

# Future Energy Exports (FEnEx) CRC

## MILESTONE SUMMARY TABLE

Research Program	Output	Milestone Number	Milestone Description	Milestone Start Date (Grant Agreement)	Milestone End Date (Grant Agreement)
<b>Research Program 1: Efficient LNG Value Chains</b>					
RP1 Efficient LNG Value Chains	Significant contribution to the objectives of RP1 Efficient LNG Value Chains	1.0	Generally aligned with the goal of making LNG Value Chains more efficient but not specifically aligned with any of the other RP1 Milestones	1/7/2020	30/6/2030
RP1 Efficient LNG Value Chains	Novel and efficient processes for recovery of helium and other high value commodity gaseous by-products of LNG production	1.1.1	Full audit of helium recovery potential from Australian and global LNG production and overview of current technology limitations	1/7/2020	30/6/2021
RP1 Efficient LNG Value Chains	Novel and efficient processes for recovery of helium and other high value commodity gaseous by-products of LNG production	1.1.2	Commissioning of helium recovery unit operation July 1 2021 June 30 2026	1/7/2024	30/6/2026
RP1 Efficient LNG Value Chains	Novel acid gas removal solutions, coupled with carbon capture and storage, for required CO2 removal during LNG production	1.2.1	Methane leak audit of LNG plants and gas distribution networks coupled with review of available detection technology & recommendations for minimisation	1/7/2021	30/6/2022
RP1 Efficient LNG Value Chains	Novel acid gas removal solutions, coupled with carbon capture and storage, for required CO2 removal during LNG production	1.2.2	Pilot scale demonstration with planned extrapolation to full scale LNG plants of both improved maintenance strategies and acid gas removal techniques so as to reduce LNG carbon footprint	1/7/2024	30/6/2027
RP1 Efficient LNG Value Chains	Novel holistic technical solutions to guard against potential adverse events during LNG production	1.3.1	Software based model of boil-off gas production with predictions of when it becomes unstable	1/7/2022	30/6/2023
RP1 Efficient LNG Value Chains	Novel holistic technical solutions to guard against potential adverse events during LNG production	1.3.2	Demonstration of sensor able to provide early detection of freeze-out events July 1 2023 June 30 2025	1/7/2023	30/6/2025
RP1 Efficient LNG Value Chains	New and improved LNG plant technologies, such as real-time quality control of scrub column production, low temperature gas dehydration, and tailored mixed refrigerants for liquefaction.	1.4.1	Optimised operation and sensing requirements for scrub columns featuring product purity control July 1 2020 June 30 2024	1/7/2022	30/6/2024

RP1 Efficient LNG Value Chains	New and improved LNG plant technologies, such as real-time quality control of scrub column production, low temperature gas dehydration, and tailored mixed refrigerants for liquefaction.	1.4.2	Construction and commissioning of a low temperature gas dehydration unit operation	1/7/2026	30/6/2028
RP1 Efficient LNG Value Chains	Written design and operational standards for best practice by LNG Design, EPC and operator industries as well as various regulatory bodies	1.5.1	Report as to best practice regards LNG storage and transportation so as to minimise boil-off July 1 2020 June 30 2028	1/7/2024	30/6/2026
RP1 Efficient LNG Value Chains	Written design and operational standards for best practice by LNG Design, EPC and operator industries as well as various regulatory bodies	1.5.2	Report on success of foaming prevention strategies based on better sensing and improved process understanding/foam modelling	1/7/2027	30/6/2029
<b>Research Program 2: Hydrogen Exports &amp; Value Chains</b>					
RP2 Hydrogen Exports & Value Chains	Significant contribution to the objectives of RP2 Hydrogen Exports & Value Chains	2.0	Generally aligned with the goal of developing Hydrogen Exports & Value Chains (including Utilisation) but not specifically aligned with any of the other RP1 Milestones	1/7/2020	30/6/2022
RP2 Hydrogen Exports & Value Chains	Optimised production & use of liquid carriers enabling efficient long-distance transport of hydrogen, such as: liquid hydrogen (LH2), methyl-cyclohexane (MCH), liquid organic hydrogen carriers (LOHCs), methanol (MeOH), & ammonia (NH3).	2.1.1	Detailed design of a liquid hydrogen production and storage plant at the scale required for export	1/7/2021	30/6/2022
RP2 Hydrogen Exports & Value Chains	Optimised production & use of liquid carriers enabling efficient long-distance transport of hydrogen, such as: liquid hydrogen (LH2), methyl-cyclohexane (MCH), liquid organic hydrogen carriers (LOHCs), methanol (MeOH), & ammonia (NH3).	2.1.2	Identify optimum integration and recovery of hydrogen from selected liquid organic carriers	1/7/2025	30/6/2027
RP2 Hydrogen Exports & Value Chains	Novel and improved materials for hydrogen containment that enable storage and transport while minimising hydrogen embrittlement and/or reduce boil-off gas (BOG) in cryogenic applications; codes and standards for safer handling; as well as accurate models for predicting liquid hydrogen (LH2) boil-off	2.2.1	Develop and test a liquid hydrogen boil-off gas model as a user-friendly software tool	1/7/2021	30/6/2023

RP2 Hydrogen Exports & Value Chains	Novel and improved materials for hydrogen containment that enable storage and transport while minimising hydrogen embrittlement and/or reduce boil-off gas (BOG) in cryogenic applications; codes and standards for safer handling; as well as accurate models for predicting liquid hydrogen (LH2) boil-off	2.2.2	Report detailing technical requirements for scale up of electrolysis methods relevant to production at export-scale	1/7/2023	30/6/2024
RP2 Hydrogen Exports & Value Chains	Novel and improved materials for hydrogen containment that enable storage and transport while minimising hydrogen embrittlement and/or reduce boil-off gas (BOG) in cryogenic applications; codes and standards for safer handling; as well as accurate models for predicting liquid hydrogen (LH2) boil-off	2.2.3	Optimal containment material identified for large-scale hydrogen storage accompanied by required operation data for its inclusion in system design	1/7/2028	30/6/2030
RP2 Hydrogen Exports & Value Chains	Advanced and robust electrolysis technologies and processes, including proton exchange membrane (PEM) and alkaline electrolysis (AE) systems, for large scale production of green hydrogen	2.3.1	Final design of integrated renewable energy co-electrolysis (power-to-gas, gas-to-power) with energy storage and heat integration to produce and transport hydrogen	1/7/2026	30/6/2028
RP2 Hydrogen Exports & Value Chains	Efficient integration of carbon capture & use (CCU) with steam reformation of methane (C1) and novel pyrolysis reforming technologies for the sustainable production of blue hydrogen, and production methods for value added synthetic carbon fuels using green hydrogen.	2.4.1	Report detailed options for (i) closed loop carbon economies and (ii) coupled methane reforming and carbon capture and storage for the delivery of hydrogen	1/7/2020	30/6/2021
RP2 Hydrogen Exports & Value Chains	Efficient integration of carbon capture & use (CCU) with steam reformation of methane (C1) and novel pyrolysis reforming technologies for the sustainable production of blue hydrogen, and production methods for value added synthetic carbon fuels using green hydrogen.	2.4.2	Pilot-scale testing demonstration of a closed loop carbon cycle for the provision of hydrogen	1/7/2022	30/6/2025
RP2 Hydrogen Exports & Value Chains	Integrated systems with solid-phase hydrogen storage materials (such as metal hydrides, metal organic frameworks, & adsorbents) and thermal 'thermal batteries' able to efficiently store and release energy, including on time and length scales relevant to export	2.5.1	Experimental design and construction of test rig for technical evaluation of solid-state hydrogen storage and thermal batteries	1/7/2023	30/6/2026

RP2 Hydrogen Exports & Value Chains	Integrated systems with solid-phase hydrogen storage materials (such as metal hydrides, metal organic frameworks, & adsorbents) and thermal 'thermal batteries' able to efficiently store and release energy, including on time and length scales relevant to export	2.5.2	Integrate optimum hydrogen export method (solid state hydrogen, liquid organic hydrogen carriers or liquid hydrogen) into co-electrolysis pilot plant	1/7/2027	30/6/2029
<b>Research Program 3: Digital Technologies &amp; Interoperability</b>					
RP3 Digital Technologies & Interoperability	Significant contribution to the objectives of RP3 Digital Technologies & Interoperability	3.0	Generally aligned with the goal of advancing Digital Technologies & Interoperability but not specifically aligned with any of the other RP3 Milestones	1/7/2020	30/6/2030
RP3 Digital Technologies & Interoperability	New information standards for the effective data exchange and communication across inter-enterprise processes, as well as methods to maintain and improve these standards.	3.1.1	Review of existing production and maintenance information standards and prioritised use cases for key operational process areas (production/maintenance; transactional /analytical data) as needed to develop data-exchange and communication systems.	1/7/2020	30/6/2021
RP3 Digital Technologies & Interoperability	New information standards for the effective data exchange and communication across inter-enterprise processes, as well as methods to maintain and improve these standards.	3.1.2	Extended implementation and demonstration of standards-based data-exchange systems for LNG and other energy sector plants using pilot data sets. Support tools evaluated and further improved using experimental data.	1/7/2027	30/6/2029
RP3 Digital Technologies & Interoperability	Digital Ecosystem Architectures that enable continuing interoperability across the industry	3.2.1	Selection of key communication pathways and initial communication infrastructure design (bus, languages) and demonstration with initial information standards for priority process areas	1/7/2021	30/6/2023
RP2 Hydrogen Exports & Value Chains	Digital Ecosystem Architectures that enable continuing interoperability across the industry	3.2.2	Adaption of digital ecosystem architecture to expanded information standards and extended use case coverage	1/7/2023	30/6/2025
RP3 Digital Technologies & Interoperability	Digital Ecosystem Architectures that enable continuing interoperability across the industry	3.2.3	Evaluation of new architectural and language concept integration, as well as adaptation of architectures to changing partner requirements in line with improvements and updates in industry information standards.	1/7/2025	30/6/2026
RP3 Digital Technologies & Interoperability	Digital Ecosystem Architectures that enable continuing interoperability across the industry	3.2.4	Adaption and finalisation of digital ecosystem architectures with an extended suite of demonstrated information standards.	1/7/2028	30/6/2030

RP3 Digital Technologies & Interoperability	Improved LNG and Hydrogen plant control systems with increased predictive ability, reaction speed and ability to adapt.	3.3.1	Techniques and specifications for integration of improved process control system designs into existing architecture developed, demonstrated and evaluated using experimental data sets for priority operations. Additional areas for improvement identified	1/7/2020	30/6/2022
RP3 Digital Technologies & Interoperability	Remote plant operation solutions based on effective data interchange, visualisation and control interfaces.	3.4.1	Integrated system for visualisation, control, & data exchange to enable remote plant operations based on initial information standard definitions and sample data set schemas, demonstrated and tested through workshops and pilots.	1/7/2022	30/6/2024
RP3 Digital Technologies & Interoperability	Remote plant operation solutions based on effective data interchange, visualisation and control interfaces.	3.4.2	Refined second generation remote plant operation solutions demonstrated in realistic scale pilot implementations	1/7/2025	30/6/2027
RP3 Digital Technologies & Interoperability	Digital Twin models for LNG and hydrogen plants suitable for process industries covering the whole plant lifecycle	3.5.1	Digital twin models extracted and described incorporating prediction and anomaly identification techniques. Models and frameworks for plant lifecycle priority areas implemented and evaluated on pilot data	1/7/2026	30/6/2028
<b>Research Program 4: Market &amp; Sector Development</b>					
RP4 Market & Sector Development	Significant contribution to the objectives of RP4 Market & Sector Development	4.0	Generally aligned with the goal of driving Market & Sector Development but not specifically aligned with any of the other RP4 Milestones	1/7/2020	30/6/2030
RP4 Market & Sector Development	Hydrogen energy market futures map: visual representation of spatio-temporal patterns and trends driving hydrogen energy export market development	4.1.1	Artificial intelligence information harvesting techniques utilized to develop draft trends and megatrends for high potential hydrogen energy export markets	30/6/2021	31/8/2024
RP4 Market & Sector Development	Hydrogen energy market futures map: visual representation of spatio-temporal patterns and trends driving hydrogen energy export market development	4.1.2	Spatio-temporal visualization produced detailing trends and megatrends for hydrogen export markets	1/7/2024	30/6/2027
RP4 Market & Sector Development	Hydrogen and LNG energy market development diagnostic: barriers and drivers of domestic market (resources, heavy and maritime transport sectors) and export market (shipping) opportunities	4.2.1	Mapping of key industry, government and community stakeholders in hydrogen and LNG energy supply chains, with key barriers and drivers of energy product usage identified	1/7/2020	30/6/2021

RP4 Market & Sector Development	Hydrogen and LNG energy market development diagnostic: barriers and drivers of domestic market (resources, heavy and maritime transport sectors) and export market (shipping) opportunities	4.2.2	Generation of final spatio-temporal maps for hydrogen and LNG energy market futures, and diagnostic tools for energy industry to drive domestic and export market adoption of product	1/7/2026	30/6/2029
RP4 Market & Sector Development	Hydrogen and LNG energy market development diagnostic: barriers and drivers of domestic market (resources, heavy and maritime transport sectors) and export market (shipping) opportunities	4.2.3	Industry workshops, conference and event presentations and publication of industry documentation to facilitate engagement	1/7/2029	30/6/2030
RP4 Market & Sector Development	Regulatory and policy framework and communication strategy for hydrogen energy industry development to balance hydrogen export market growth with sustainable and affordable domestic supply of energy	4.3.1	Evaluation of LNG reservation policy and comparison of the distribution of economic benefits between industries between East and West Coast domestic markets for LNG	1/9/2020	31/8/2022
RP4 Market & Sector Development	Regulatory and policy framework and communication strategy for hydrogen energy industry development to balance hydrogen export market growth with sustainable and affordable domestic supply of energy	4.3.2	Policy recommendations and community guidelines developed and disseminated for effective interventions to balance the needs of export and domestic market development to industry and government	1/7/2022	30/6/2025
RP4 Market & Sector Development	Detailed regional input/output supply chain map and stakeholder analysis to accommodate the emerging hydrogen export capability.	4.4.1	Analysis of key barriers to coordination across government, industry and community stakeholders necessary to achieve supply chain transitions to future energy product sectors Mapping and stakeholder analyses findings disseminated to relevant stakeholders	9/1/2020	31/8/2023
RP4 Market & Sector Development	Technology adoption diagnostic instruments and intervention models to support the development of firm and human resource capabilities to utilise new energy technologies developed in Programs 1-3.	4.5.1	Diagnostic tools piloted with employee surveys across energy businesses to assess and model barriers and enablers to technology adoption and innovation.	1/7/2025	30/6/2026
RP4 Market & Sector Development	Technology adoption diagnostic instruments and intervention models to support the development of firm and human resource capabilities to utilise new energy technologies developed in Programs 1-3.	4.5.2	Models for improving business structures, systems and processes to support energy technology uptake developed and refined using data collected and stakeholder interviews	1/7/2025	30/6/2028