

Prospective FEnEx CRC R&D Projects for Program 1: Efficient LNG Value Chains

This list is indicative of potential projects that may be conducted within the collective program subject to the review, prioritisation and approval by the industry research panel. Valuations assume A\$500 per tonne LNG for conversion between production & revenue, based on World Bank long-term forecast of 10 USD per BTU for LNG in Japan.

R&D Project	Description	Value	Valuation Basis
Helium Recovery	Qualification of gas separation technology (zeolites, membranes, process designs) for recovery of He directly from end-flash gas without requiring a N ₂ rejection unit (NRU) vent stream and energy intensive cryogenic separation.	A\$1.2b ¹ A\$15.5m / y ²	Recovery of He from Ichthys gas field (12.8 TCF of sales gas and 0.065 mol% He). Ichthys does not require an NRU to reject N ₂ from the LNG product and therefore lacks the N ₂ vent stream to feed a He recovery process. Ichthys gas field He is valued as grade-A He product (US Government's 2017 value of US\$200 per thousand cubic feet of grade-A He is used).
CO ₂ utilisation via Sabatier Process ³	Qualification of technology to convert AGRU CO ₂ vent stream to CH ₄ using a Sabatier reactor and H ₂ produced from solar-powered electrolysis of H ₂ O.	A\$1.0b / y A\$460m / y (4.6 MTPA train)	Application of Sabatier process to AGRU vent and site flue gas for a 10 MTPA LNG plant treating natural gas with 10 mol% CO ₂ . Converting CO ₂ into LNG accounts for \$1b of \$5b annual LNG revenue and 20% uplift in sales.
AGRU Operation Improvements	Use of installed AGRU for foaming studies to provide data for validation of foaming models and optimisation of anti-foam injection. Qualification of foaming prevention technologies such as upstream water wash will also be carried out under this project.	A\$220m / event ⁴	Prevention of a single severe foaming event in a large LNG train. Specific value used is based on Woodside Energy Pluto LNG liquid carryover from AGRU to dehydration in June 2013, which led to a 3-4m BoE production forecast downgrade (US\$280-350m).

¹ Value calculated in US\$ due to availability of US Government He prices and converted to \$A using August 2018 exchange rate provided by Clough.

² Ichthys 40-year operational life for 8.9 MTPA converted to operational life for 4.6 MTPA to obtained annual He production at 4.6 MTPA baseline.

³ This project would also fit within the *Hydrogen Export & Value Chains* program.

⁴ Converted to \$A using August 2018 exchange rate provided by Clough.

R&D Project	Description	Value	Valuation Basis
Rapid Cryosolids Sensor	Qualification of a Rapid Cryosolids Sensor for direct measurement of freeze-out temperature. Direct measurement lowers risk of liquefaction unit blockage and allows further optimisation of liquefaction unit operation.	A\$44m / event	Prevention of a single liquefaction unit blockage on a 4.6 MTPA LNG train that would otherwise require a one-week production outage to rectify.
Advanced Process Modelling and Control for LNG Facilities ⁵	Use of installed LNG train for qualification of new process control technology, including improved process models, plant-model mismatch mitigation, and implementation of APC 2.0.	A\$115m / y	Development of self-tuning APC to maintain accurate process models within APC allowing operators to continuously reap the 5% production increase initially provided by APC. For a 4.6 MTPA LNG train this equates to maintenance of \$115m additional revenue per year.
Cryogenic Gas Processing Operation Improvements	Use of inlet compression unit and high design pressure to operate and subsequently model scrub column close to the critical point. Cryogenic process streams to qualify cryogenic membranes, LNG flow meters, LNG sampling systems, and novel liquefaction processes will also be carried out under this project.	A16m / y	Scrub column pressure increase due to an improved scrub column model allowing operation close to the critical point. An increase in operating pressure from 5 MPa to 5.5 MPa for a 4.6 MTPA LNG train equates to 1.2 MW less power consumed, or A\$16m production increase per year at fixed power consumption.
Debottlenecking and Maintenance Improvements ⁶	Qualification of non-intrusive technologies and demonstration of products targeting incremental productivity improvements for LNG plants.	A\$5m / y	A new maintenance technique reducing major shut down duration by three days. For a 4.6 MTPA LNG train on a four yearly major shut down cycle, additional train uptime equates to A\$5m additional production per year (annualised).

⁵ This project would also fit within the *Digital Technologies & Interoperability* program.

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LNG Storage and Regasification	Use of installed LNG storage vessel for qualification of new LNG storage insulation systems, boil-off gas (BOG) models and LNG rollover models. Use of LNG slipstreams for qualification of LNG regasification technologies will also be carried out under this project.	A\$40m / y	An LNG storage insulation system reducing BOG rate by 0.5% of stored volume per day. This equates to A\$40m less product lost as BOG per year for a 250,000 m ³ LNG carrier transporting LNG 144 days per year.
Digital Twin ⁷	Development and demonstration of a high-fidelity LNGFF Digital Twin, including operator training simulator (OTS), 3D VR model, and detailed multiphysics simulations of installed equipment.	A\$22m / y	A report on the high-fidelity Snøhvit LNG simulator praised its contribution to improved process design. Assuming a long-term value of improved design being fewer design-related plant trips, a 1% availability increase for a 4.3 MTPA LNG plant such as Snøhvit would deliver A\$22m of additional product per year.

⁷This project would also fit within the *Digital Technologies & Interoperability* program.