Project Yuri Phase 0 – 10MW Green Hydrogen for Ammonia in the Pilbara

Lessons Learnt Report No. 1

Project details	
ARENA Project ID	2021/ARP005
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[1] https://engie.com.au/yuri

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1. Executive Summary

ENGIE and Mitsui are developing one of the world's first industrial-scale renewable hydrogen projects to provide feedstock into Yara Pilbara Fertilisers' (Yara) existing ammonia operations near Karratha in Western Australia.

Scheduled for completion in 2024, the first phase of the Yuri project will produce up to 640 tonnes of renewable hydrogen per year as a zero-carbon feedstock for Yara's ammonia production facility in Karratha. This will be key to developing a 'Pilbara Green Hydrogen Hub', serving local and export markets, and building on existing export infrastructure and abundant renewable energy resources in the region. This project is receiving funding from ARENA and the WA Renewable Hydrogen Fund as part of the Western Australian Government's Renewable Hydrogen Strategy.

The project will include a 10 MW electrolyser powered by 18 MW of solar PV and supported by an 8 MW battery energy storage system, generating renewable hydrogen for use in Yara's ammonia facility at Karratha.

Construction works started on 1 December 2022.

This report intends to share lessons learned during the business development phase and throughout the first months of the execution phase.

2. Key Learnings

2.1. Lesson learnt No. 1: Energy Management System (EMS)

Category: Technical

Objective: Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale

Detail: The control system of complex microgrids combining multiple generation assets (renewables, BESS, synchronous generators) is comprised of an integrated power management and energy management system. The power management system is responsible for ensuring system stability following disturbances. The energy management system optimises the operation of the plant by optimally dispatching the mix of generation assets with respect to the load profile.

The autonomous control of microgrids with integrated EMS & PMS is relatively novel and few companies have expertise and capability to deliver this control system. The introduction of electrolysers and associated process equipment adds an additional layer of complexity to the control system:

1) Unlike traditional microgrids where the load is determined by demand and thus not controllable, the operation of the electrolysers is part of the overall optimisation. Characteristics including efficiency curves, start/stop times, and how the load is split between the stacks should be considered in the optimisation, however there is very little expertise on this today on the market. Furthermore, due to limited actual operation experience, electrolyser OEMs themselves have limited information exactly how flexible operation (i.e. frequent starting/stopping and ramping) will impact performance and degradation, making it challenging to appropriately consider this in the optimisation.
2) EMS providers are experienced in controlling generation assets; however, have limited to no experience controlling process equipment and are generally reluctant to include this in their scope. As such a separate control system for the process system is required and it is essential that the interface of this to the EMS is correctly developed.

Implications for future projects and conclusion:

1) Consider the EMS as a long-lead item. Consequently, appointing the EMS supplier as early as possible is recommended; and
2) Consider the engineering and procurement model to minimise interfaces between suppliers and allow focus on resolving or de-risking technical complexity.

2.2. Lesson learnt No. 2: Harmonic Filter

Category: Technical

Objective: Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale

Detail: Harmonic filters are a long lead engineered procurement item, however, ordering the item is dependent on completion on power quality studies and the completion of procurement of associated electric equipment. Power quality studies and the design of the harmonic filter are relevant to all projects with power electronic based generation or loads, but are more complex and time consuming when all generation and loads are converter based and OEMs may not have the software models available.

Implications for future projects and conclusion:
During the feasibility stage it is recommended to:

- perform a harmonic baseline measurement campaign to measure the power quality of the existing system; and
- carefully consider the harmonic levels of equipment in the equipment selection process and obtain the harmonic models of inverters and rectifiers.

This will enable the harmonic studies to be performed during the feasibility study or early in the detailed engineering phase and de-risk procurement of the harmonic filter.

2.3. Lesson learnt No. 3: Electrolyser

Category: Technical

Objective: Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale

Detail: The emerging green hydrogen industry relies on established electrolyser OEMs (based overseas) with limited experience in supplying equipment to countries including Australia. These OEMs are experiencing their own learnings of the engineering and compliance requirements to supply equipment to countries including Australia.

Implications for future projects and conclusion:

1) Complete a thorough due diligence with OEMs to understand OEM strength and weaknesses, and where supplemental resources may be required; support for additional engineering, alternative sub-suppliers or subcontractors and understanding of timeline to complete engineering to Australian standards.
2) As part of due diligence, assess the additional resources that may be required in-country to support engineering, fabrication and Quality Assurance and Quality Control (QA/QC) for electrolyser package.
3) Validate the OEMs delivery schedule as part of this due diligence.

2.4. Lesson learnt No. 4: Soiling losses for PV in the Pilbara

Category: Technical

Objective:

1) Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale; and

2) Challenges and lessons learned from establishing commercial scale facilities in the Pilbara for renewable energy, renewable hydrogen and renewable ammonia production and export.

Detail:
1) There is a limited number of solar photovoltaic (PV) plants in the Pilbara. Consequently, little data is available on soiling losses in the region.
2) It is also noted that soiling losses are heavily influenced by the surroundings (i.e. proximity to sea, industrial sites, etc.).

Implications for future projects and conclusion: Especially for larger projects, it is recommended to perform soiling monitoring campaign as early as possible during development phase to inform both soiling losses and possible solutions, notably regarding the cleaning strategy of the PV panels.

2.5. Lesson learnt No. 5: Battery Energy Storage System

Category: Technical

Objective:
1) Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale; and
2) Challenges and lessons learned from establishing commercial scale facilities in the Pilbara for renewable energy, renewable hydrogen and renewable ammonia production and export

Detail: Regulatory requirements for new technology such as BESS may not be transparent during engineering and require additional work by project teams to develop in collaboration with regulatory authorities.

Implications for future projects and conclusion: If adopting new technologies, consider regulatory gaps and collaborate with regulatory authorities to address gaps in the immediate term. For example, BESS fire protection requirements may leverage regulations in other Australian States if not available in Western Australia.

2.6. Lesson learnt No. 6: Photovoltaic panels

Category: Technical

Objective:
1) Challenges and lessons learned about the integration of the various systems and technologies at this commercial scale; and
2) Challenges and lessons learned from establishing commercial scale facilities in the Pilbara for renewable energy, renewable hydrogen and renewable ammonia production and export.

Detail: Large solar panels magnify forces required to be sustained by the whole panel system, particular in cyclone regions. As a result, larger panels may need to be installed at lower tilt angles than smaller panels, which reduces power generation.

Implications for future projects and conclusion: As part of conceptual design, pre-qualify the panel suppliers and panel size by holistically assessing PV plant design (tilt angle, configuration, panel physical size & orientation, layout, and rack structure design etc). For cyclone prone regions, it is suggested that the panel selection and structural calculations and certifications of the panel and support structure is performed during the development phase of the project.

2.7. Lesson learnt No. 7: Permitting

Category: Technical

Objective: What commercial, regulatory and social barriers the project encounters, and how they are effectively addressed

Detail: Permitting timeframe, and in particular for environmental approvals, may extend beyond the initial project schedule expectations.

Implications for future projects and conclusion: It is recommended to:

1) Anticipate long permitting timeframes, considering that processes in Australia (community consultation, cultural heritage consideration...) make it a potentially time-consuming exercise; and
2) Prefer development areas with limited sensitivity if possible.

2.8. Lesson learnt No. 8: Support of the Murujuga community

Category: Social

Objective: How is social license and genuine support for the project established and maintained with relevant communities; particularly the Traditional Owners of the lands impacted by the project.

Detail: Consultation processes with the local community to support Yuri Project, including Traditional Owners, are underpinned by the long-term relationships created through Yara Pilbara's pre-existing presence, genuine interest and strong connection with the local communities which neighbour the company's operations including Karratha, Dampier and Roebourne.

Yara's approach to community engagement is relationship based rather than transactional, with many years devoted to building mutual respect and trust. This is particularly evident with the Murujuga Aboriginal Corporation and the five groups it represents and the Company's understanding of their cultural heritage and connection to Country.

While Yara utilises traditional engagement forums such as regular scheduled meetings, the company is fully residential and does not use fly-in/fly-out which allows for sustained and almost daily informal engagement with stakeholders at all levels of the community.

Building and maintaining ongoing trust also requires and relies on transparency. Yara places great emphasis on this knowledge sharing. It is not uncommon on a weekly basis for tours of the facilities to be undertaken to allow stakeholders to understand the nature and outputs of Yara's operation and how these interact with the environment in which the company operates.

While the key relationship with relevant communities is through Yara Pilbara, the developers Engie and Mitsui and their EPC Contractor educate all their personnel on the significance and importance of local cultural heritage and Traditional Owners, their role in supporting them, and that ultimately the project operates under and affects Yara Pilbara's social licence.

Implications for future projects and conclusion: It is important to engage and build trust with local communities over the long-term, maintaining transparency from early phase, including consultation for any public (media etc.) communication.

Appendix A - Abbreviations & Definitions.

ARENA	Australian Renewable Energy Agency
BESS	Battery Energy Storage System
CFA	Country Fire Authority
EPC Contract	Agreement for the design, engineering, procurement, supply, construction and commissioning for the Project
EMS	Energy Management System
OEM	Original Equipment Manufacturer
PV	Photovoltaic
QA/QC	Quality Assurance and Quality Control
WA	Western Australia