

**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%20%20woodside%20ceo%20and%20managing%20director%20address%20appea%202012.pdf>

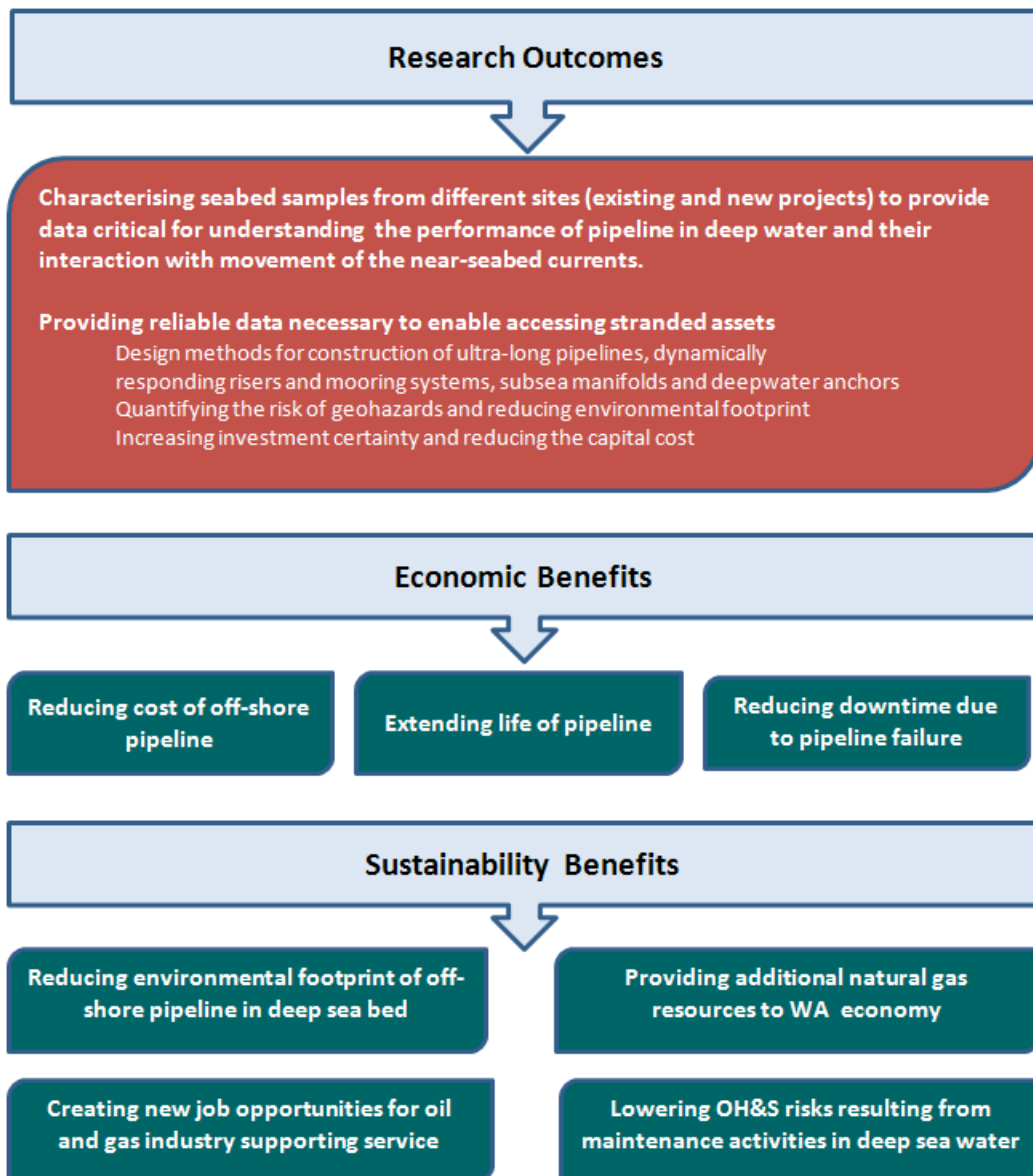


Figure 1 Research to Economic Impact for Deep Water Infrastructure <sup>12</sup>

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>

## Global issues, global solutions

Our researchers collaborations and projects bring together varied perspectives and resources to offer a truly global approach to offshore engineering. This map shows a selection of academics, industry and research connections over the past five years and highlights the diverse backgrounds of our research team.



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