FUTURE ENERGY EXPORTS

Cooperative Research Centre

INFORMATION BROCHURE

CRC FOR FUTURE ENERGY EXPORTS

"Future-proofing Australia's energy exports through industrial-scale innovation."

INTRODUCTION

Australia has a long and very profitable heritage as an energy exporter. Most recently this has occurred via our extensive natural gas endowment, and a significant demand for energy from Japan, Korea and China. Given Australia's distance to market the only viable way to export this globally important energy source has been to produce and ship Liquefied Natural Gas (LNG). Over the past six years, our nation's LNG industry has leveraged these natural resources and rapidly grown the capacity to export 80 million tonnes of LNG per annum, making Australia the world's biggest exporter of this commodity.

However, two major threats exist to Australia's leadership of this export industry, and the associated revenue it delivers. In the near-term, new, competitively sourced LNG supply from the USA, as well as Canada, the east coast of Africa and elsewhere threaten to displace Australian sales on the basis of price. To maintain its leadership, Australia's LNG industry must reach new levels of efficiency in all parts of the LNG value chain by using less energy, processing lower grade natural gas with greater reliability and recovering more high value by products.

The second, longer term challenge faced by our nation's LNG industry is the decarbonisation by energy importers. Japan has already announced the 2020 Tokyo Olympics will be powered by hydrogen, with Korea and China moving in the same direction. This presents the opportunity for Australia to leverage the know-how, capability and infrastructure of its existing LNG industry to establish a world-leading hydrogen export industry. However, multiple challenges need to be addressed to do this efficiently and effectively.

The Future Energy Exports Cooperative Research Centre (FEnEx CRC) will execute cutting-edge, industry-led research, education and training to address these imminent threats and help ensure Australia retains, and increasingly benefits from, its position as a major global energy exporter.

The purpose of this document is to provide information to organisations interested in participating in the FEnEx CRC.

Alignment with National Priorities

The proposed FEnEx CRC is strongly aligned with Australia's industry, education and research priorities. It originated from outcomes delivered through NERA Growth Centre (www.nera.org.au) in combination with the needs outlined by the Chief Scientist's hydrogen white paper to COAG in December 2018. The lead researchers all have strong track records engaging with industry and delivering tangible research outcomes in line with the National Science Priorities. The FEnEx CRC will coordinate its research programs to complement and leverage the current and future programs seeking to grow Australia's domestic hydrogen industry. This includes being poised to commence acting on the recommendations delivered by the COAG Energy Council currently expected at the end of 2019.

Further information about relevant priorities can be found via:

Australian Government, Department of Industry Innovation and Science
Industry 4.0 Initiative

Council of Australian Governments Energy Council
Hydrogen for Australia's Future

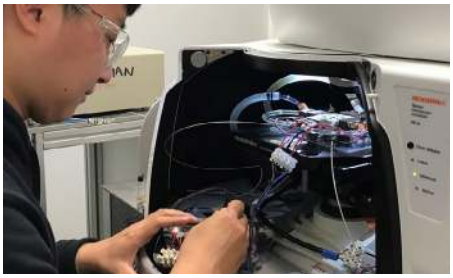
Hydrogen Working Group

"Reducing the cost of producing hydrogen is the major challenge for Australia to position itself to be a major exporter of hydrogen, complementing our success in the LNG market'

Alan Finkel, Chief Scientist, Australian Government and Chair, Hydrogen Strategy Group, from Hydrogen for Australia's Future

Participant Benefits

The FEnEx CRC will provide outstanding value for organisations in the Australian energy sector, through the improved productivity delivered by innovation and technology deployment, as well as from the economic benefits generated by export revenue and employment in the LNG and hydrogen energy sectors. More broadly, Australians will benefit from greater diversification of their energy sources, and by helping raise world living standards while also lowering global CO_2 emissions.

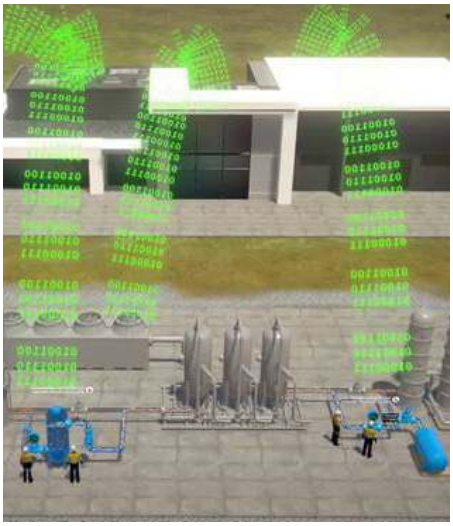


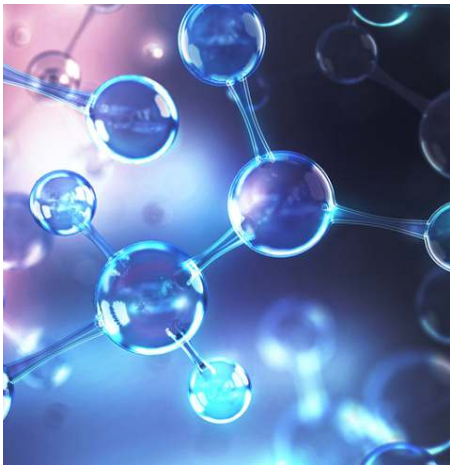
RESEARCH

- Leveraged investment from industry and government partnerships.
- Creating new knowledge for future opportunities & collaborations.
- Financial support and development of 80 industry-ready higher degree by research students amongst university participants.
- Access to a world-class network of stakeholders in the energy sector.

NATURAL GAS INDUSTRY

- Leading edge solutions to commercial challenges and opportunities. It is estimated that addressing the challenges confronting the LNG energy sector could be worth $12.2 billion per annum, when extrapolated across all 10 LNG projects in Australia.
- Access to infrastructure to develop and pilot new technologies.
- Access to world leading researchers and capabilities, and to a post-graduate and post-doctoral community with a culture of industry engagement and innovation.
- Potential eligibility for R&D tax credits.
- Access to low cost upgrading and replacement of major process automation and control infrastructure.
- Improved maintenance and reduced inventory costs.
- Leveraged investment from industry and government partnerships.





HYDROGEN INDUSTRY

- Identification of new business opportunities including an emerging export industry which could be worth A$1.7 billion by 2030.
- Access to pilot infrastructure to develop and pilot new technologies.
- Access to training and future leaders and technologies able to support new business.
- Access to world leading researchers and capabilities, and to a post-graduate and post-doctoral community with a culture of industry engagement and innovation;
- Generation and access to new IP for commercialisation.
- Potential eligibility for R&D tax credits.
- Leveraged investment from industry and government partnerships.

BROADER COMMUNITY

- Access to evidence to inform policy and to share with communities about the benefits of a LNG / H_2 energy sector.
- Ability to engage and consult with business, community, government and other stakeholders to ensure that the industry operates on a transparent framework that generates a social license to operate.
- Leveraged investment from industry and government partnerships.
- Access to a more diversified energy mix that can be supplied domestically.
- Potential for Australian energy consumers to access energy at a reduced price.

Our Research Programs

The FEnEx CRC's research partners bring world leading multi-disciplinary expertise and include: the University of Western Australia, Curtin University, the University of Melbourne, the University of Adelaide, the University of Technology Sydney, and the Queensland University of Technology.

Program 1: Highly Efficient LNG Value Chains

The Australian LNG export industry is dominated by large-scale processing plants and continuous production from a variety of natural gas reservoirs located both on- and off-shore. Their business model is based on the amount and reliability of LNG production over decadal time frames. The technical challenges affecting this export industry's competitiveness may be classed as follows:

- Amount of LNG that can be made per day (throughput limitations).
- Energy required to make, store and transport the LNG (efficiency limitations).
- Unplanned shutdowns interfering with contractual supply requirements (reliability limitations).
- Compositional changes in the natural gas source feeding the plant (gas quality limitations).
- Inability to extract & monetise high-value components in the gas (value-add limitations).

Many technical problems fall across more than one category (e.g. poor gas quality can lead to unplanned plant shutdowns). Unfortunately, the economies achieved through the very large scales at which these plants operate also act to stifle the innovation required to solve these challenges because the risk associated with trialling any new technology is unacceptably large. To remain competitive with the imminent flood of US-based LNG supply, a coordinated CRC-scale research & demonstration program is required to alleviate the above limitations to Australia's LNG export industry.

Program 2: Growing Australia's Hydrogen Export Industry

Decarbonisation by energy importers presents an opportunity for Australia to leverage its existing LNG know-how, capability and infrastructure to establish a world-leading hydrogen export industry. However, economically viable hydrogen exports require:

- Cost-effective, large-scale production to meet the international demand for energy and provide the required economies of scale.
- Optimised selection & operation of the hydrogen storage and transport methods (e.g. LH_2, NH_3, MeOH, solid-state).
- Understanding the impact of exports on domestic hydrogen supplies and electricity networks.

The first challenge requires the development of pathways to blue, green and carbon negative hydrogen production at about $2 per kg. Initially, fossil-based sources of carbon-neutral 'blue' hydrogen are most likely to reach both the cost and scale required for export: however, establishing a well-defined hydrogen value chain will in turn deliver economic incentives that drive the growth of competitive green hydrogen production technologies. The many ways hydrogen can be stored, transported and used requires significant research to understand and minimize the life-cycle costs of delivery to market, which will inevitably be customer and application-specific. Additionally, to avoid the mistakes and replicate the benefits of LNG exports on Australia's domestic energy sector, a critical evaluation of the similarities and differences applicable to hydrogen is essential.

Program 3: Unlocking Resource Value via Interoperable Digital Technologies

Australia's entire resources sector relies upon automated processes controlled by a wide-variety of hardware and software tools, many of which are legacy solutions. New digital technologies offer tremendous opportunities to increase the productivity, reliability and security of these processes particularly in the technically demanding LNG and hydrogen export sectors. However, these digital technologies are typically not interoperable: products from one vendor cannot communicate or work with products from another. This constraint applies to interactions between new and legacy digital systems, as well as between modern Industry 4.0 technologies.

This program will work to develop the industry-wide standards necessary to ensure new digital technologies for use in both LNG and hydrogen export are interoperable and provide a platform for demonstrating that interoperability. In parallel, emerging Industry 4.0 technologies for advanced process automation and control (e.g. digital twins, predictive maintenance sensing) will be benchmarked rigorously to demonstrate their fidelity and value to the energy export industry. The successful deployment of interoperable Industry 4.0 technologies in LNG and hydrogen export plants will enable:

- increased throughput and energy efficiency through the improved understanding of the process delivered via advanced digital sensors and models, and
- reduced maintenance and inventory costs through the ability to reliably predict equipment failure rates and thereby avoid excessive expenditure on contingent spares.

The program will leverage facilities available at the UWA Industry 4.0 Testlab for Energy & Resources Digital Interoperability, the CISCO Innovation Central Centre at Curtin, the ACEPT Facility at South Metropolitan TAFE and other data streams made available by industry partners.

Education and Training

The FEnEx CRC education and training program will be designed to deliver a highly skilled workforce with the capabilities needed to transform the sector's productivity. It is imperative that both vocational and tertiary-level skill sets relevant to the energy export industry are updated in-line with advances in digital and process technologies to enable tomorrow's workforce to compete globally while transitioning towards a low carbon future. By working through and growing educational partnerships between the Universities and with selected TAFE colleges, the FEnEx CRC education and training programs will focus on developing industry-ready researchers, engineers and operators. Additionally, professional development opportunities, particularly in the areas of digital technology, will be developed to support SMEs and start ups and facilitate career progression within larger companies.

Approximately 7.5% of the CRC's cash budget will be allocated towards the Education and Training Program, which will complement the research agenda and consequently, align with industry needs. The program will provide for:

- Approximately 80 research by higher degree candidates, PhDs and Masters by research. Customised programs in business, leadership, commercialisation; and driving innovation will generate highly valued and effective workplace candidates.
- Tertiary programs that provide graduates with the skills, knowledge and aptitudes required by the evolving energy sector;
- Flexible vocational, trade and micro credential courses; and
- Innovation centres that foster creativity in the CRC's partners and other SME and start-ups, particularly those working in the digital technology space.

Additionally, the CRC will provide broader community communication to expand the Australian population's awareness and understanding of hydrogen, which, up to date, has been limited to industrial uses.

Governance

The FEnEx CRC has a draft term sheet, developed in consultation with participants, that articulates the governance and management of the CRC. The draft document is available upon request.

In summary, the FEnEx CRC will be established as a not-for-profit company limited by guarantee. It will be governed by a skill based board, with the majority of directors independent of the participants. A Research Advisory Panel, chaired by a director, with other members elected from participants and external experts, will be responsible for reviewing research proposals against criteria pertaining to industry need, commercial potential and scientific basis. Following assessment, the Research Advisory Panel will make recommendations to the Board for a proposal's approval and / or to participants for its further development.

The CRC will maintain a flexible approach in considering options for ownership and use of IP beyond a default position of the FEnEx CRC owning the legal title to the IP, with alternative arrangements stipulated in Project Agreements. The CRC will have two participant categories, one for research institutes and the other for non-research institutes such as industry and government. Non-research participants have four status levels.

- Founding status is available to a maximum of four CRC industry participants, and requires an average $300,000 untied cash contribution per annum from each participant, plus additional contributions as described below.
    a) Members that contribute an average $300,000 untied cash per annum for ten years, plus an additional $200,000, will be granted a two year board term.

b) Members that contribute an average $300,000 untied cash per annum plus an additional $450,000, will be granted a ten-year board term (or remainder of the CRC term should a participant qualify for this status after establishment of the CRC).

c) Incumbent Founding participants will be given first right of approval to maintain this status.

- Tier 1 status is available to participants that contribute at least $300,000 untied cash per annum to the CRC throughout its 10-year duration. Participants with Founding or Tier One status will be members of the CRC; and be critical to achieving the strategic objectives of the CRC and for the utilisation of research outputs. CRC members have voting and nomination rights for the selection of board members and for committees and panels.
- Tier 2 status is available to participants that contribute at least $150,000 but less than $300,000 untied cash per annum to the CRC throughout its 10-year duration. They can lead and / or participate in selected projects and will be essential for the adoption and utilisation of CRC outputs.
- Tier 3 status is available to participants that contribute at least $50,000 but less than $150,000 untied cash per annum to the CRC and will participate in agreed projects of the CRC.

The CRC Program

The Australian Government's CRC Program supports industry-led collaborations between industry, researchers and the community. The program aims to:

- Improve the competitiveness, productivity and sustainability of Australian industries, especially where Australia has a competitive strength, and in line with Government priorities.
- Foster high quality research to solve industry-identified problems through industry-led and outcome focussed collaborative research partnerships between industry entities and research organisations.
- Encourage and facilitate small and medium (SME) participation in collaborative research.

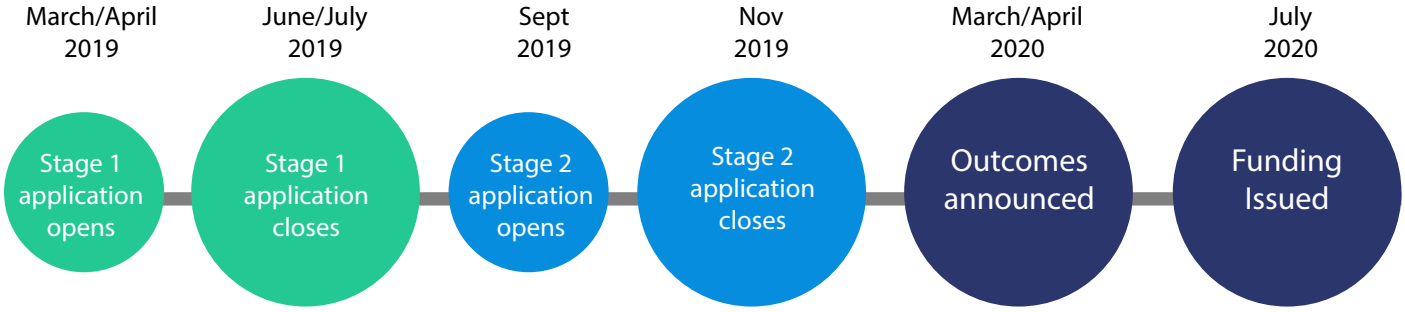
Since its inception in 1990, the CRC Program has committed $4.6 billion in funding to support the establishment of 221 CRC Grants and 76 CRC-P Grants - a total of 297 collaborations funded over the program's lifetime.

Next Steps and Timeline

Determine whether your organisation is interested in becoming a participant of the CRC. You should consider the following areas:

- Whether your organisation has an interest in the research areas we are proposing.
- Whether the consortium approach to research is appealing to your organisation.
- Whether there is any feedback you have on the research areas we are proposing for investigation

If you are interested in being involved in the CRC, please contact us and we will take you through the next steps. The anticipated timing of the two-staged CRC application process is provided below.



CONTACT US

Professor Eric May
Acting Chief Executive Officer, FEnEx CRC
Chevron Chair in Gas Process Engineering,
University of Western Australia
T: +61 8 6488 2954
E: eric.may@uwa.edu.au

Jill Stajduhar
Acting Operations Manager, FEnEx CRC
Centre Manager, Australian Centre for LNG Futures
M: +61 457 836 040
E: jill.stajduhar@uwa.edu.au

Professor Craig Buckley
Program Leader, FEnEx CRC
Deputy Director, Fuels & Energy Technology Institute,
Curtin University
T: +61 8 9266 3532
E: c.buckley@curtin.edu.au

Professor Paul Webley
Institution Lead, FEnEx CRC
Head of Department, Chemical Engineering,
University of Melbourne
T: +61 3 9035 7873
E: paul.webley@unimelb.edu.au

Professor Graham Nathan
Institution Lead, FEnEx CRC
Director, Centre for Energy Technology,
University of Adelaide
T: +61 8 8313 5822
E: graham.nathan@adelaide.edu.au

Dr Geoff James
Institution Lead, FEnEx CRC
Research Principal, Institute for Sustainable Futures
University of Technology, Sydney
M: +61 401 681 282
E: geoffrey.james@uts.edu.au

Dr Gudrun Seynsche
Institution Lead, FEnEx CRC
Director, Major Research Initiatives,
Queensland University of Technology
T: +61 7 3138 4232
E: g.seynsche@qut.edu.au

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