducted at UWA's Centre for Sleep Science.

Equipped with state-of-the-art sleep recording and analysis equipment and five bedrooms, the facility also includes training and education facilities.

**"Sleep science can help optimise shift scheduling, improve sleep quality when off-shift, and support the development of best practice in safety and productivity for the workforce," says Winthrop Professor Peter Eastwood.**

"Research over the past 15 years has resulted in an explosive growth in our understanding of the consequences of poor sleep, which include increased risk of illness, accidents and loss of productivity."



## Safer Work Environments

UWA's state-of-the-art environment chamber is capable of simulating environmental conditions and measuring and assessing the effects of heat or cold stress on individuals.

**The facility can replicate desired humidity and temperature and has application for people working in hot or cold environments, and in underground or above ground mines. It can test a range of risk mitigation strategies and provide the science that underpins OSH policy decisions and practices.**

"We can assess four to six people at a time and identify the best safety and health practices for people working in hot or cold environments," said Winthrop Professor of Exercise Physiology and Biochemistry Brian Dawson, from the School of Sport Science, Exercise and Health.

## Accelerating Leader Development

**UWA's Accelerated Learning Laboratory (ALL@UWA) is a high-performance facility for accelerating leader development, providing a dynamic, intensive learning environment that creates opportunities for individuals to achieve developmental 'leaps'.**

ALL@UWA is led by a highly specialised team of internationally recognised experts in the business and psychology disciplines that employs an innovative set of technologies, software and materials.

"We provide unique tools for leaders to build a strategic understanding of safety in complex organisations and we accelerate their skills in building safe, high-performing and dynamic work environments," says Winthrop Professor Mark Griffin. "We focus on a range of skills such as proactivity, innovation, communication, self-regulation and team effectiveness."

ALL@UWA is part of the prestigious network of similar facilities at the Australian Graduate School of Management and the Melbourne Business School.

**ALL@UWA has a particular focus on:**

- Leader development
- Safety leadership
- Proactivity and innovation
- Decision making
- Communication skills
- Organisational health
- Team effectiveness
- Work design
- Motivation
- Self-regulation
- Thinking styles
- Cross-cultural communication



# Transformational technology for climate change and ecosystems

## Creating Fresh Water Solutions

Boosting fresh water yields by one third and reducing carbon dioxide emissions are the exciting results of experimental research using multi-effect distillation technology. The technology utilises low-grade process heat from refineries, mine-site operations or geothermal bores to distil mineralised water or sea water.

"This technology allows water-consuming process plants to be more self-reliant and sustainable," says Winthrop Professor Hui Tong Chua.

The technology could support rural and remote areas by supplying water for both communities and mine-site operations, and deliver environmental benefits and improved project economics.

The research is a collaborative venture between industry, the WA Geothermal Centre of Excellence and the National Centre for Desalination.

## Gliders Chart the NW Shelf

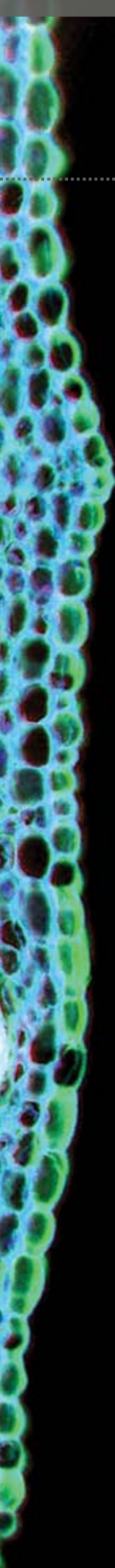
Capable of collecting an unprecedented range of data on Australia's coastal ecosystems and climate change, UWA's \$15 million Australian National Facility for Ocean Gliders is assisting industry to monitor and manage environmental and safety risks.

"Ocean gliders can detect oil seepage from leaking pipelines and measure pipeline acoustics to establish pipeline stability on the seabed," says Winthrop Professor Charitha Pattiaratchi, a world leader in coastal oceanography. "They also monitor the health of coastal ecosystems."

This world-class facility includes 13 ocean gliders that can operate continuously for up to eight months in water depths to 1000 metres. The facility will expand into the North West Shelf in the future to support environmental monitoring in the region.







### The Power of Plants

UWA's state-of-the-art genomics, protein, imaging and computational systems biology facilities are generating new knowledge about plants for the benefit of Australian agriculture, ecosystems and plant science.

The facilities at the Centre of Excellence in Plant Energy Biology are capable of identifying specific plant genes and proteins, analysing responses to different environmental stressors and undertaking molecular profiling.

**“We can provide industry with baseline data, including DNA bar-coding of species diversity before and after land restoration and rehabilitation,” says Winthrop Professor Steven Smith. “We can also help develop technologies to accelerate successful re-establishment of the landscape after mining, and promote understanding of drought tolerant plants.”**

The facilities are also used to investigate bio-energy applications, including algae crops for bio-fuel, converting biomass to methane production, waste water clean-up and production of soil conditioners. Collaborations are also generating new technology to persuade native seeds to germinate and establish rapidly during the wet months – building ecosystem resilience.



### Sustaining Our Ecosystems

UWA's WA Biogeochemistry Centre is a stable isotope facility providing analytical capacity for the ecological sustainability of natural ecosystems and their response to disturbance and environmental change.

**With environmental and geoscience applications, the Centre supports industry decision making on water management, life of mine planning, and assessment of mining impacts on the ecology and functioning of mining environments.**

“We support resource companies to work towards identifying the tolerance of an ecosystem to disturbance, and capacity of those systems to recover,” says Dr Pauline Grierson. “We collaborate to assess the relative dependency of ecosystems on groundwater versus soil and surface water, and on the likely impacts of altered hydrology – especially due to dewatering.”

## Deeper Knowledge of Marine Environments

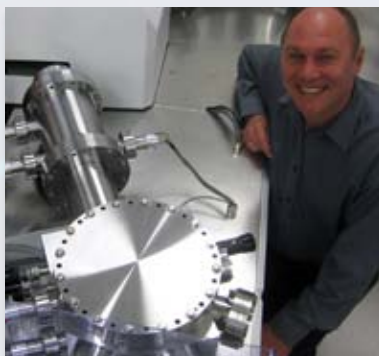
State-of-the-art image analysis and remote video camera equipment at UWA's Centre for Marine Futures is revolutionising our knowledge of WA's marine environment.

With unparalleled capability in speed and accuracy of image processing, together with detailed habitat maps and a fish archive of more than 5,000 images, these facilities make it faster, easier, safer and more cost-effective for industry to run dredging monitoring programs.

"Our video systems can work at depths to 500 metres, far exceeding depths that divers can safely sample," says Professor Jessica Meeuwig. "Industry can use this capability to reduce any potential impacts on the marine environment."







### **Sustainable Environmental Futures**

New high-performance machines at UWA's Advanced Geochemical Facility for Indian Ocean Research are delivering unrivalled capabilities to help solve environmental issues of global and regional significance, including the future of WA's unique Ningaloo Reef and Kimberly coast.

"Two plasma mass spectrometers and a new laser system will assist geological research relevant to the resources industry, including measuring the age and origins of rocks and ore bodies," says Winthrop Professor Malcolm McCulloch. "They will also support environmental management by providing baseline data on coral reefs."

The facility was established to study environmental change affecting coral reef systems, and will also assist in the successful management and sustainable development of the Indian Ocean region.

### **Investing in CO<sub>2</sub> Sequestration Science**

Industry capability in reducing carbon dioxide emissions via geo-sequestration has been boosted with a \$10 million investment in state-of-the-art facilities at UWA. These will feature a geosequestration research laboratory and geophysical surveying and data analysis equipment.

"These facilities will bring together world-class expertise in geophysics and gas process engineering," said Winthrop Professor Eric May, who will work closely with Winthrop Professor David Lumley. "We will conduct cutting-edge research in carbon dioxide capture and storage, and train the next generation of engineers and scientists in this increasingly important industry."

"We will also put our research into practice at the South West Hub CO<sub>2</sub> Geosequestration Project, a field research facility in which UWA is a key partner."





# Minerals and exploration innovation

## Exploration Technology Breakthrough

Persistence and collaboration, combined with world-leading science, has helped UWA and Rio Tinto develop the VK1 airborne gravity gradiometer – an advanced piece of exploration technology designed to detect otherwise invisible, buried ore bodies.



Operating from an aeroplane, VK1 is a next-generation airborne survey system. The technology measures subtle changes in the Earth's gravity field, from which it produces a density map that identifies the presence of ore bodies.

Rio Tinto chief executive Tom Albanese said, "As ore bodies become harder to find, we hope that pioneering new technologies like VK1 will help us uncover the next generation of mineral resources."

Some 30 years in the making, two VK1 systems have undertaken initial flight trials near Perth, and more comprehensive trials are planned this year. VK1 components are built within UWA's Physics Workshop. VK1 is named after UWA Physicist Dr Frank Van Kann, who invented the technology.

## The Science of Pink Diamonds

The origins of pink Argyle diamonds are being investigated using optical spectroscopy facilities that have helped characterise the colour of pink diamonds by analysing the reaction to certain wavelengths of light of the atomic defect responsible for the colour.

“Rio Tinto Diamonds wanted to characterise this change and discover the underlying cause of the defect and its behaviour,” says PhD student Keal Byrne. “This work will provide Rio Tinto with an understanding of the cause of colour in their most prized gems and also with methods for verifying the authenticity of pink Argyle diamonds.”

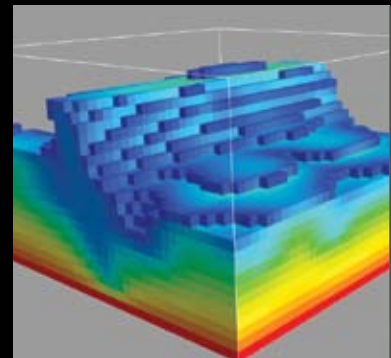
The properties of this crystalline defect could also be useful for research into optical systems and technologies.



## Advancing Exploration and Recovery

The Centre for Petroleum Geoscience and CO<sub>2</sub> Sequestration undertakes research which has applications to advanced hydrocarbon exploration and recovery, unconventional energy resources, and sub-surface CO<sub>2</sub> sequestration.

Its research is supported by the high-performance computational capability at iVEC@UWA - a world-class research facility that hosts supercomputing and visualisation. It assists the Centre with supercomputing and visualisation of 3D and 4D time-lapse seismic imaging of reservoirs and fluid flow, in addition to their detailed core, log and outcrop-scale reservoir geology analyses, depositional systems and sequence stratigraphy, and basin-scale structural and tectonic evolution studies.





# Energy for the future

## Geothermal Energy Breaking New Ground

A three kilometre geothermal research well in the Perth Basin is breaking new ground in establishing a deep earth observatory to help scientists better understand how to harness ‘deep heat’ as a renewable energy option. UWA is a research partner in the project, being led by CSIRO.

This observatory will be part of a \$20 million facility that will demonstrate the use of geothermal energy from hot sedimentary aquifers to heat and cool The Australian Resources Research Centre using adsorption chillers – with the intention to expand the concept into the broader Perth metropolitan area.

“The geothermal well will contain sensors for monitoring and testing and will collect a range of seismic and geochemical data, furthering our understanding of aquifer systems and reservoirs,” says Professor Klaus Regenauer-Lieb.



## Optimising Energy

Equipped with highly advanced analytical instrumentation, the **fluidised bed reactor** at the UWA Centre for Energy is a unique research and development tool for industries in coal, petroleum, minerals and metallurgy, environmental protection, waste treatment and forestry.

The facility is capable of operating pyrolysis, gasification and combustion of coal and biomass, processing of heavy oil, mineral processing, thermal decontamination of solids, and off-gas processing and treatment.

“This facility provides vital data on behaviour, reaction kinetics and characteristics of a range of materials for process design and optimisation of operations in the energy and mineral processing industries,” says Director of the Centre for Energy, Professor Dongke Zhang.

## Tapping Into Stored Gas

Understanding how to store gas effectively is driving highly experimental research at the UWA Centre for Energy.

In utilizing the purpose-built gas storage measurement apparatus, world-leading researchers are accurately measuring how methane gas and carbon dioxide are being stored in adsorbent powders.

“The best way to understand how to store gas is to measure the storage directly. This unique apparatus, which can measure pressures up to 50 Bar and temperatures up to 70 degrees Celsius, provides us with very reliable measurements to help us achieve that goal,” says Winthrop Professor Hui Tong Chua.





## Developing New Energy Technologies

A unique testing facility capable of quantifying the reaction kinetics and composition of gases produced from solid and liquid fuels, the **high pressure thermo-gravimetric analyser** can simulate the gasification process of a range of materials, including municipal waste, heavy oil and petroleum residue.

One of only two of its kind in Australia, the facility is a key capability in the development of technologies to convert coal, biomass, heavy oil and other organic waste feedstock into synthetic natural gas.

“This facility is supporting the development of alternative energy options and new energy technologies in a carbon-constrained world,” said Director, Professor Dongke Zhang.



## Cracking Chemical Codes

A major breakthrough in clean fuel technology has been achieved using the unique catalytic cracking facility at the UWA Centre for Energy, helping researchers identify how to provide clean fuel for our cars and zero-emission carbon for batteries.

The only one of its type in Australia, the facility has helped researchers break the chemical bonds of methane gas.

“By cracking methane we’ve been able to create hydrogen without producing any carbon dioxide,” says Winthrop Professor Hui Tong Chua. “The by-product is hydrogen and graphitic carbon, which also has the potential for high-value applications.”

The technology also has application in gas processing for fertiliser production.





# Enabling world-class research

## Inspiring High-Impact Science

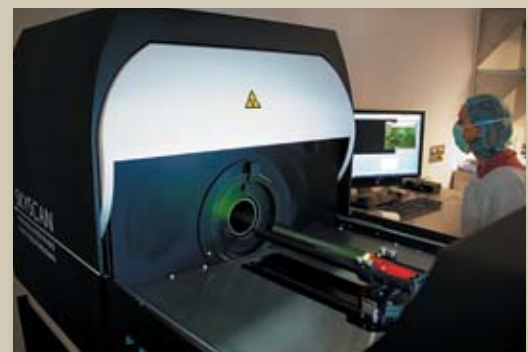
UWA's \$40 million world-class Centre for Microscopy Characterisation and Analysis (CMCA) is an inspiring collaborative research facility with 13 core co-located capabilities. Supported by an intellectual hub of expert scientists, the CMCA is a unique analytical facility that supports cutting-edge research in biological, biomedical, geo-environmental and physical sciences, with strong relevance to the energy and minerals sector.

The Centre's application in earth and environmental sciences focuses on analysing and characterising minerals, rocks and soils.

Its high-impact capability supports Australian industry in a broad range of areas. Among its achievements, it has conducted atomic-level analysis to understand new generation steels, contributed to alumina-based R&D projects, helped identify and validate new mining exploration methods, and assisted in 'cracking' methane gas.

### CMCA World-Class Facilities

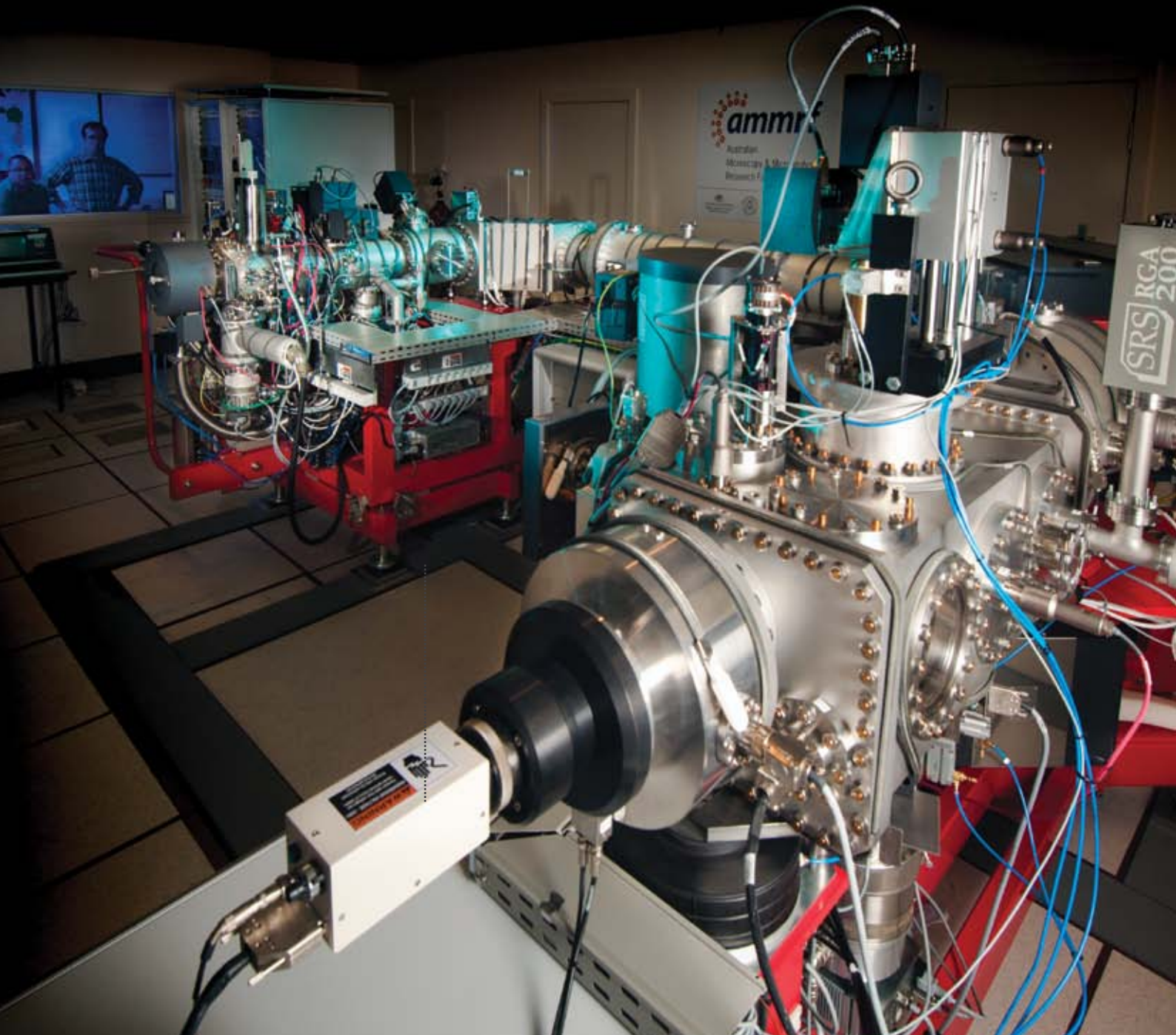
- AMMRF Flagship
- Ion Probe Facility
- Scanning Electron Microscopy
- Electron Probe Micro-Analysis with Spectroscopic Cathodoluminescence
- Flow Cytometry
- Transmission Electron Microscopy
- Optical and Confocal Microscopy
- Scanned Probe Microscopy
- Bioimaging Facility
- Visualisation
- Specimen Preparation
- Mass Spectrometry
- Nuclear Magnetic Resonance Spectroscopy
- X-ray Diffractometre



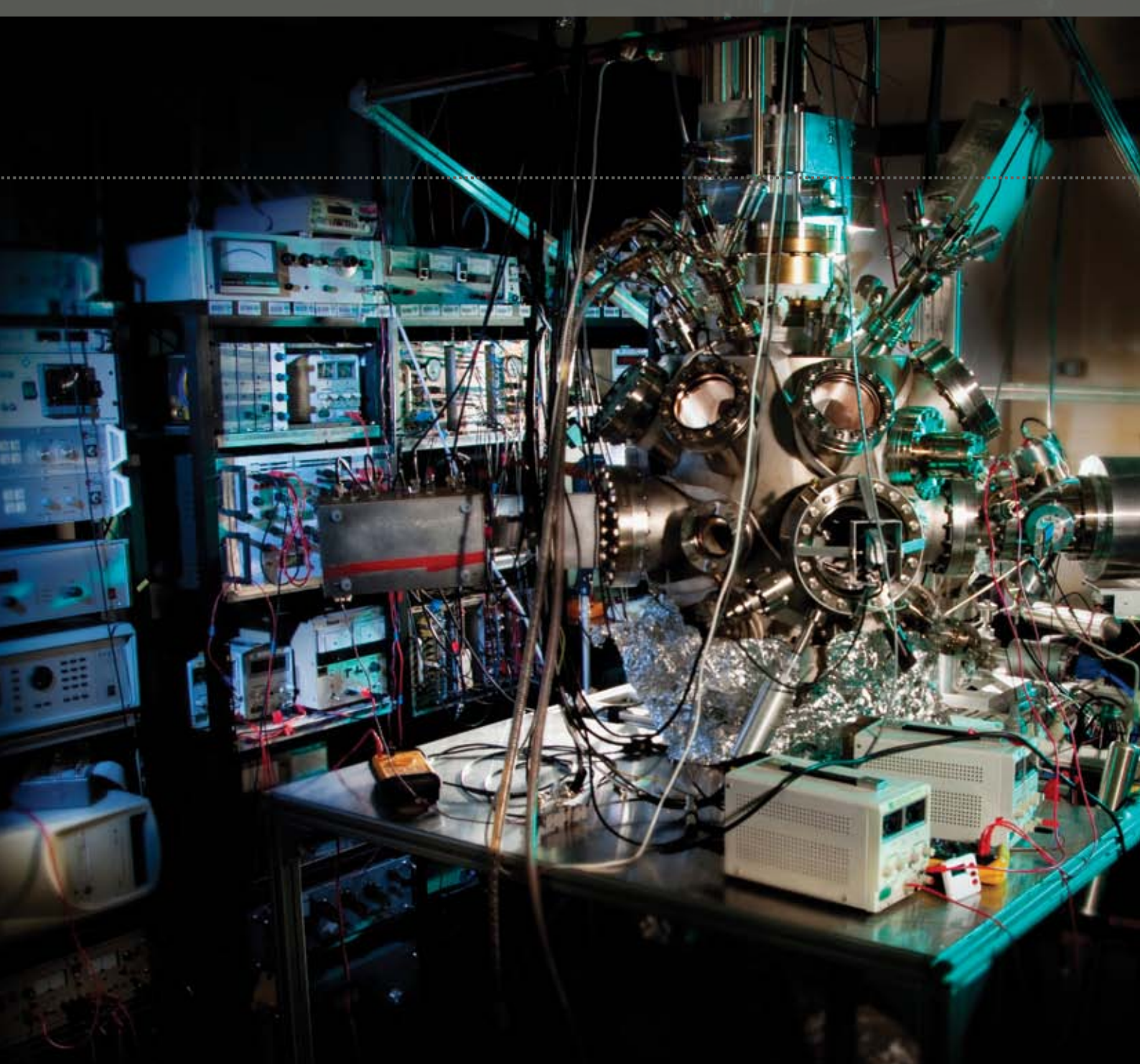
## Accessing World-Class Research Infrastructure

The AMMRF (Australian Microscopy & Microanalysis Research Facility) enables Australian research and innovation, and plays an important role in resource industry R&D. Access to AMMRF facilities can follow a number of paths according to company needs, with the main forms of access being:

- contract R&D projects
- leveraged R&D projects, which may involve a number of collaborative partners
- access by industry users to instruments and capability, with training provided
- testing and consultancy services
- training courses and programmes which build in-house competency







## Innovation Hub

UWA's Physics Workshop is a technical hub of innovation for the creation of unique cutting-edge research tools and equipment that cannot be bought 'off the shelf'. A highly advanced research and development space, the facility specialises in high-precision machining, ultra-high vacuum technology and cryogenics.

Its skilled technicians employ state-of-the-art computer-aided design packages for initial concept design and are involved in fabrication, installation and commissioning.

The facility supports experimental research for the energy, minerals, health and other sectors and is an enormously valued co-located facility for many UWA researchers - particularly in the chemistry and mechanical engineering fields.



## Supercomputers Power Research

**UWA researchers are harnessing the high-performance supercomputing and visualisation capabilities of iVEC to support leading-edge research across a range of disciplines, particularly geosciences and astronomy.**

iVEC@UWA is one of three locations providing a world-class research facility that hosts supercomputing, visualisation and video conferencing. It delivers services in supercomputing, eResearch, parallel programming, data storage, novel visualisation of data sets, and education for the development of leading-edge supercomputing expertise for researchers and industry.

Industry has utilized iVEC's capability to improve grain production, wine quality, land and water management for urban planning, satellite imaging, and to provide public access to marine scientific data.

iVEC manages the \$80 million Pawsey Centre Project, a collaboration that is creating a world-class supercomputing facility. Due for completion in 2013, it will provide a facility to support the needs of the Australian radio astronomy research community, as well researchers in other areas of computational and data-intensive science, such as nanotechnology, biotechnology and geoinformatics.

"This investment will also provide additional support for the computational and data processing capabilities required to fully implement the Australian Square Kilometre Array Pathfinder (ASKAP) and Murchison Widefield Array (MWA) radio telescopes," says iVEC@UWA Director Associate Professor Paul Bourke.







**Winthrop Professor  
Mark Randolph**

Professor Randolph founded the Centre for Offshore Foundation Systems in 1997 to better understand the

particularity of Australian soils and to develop suitable foundation solutions for offshore infrastructure development and engineering. His research team has contributed significantly to our knowledge of North West Shelf seabed conditions, with particular insights gained from using the innovative centrifuge facility – unique in Australia.



**Winthrop Professor  
David Lumley**

Professor Lumley is Director of the Centre for Petroleum Geoscience and CO<sub>2</sub> Sequestration and Woodside-

Chevron Chair in Petroleum Geoscience. He is an internationally respected expert in time-lapse imaging of subsurface fluid flow, including hydrocarbon recovery, and environmental and global-climate processes such as groundwater contaminant flow and CO<sub>2</sub> injection and storage. The Centre builds on existing strengths at UWA in biostratigraphy and sedimentology of petroleum basins and basin-scale tectonics and geodynamics.



**Winthrop Professor  
Tim Ackland**

Professor Ackland is Head of the School of Sport Science, Exercise and Health. His research interests include

the mechanics of human movement, with themes spanning occupational biomechanics and ergonomics, exercise rehabilitation, and high performance sport. His leading research in occupational biomechanics and ergonomics supports workplace injury prevention and optimisation of human performance in industry.



**Winthrop Professor  
Mark Griffin**

Professor Griffin is co-Director of the Accelerated Learning Laboratory. His research seeks to understand how

organisational contexts shape, and are shaped by, individual performance and well-being. Current projects investigate leadership, safety, performance management and work stress. Professor Griffin has extensive experience managing large leadership and safety projects across Australia, Europe and the USA.



**Winthrop Professor  
Malcolm McCulloch**

Premier's Research Fellow, Professor McCulloch is working on applying isotopic and trace element

geochemical methods to better understand the impacts of climatic and anthropogenic processes on the Earth's environment. He leads the new Advanced Geochemical Facility for Indian Ocean Research, studying environmental change affecting coral reef systems, and supporting the sustainable development of the Indian Ocean region.



**Winthrop Professor  
Klaus Regenauer-Lieb**

Professor Regenauer-Lieb is an eminent scientist and Director of the WA Geothermal Centre of Excellence. He is at

the forefront of mathematical geophysics and computational geodynamics, which holds the key to locating new mineral deposits. Combining geology with geodynamics, his work involves looking back four billion years to understand where the Earth's deposits of various valuable minerals were formed. This allows exploration companies to intelligently predict locations for mineral exploration.



**Winthrop Professor  
Steven Smith**

Professor Smith was part of the founding team of the ARC Centre of Excellence in Plant Energy. He is Director of the

Centre of Excellence in Plant Metabolomics that carries out fundamental research in plant metabolic biology. The Centre's goal is to develop strategies to select or tailor plants for improved performance under environmental extremes, and for improved production of food, materials or bio-energy.



**Winthrop Professor  
Dongke Zhang FTSE**

Professor Zhang is Director of the Centre for Energy. He has conducted extensive research into fuel processing

and conversion, and combustion science and technology, with a specific focus on coal, natural gas and bio-energy. He brings a depth of knowledge, research and innovation to UWA and has strong industry links. His work in bioenergy includes thermochemical conversion of biomass to hydrogen and synthetic petroleum, transesterification of vegetable oil to biodiesel, bioethanol and biobutanol, and biochar and chemicals.



**Winthrop Professor  
Mark Cassidy**

Professor Cassidy is Director of the Centre for Offshore Foundation Systems and leads a research team investigating

offshore geotechnics and engineering, predominantly developing wave-structure-soil interaction models for the analysis of oil and gas platforms, mobile drilling rigs and pipelines. His research contributes to our understanding of Australia's sub-sea soils, and supports safe future offshore infrastructure development and engineering.



**Winthrop Professor  
Eric May**

Professor May is the Chevron Chair in Gas Process Engineering. His research has developed breakthrough

techniques for measuring gas properties under extreme conditions - providing critical data to advance the computer models used to design and optimise gas processing plants. He leads a team in natural gas research, covering areas of LNG production, CO<sub>2</sub> sequestration and gas processing, including the development of alternative methods for removing CO<sub>2</sub> and nitrogen from natural gas.



**Professor  
Jessica Meeuwig**

Professor Meeuwig is a Conservation Fellow of the Zoological Society of London and Director of the Centre for

Marine Futures. Her main expertise is in marine and fisheries conservation and quantitative modelling. Her research includes investigating the displacement of humpback whales as a result of coastal development, researching how sharks and fish use underwater banks and canyons, and how marine sanctuaries generate ecological and economic benefits.



**Dr Pauline Grierson**

Dr Grierson is Director of the WA Biogeochemistry Centre and leads the Ecosystems Research Group. She has extensive experience in the

application of stable isotope methods to examine ecosystem processes, particularly in assessing ecological water requirements of semi-arid ecosystems. Much of her research is focussed in the north-west, where rainfall is predicted to increase due to climate change and where management of water resources is crucial for mining companies.

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