FUTURE ENERGY EXPORTS
Cooperative Research Centre

Technology Investment Roadmap: Discussion Paper Submission

Future Energy Exports Cooperative Research Centre – June 2020

The Future Energy Exports (FEnEx) CRC is a national collaboration of 28 industry, government and research partners. We seek to future-proof Australia's status as an energy export superpower, and use industrial-scale innovation to help Australia's LNG exports remain competitive while also growing Australia's emerging hydrogen export industry. Over the next decade, the collaboration will use $162 million of resources to research, develop and demonstrate many of the low emissions technologies considered by the Roadmap. We welcome the opportunity to make this submission and look forward to helping implement the resulting Technology Investment Roadmap.

Competitive Advantage

Our established, world-leading LNG sector represents a competitive advantage that should be leveraged when setting Australia's technology priorities. The Discussion paper notes the increasing importance of LNG in reducing emissions and highlights how an LNG development led to the world's largest CCS project (Box 2). However, it is also notable that ***LNG production technology*** **is highly-advanced and operates at large-scales**. Adapting technologies, engineering solutions and workforce skills from the LNG industry should be central to strategies targeting large-scale emissions abatement coupled with economic opportunity. Australia's established LNG sector will be a key advantage in the global race to grow a viable hydrogen export industry.

Shortlist of Prioritised Technologies

The FEnEx CRC offers the following recommendations and commentary on the technologies mentioned in Figure 7 of the Discussion paper.

Hydrogen: The focus on *electrolysers* is highly appropriate; however, we recommend that it be broadened to ***electrolysis chains***. There are many opportunities for cost reduction in the technology chain converting renewable energy into various forms of stored hydrogen (gas, liquid, organic liquids, ammonia, and metal-hydrides). The FEnEx CRC's research and demonstration programs will focus on improving efficiencies and lowering the costs for elements in this chain to help reach the $2/kg goal.

The Roadmap should also consider ways to incentivise integrating such green hydrogen production with natural gas processing to enable the conversion of reservoir CO_2 into methane via the Sabatier reaction.[1] A large source of Scope 1 emissions could then be converted to Scope 3 emissions associated with power generation. Such technology could also be used to convert CO_2 generated from biomass into carbon-neutral 'renewable methane'.

Currently, the cheapest way to produce clean hydrogen is to integrate natural gas reforming with carbon capture and storage. Technologies that improve SMR, pyrolysis or methane cracking, and lower their associated carbon emissions should be listed under Hydrogen in the Roadmap and prioritised.

1. https://www.nature.com/articles/s41929-019-0244-4

Fugitive Emissions and Waste: The FEnEx CRC strongly supports, and will conduct appreciable R&D into, the prevention and use of fugitive emissions. The *Landfill gas* and *Ventilation Air Methane abatement* categories should be prioritised as they constitute two ends of an applications spectrum that also includes fugitive emissions from natural gas production and processing. The Fugitive Emissions survey listed in Appendix B of the Discussion paper does not identify the patented ***ILZ process technology***, recently commercialised and demonstrated at the tonne scale by the Australian company Gas Capture Technologies.[2] Originally developed to capture and utilise very dilute methane vented from LNG plants, the award of a Global Innovations Linkage grant in 2017 has enabled the ILZ process technology to be up-scaled and field-tested. It is now being used in China to recover dilute methane from coal mine vent streams, upgrading it to pipeline quality. This technology is also currently undergoing testing with landfill gas companies in both the USA and Italy. Given the TRL (8 to 9) and Commercial Readiness Index (2 to 3) of the ILZ process technology, demonstrations in Australia could occur in the short term (2021-22) with appropriate prioritisation.

Electricity: *Gas generation to firm variable renewables* is an extremely important technology for abating emissions on an increasingly large scale. The Roadmap should more clearly convey to the Australian public why simply increasing renewable electricity production in isolation is not a viable method of reducing emissions. The deleterious intermittency of renewable sources on electricity grids leads to hidden costs and emissions that are not, in general, accounted for properly: intermittency due to renewables can even cause net CO_2 emissions to rise when coal-based generation is used to compensate. The data for Germany's electricity production during Week 18 of 2019[3] provides a clear example of the issue. In Europe this problem can be partially masked by highly networked electricity grids but it will be acutely apparent in Australia's more isolated context. A strong focus is needed on technologies that increase the flexibility and efficiency achievable by integrating dispatchable natural gas with renewables to generate electricity.

Transport technologies are particularly important for reducing Australia's emissions given our scale of energy use in this sector and the relative maturity of several abatement options. We fully support the focus on *Hydrogen fuel cell heavy vehicles* and would recommend demonstration pathways through bus fleet and selected long distance haulage conversions for example. Equally, however, the Roadmap should prioritise the more general ***uptake of LNG-fueled heavy transport*** which is an even more mature set of technologies highly relevant to Australia's resources industry. This includes the shipping sector where LNG-powered engines constitute the best solution to meeting urgent emissions reduction targets mandated by the International Maritime Organisation. Lowering barriers to small-scale LNG production, particularly in regional Australia, would also align well with this priority.

Industry: *Carbon Capture Use and Storage (CCUS)* is an area where Australia is already a global leader. Our comparative advantage in CCUS should be built on, particularly in the oil and gas sector where infrastructure, expertise and incentives exist to deliver significant benefits in the medium term (2023-30). Significant research[4] has shown how enhanced gas recovery via CO_2 sequestration could offset CCUS costs by accelerating revenue generation.

Enabling technologies: Research Program 3 of the FEnEx CRC will focus on ***Interoperable digital technologies*** that cut across both the LNG and hydrogen sectors. A lack of interoperability between hardware and/or software from different vendors often limits the potential of digital technologies and

2. https://www.gascapture.com.au/
3. https://www.smard.de/en/5790
4. See, for example, doi.org/10.1016/j.energy.2016.04.120 and references therein.

presents a barrier to innovation and market access by smaller, new players. The hydrogen industry has the additional challenge of limited operational experience with digital process technologies given its rapid evolution. The FEnEx CRC will work with Australia's recently established Industry 4.0 Testlab network, which has nodes at both the UniSA and UWA, to resolve interoperability constraints, develop *optimised control systems* and validate *digital twins* to drive process improvements.

Leveraging Private Investment

The FEnEx CRC's Research Program 4 will focus on Market and Sector Development for the LNG and Hydrogen sectors, including ways to incentivise private investment and maximise the benefits derived by Australia. The natural risk-aversion implicit to capital intensive large-scale industry projects is a major barrier to the adoption of new technologies. To help overcome this hurdle, regulatory policy governing major project approval should incentivise formal programs to demonstrate and qualify new technologies. Furthermore, requiring the proponents of major resource projects to co-invest in establishing grid connections to onsite generation utilities would help mitigate emissions through the use of centralised power sources, and also provide longer term social and economic benefits.

Infrastructure and Skills

In addition to prioritising technologies, the Roadmap should consider the pathways for their validation and deployment. Substantial barriers exist to the adoption and use of new technologies at the industrial-scale, including risk aversion and market dominance by existing proprietary solutions. National, open-access infrastructure designed for de-risking new technologies at industrially-relevant scales is needed to promote their adoption and help establish innovation cycles. Large-scale testing facilities for demonstrating low emissions technologies would accelerate tangible progress in the same way that national research infrastructure like the Australian Synchrotron helps drive fundamental science forward.

The FEnEx CRC's flagship project is to establish the ***Futures Facility***.[5] This open-access, national infrastructure for industrial-scale technology demonstration will be based on a 10 tonne-per-day LNG plant[6], co-located with hydrogen production and liquefaction capabilities. The Futures Facility is custom-designed for testing and demonstrating many of the process and digital technologies detailed above and in the Roadmap discussion paper. Such an accessible facility would be unique globally and provide Australia with a significant advantage in the development and effective translation of low emissions technologies into industrial practice.

Additionally the Futures Facility could help deliver unrivalled training and educational opportunities for operators, maintenance contractors, engineers and data analysts who will be central to the next 50 years of Australian energy and resources production. Such major infrastructure could thus accelerate the growth, and even export, of knowledge and skills. By providing a public platform for the demonstration and explanation of new solutions, the Futures Facility could become a powerful tool for cultivating a technology-oriented approach to the challenge of emissions reduction.

Supporting emissions reductions through technology-driven global supply chains

Australia's political and geological stability, together with its natural resources and low population density, mean it has many opportunities to contribute to global emission reduction efforts. These include the large-scale generation and export of low carbon energy sources through LNG and hydrogen, but also extend to providing CCUS opportunities to international partners. For example,

5. https://www.fenex.org.au/research-areas/efficient-lng-value-chains/
6. https://lngfutures.edu.au/lng-futures-facility/

they may be merit in considering how the offshore depleted fields, associated wells and pipeline infrastructure on Australia's North West Shelf might be used to receive and sequester CO_2 from international customers. The looming cost and liability associated with decommissioning these assets could potentially be inverted into a sustained source of revenue as other countries pay for the secure and reliable disposal of CO_2 produced as they transition to low-emission economies.

Technologies that facilitate the handling and shipping of fluids such as LNG, hydrogen, ammonia, CO_2 and LPGs would greatly increase Australia's ability to participate in global-supply chains associated with emissions reduction. One example of such a technology is the ***Universal Transfer System*** developed and offered by Connect LNG.[7] It comprises a universal floating platform system, floating cryogenic flexible pipes and a robust interface for connecting to multiple ship carriers. The resulting ability to load and bunker LNG and other liquids at significantly lower cost than traditional jetties with increased flexibility and minimal environmental impact is particularly important for countries like Australia. Particularly if it can be adapted and used for the distribution of clean hydrogen vectors, this technology could play a major role increasing the connectivity of both domestic and international energy supply chains important to Australia.

The Australian resource sector is both financially conservative and keen to demonstrate reductions in the environmental footprint of their operations. Stretch goals intended to establish pathways to the cost-effective technology deployment should therefore aim to leverage these two motivations. Targets such as a 10% reduction in the energy cost per tonne of production for any new project seeking regulatory approval relative to an industry-standard benchmark might help overcome the inherent risk aversion that entrenches the status quo. Lower energy costs ultimately mean reduced expenditure or more revenue for a resource company and would simultaneously lead to lower emissions. If stretch goals are to be achieved in a timely manner, they must be linked clearly to incentives that will motivate the stakeholders being asked to deliver them. Furthermore, when designing such targets policy makers should (i) ensure they can be measured consistently and (ii) reward those that implement and achieve them rather than those that promise to do so.

7. https://www.connect-lng.no/