GOVERNMENT OF
WESTERN AUSTRALIA

TrHyHub: Community Summary

CREDIT: Development WA

Fraunhofer ISE

MID WEST PORTS

Port of Rotterdam

Contents

1. Context and Background

The Western Australian Government's Renewable Hydrogen Strategy, released in October 2024, envisions Western Australia as a leading producer, user and exporter of renewable hydrogen.

The strategy has a target to secure an international off-take agreement for export of renewable hydrogen products by 2030. In addition, the strategy outlines a priority action for investment, both public and private, in infrastructure and activation of hydrogen hubs and Strategic Industrial Areas (SIAs) in the Pilbara, Mid West and Kwinana.

The proposed Oakajee Port and SIA is the focus for the Mid West Hydrogen Hub and is located north of the City of Greater Geraldton. Once developed, the Mid West Hydrogen hub is intended to improve Western Australia's global competitiveness by co-locating users and producers of renewable hydrogen and attracting investment through coordination of common user infrastructure.

The Oakajee Trilateral Hydrogen Hub study (TrHyHub study) is one component of a set of studies being undertaken by the Department of Jobs, Tourism, Science and Innovation (JTSI) on behalf of the Western Australian Government relating to the development of the Oakajee SIA.

The TrHyHub Study analyses the critical components that could ultimately deliver a supply chain in the form of ammonia and other hydrogen products from Oakajee SIA to Germany via the Port of Rotterdam. It is a collaborative effort between key stakeholders in Australia, Germany, and the Netherlands.

In Australia, the consortium is led by the Western Australian Government, through JTSI, in close partnership with Mid West Ports Authority (MWPA). In the Netherlands, the project is led by the Port of Rotterdam and part-funded by the Dutch Ministry of Economic Affairs and Climate. In Germany, the project is led by Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) and funded by the German Federal Ministry for Education and Research.

The study was guided by 6 specific objectives:

1. To conduct foundation studies necessary for Oakajee to become a future world class Hydrogen Hub.
2. To investigate the hydrogen production potential in the Mid West region.
3. To investigate the technical and economic feasibility of the single point mooring system which may accelerate exports from Oakajee SIA ahead of 2030.
4. To signal the viability of Northwest Europe as a potential offtake market.
5. To stimulate collaborative research and development of hydrogen related technology
6. To create an attractive investment environment for Australian as well as European companies.

2. Objectives and Findings

2.1. Foundation Studies for Oakajee SIA and Port

With its strategic positioning and renewable energy capabilities, the Oakajee Port and SIA stands as a central hub for renewable industry growth in Western Australia. The land around Oakajee has excellent renewable energy potential for solar and wind energy when analysed using a multi-criteria analysis and factoring legal, environmental, social and technical considerations.

In achievement of its first objective, the TrHyHub Study undertook necessary foundational studies to facilitate the Oakajee SIA's evolution into a future world-class industrial hydrogen port complex.

Oakajee has long been identified as a potential location for a major deepwater port expansion. An approved port and SIA masterplan for iron ore export is now being updated to accommodate the production and export of hydrogen-related products, as well as potential iron ore and green steel exports. The Oakajee SIA will be strategically connected to necessary infrastructure in the region and will benefit from a large skilled labour force due to its proximity to the City of Greater Geraldton.

The central focus of the TrHyHub Study was on the technical design, location, and feasibility of ammonia export port infrastructure situated in the Oakajee port, overseen by the Mid West Ports Authority (MWPA). Also investigated in the study were spatial, technological and ecological aspects that will require future impact analysis as proposed industrial developments arise.

2.2. Hydrogen Production Potential in the Mid West Region

The TrHyHub Study involved an assessment of the total hydrogen production potential of the Mid West region.

A geographic information system analysis conducted through the TrHyHub study revealed that the land within a 350-kilometre radius of the Oakajee SIA has significant potential for large-scale renewable electricity generation which could support the theoretical production of millions of tonnes of hydrogen per annum. While realising this volume of hydrogen production will require substantial time and coordination with all parties involved, realising even a portion of the theoretical hydrogen production at this scale would provide for a substantial portion of the European demand for hydrogen in 2050.

In calculating demand figures, the TrHyHub Study assumed an initial annual hydrogen production from Oakajee of approximately 0.5 million tonnes per annum (mtpa) being converted into 3 mtpa ammonia for export. Several suitable renewable energy generation

locations were also identified in the immediate vicinity of Oakajee. These locations have the potential to host substantial renewable energy production capacities, which could increase planned renewable ammonia production capacity from 3 Mtpa to over 15 Mtpa. This is already equivalent to the current European ammonia production capacity and represents more than five times the current German demand for ammonia.

The TrHyHub study's techno-economic analysis of an ammonia supply chain from Oakajee to Germany confirmed that the cost component related to the long-distance from Australia to Europe does not constitute a significant cost factor, accounting for only 9% of the total cost of producing and delivering the products.

The higher shipping cost is offset by the significant solar and wind resources available at Oakajee which enables the costs of production and storage of hydrogen to be considerably reduced.

In addition to ammonia, the TrHyHub Study investigated liquid hydrogen and methanol for export to Germany from Oakajee. Both of these products face technical and economic barriers to export, such as a lack of commercially available transport vessels for liquid hydrogen and the need for significant upscaling of production plants to reduce costs.

As such, the analysis indicates that ammonia is the most suitable option for a supply chain from Western Australia to Germany in the short term, with substantial cost savings to be anticipated into the future.

2.3. Technical and Economic Feasibility of the Single Point Mooring System

This objective of the TrHyHub study aimed to determine the optimal port engineering solutions required to enable ammonia exports from Oakajee ahead of the 2030 targets.
The study concluded that an offshore single point mooring (SPM) concept, which includes a Catenary Anchor Leg Mooring (CALM) buoy specially designed for loading liquid ammonia exports onto tankers, would be the most feasible option for accelerated exports from Oakajee.

The SPM system was chosen due to its minimal impact on the environment and community, short construction timeframes, and cost-efficiency compared to a jetty terminal. In addition, the SPM system is well suited to the local weather conditions and operational requirements at Oakajee, enabling it to operate weekly and be functional over 85% of the time.

The TrHyHub Study notes that the capacity of the SPM system is lower than that of a fixed jetty behind a protected port basin, which may support the import of equipment for the new hydrogen projects and industrial facilities.

Again, a key finding of the TrHyHub Study is that the SPM system could be implemented as part of first phase planning, delivering a strategic stepping stone towards a larger, breakwater-protected port in the future.

2.4. Signalling the Viability of Northwest Europe as an Offtake Market

Through this objective, the TrHyHub Study aimed to demonstrate the viability of Northwest Europe as a market for hydrogen ventures in Western Australia, with the aim of stimulating interest from potential stakeholders.

Following the European Commission's REPowerEU plan launched in 2022, the European Union (EU) set a target of importing up to 10 million tonnes of renewable hydrogen by 2030 to replace fossil fuels in all sectors across Europe.

The TrHyHub Study concluded that Germany presents a promising market for renewable hydrogen, with the current national consumption of hydrogen being approximately 1.6 million mtpa across various production industries. With more than 90% of this amount currently fossil-sourced, Germany's National Hydrogen Strategy announced its aim to shift these sectors, along with steel and select transportation sectors, to renewable hydrogen.

Given the limited capacity of Germany to produce renewable hydrogen as a result of land use constraints for solar and wind infrastructure, the German National Hydrogen Strategy concludes that most of its renewable hydrogen will need to be imported.

The TrHyHub Study's assessment found that the most prevalent hydrogen carrier foreseen in the short term is renewable ammonia, which could be imported from Oakajee SIA through the Port of Rotterdam in recognition of its extensive logistics connections to the most promising offtake regions in Germany, notably North Rhine-Westphalia and Ludwigshafen.

While the focus of the TrHyHub Study is hydrogen and ammonia supply to Northwest Europe, it is important to note that Western Australia's current primary energy export markets are in Asia. In the short-term, European offtake may offer the most relevant for Oakajee green hydrogen and ammonia.

The TrHyHub study's scope also included an analysis on regulatory frameworks for exporting hydrogen and ammonia to Europe to identify potential bottlenecks, as well as an investigation into the impact of policies on the economic competitiveness of these products.

Key regulatory frameworks include the EU Emissions Trading System, Carbon Border Adjustment Mechanism, and Renewable Energy Directive. These regulatory mechanisms promote renewable hydrogen by imposing additional costs on fossil products and fuels, thereby raising the overall cost of fossil-based ammonia. It was concluded that green

ammonia produced in Oakajee could meet European certification requirements for a Renewable Fuel of Non-Biological Origin.

2.5. Stimulating Collaborative Research and Development

The TrHyHub Study sought to stimulate collaborative research and development efforts across Australia, Germany and the Netherlands, fostering advancements in hydrogen-related technologies.

Throughout the study, the contributions of numerous experts combine and reflect international knowledge and experience, paving the way for future research. In addition, the establishment of an international Industry Reference Group (IRG), consisting of experts from various fields across the hydrogen industry, was instrumental in ensuring that the TrHyHub is aligned with latest global developments.

One cost driver in the ammonia supply chain is the operation window of ammonia synthesis. As further research and development in this field is needed, Fraunhofer ISE is working on new ammonia syntheses processes that will reduce the cost of renewable ammonia, making it more competitive with non-renewable ammonia. Fraunhofer ISE's work in this area also includes optimisation and process development to produce fuels, including Direct Air Capture, chemicals and energy sources as well as on new technologies for the direct use of ammonia.

2.6. Creating an Attractive Investment Environment

The TrHyHub Study focussed on the aim of creating an attractive investment and development environment for both Australian and European hydrogen enterprises to participate. This partnership is further reinforced by Australia and Germany's recent agreement to deepen cooperation on new green hydrogen supply chains through the $660 million H2Global funding window.

The vision and shared ambition for Oakajee is also shown in the efforts of 6 key proponents, who were allocated land in the Oakajee SIA in 2022 for the development of various hydrogen and ammonia projects.

Given Oakajee's proximity to the Geraldton Port, the TrHyHub Study demonstrates the two ports should be developed in close coordination. This would help avoid over or under-capacity while also allowing flexibility in terms of allocating activities to the most suitable port.

Additionally, the TrHyHub Study findings recognise the increased importance of developing common-user infrastructure to support future energy industries. Alignment amongst the key government stakeholders involved in the development of Oakajee SIA is essential in

realising Oakajee's vision, and is currently being coordinated by JTSI, with the agency able to define investment proposals for common user infrastructure.

3. Conclusion

The TrHyHub study underscores the viability of large-scale renewable ammonia exports from Western Australia to northwest Europe via the Port of Rotterdam, where there is an existing and growing demand for ammonia.

As concluded in the study, the Oakajee SIA has a clear comparative advantage in the production of renewable ammonia and hydrogen, due to its abundant land and significant renewable electricity potential. With an established demand and sufficient investments, the Oakajee SIA could be the kick-start of a green hydrogen hub at scale.

The Western Australian Government is committed to realising this vision for the Oakajee SIA. To deliver on this vision, the Western Australian Government is progressing 6 studies which aim to activate the Oakajee SIA, including:

1. The TrHyHub Study.
2. Western Power, in partnership with Energy Policy WA, examining the feasibility of connecting Oakajee SIA's electricity to the Southwest Interconnected System.
3. DevelopmentWA conducting land planning and engineering activities.
4. DevelopmentWA developing a cultural heritage management plan, leveraging the Yamatji Nation Indigenous Land Use Agreement (ILUA) between the Western Australian Government and the Yamatji people.
5. Water Corporation conducting studies to investigate common user water supply solutions, including a desalination plant.
6. Development of environmental and approval plans

A number of these studies are now complete, demonstrating a positive journey ahead for Oakajee, actioned by the collective efforts of all stakeholders to ensure its success in the emerging global hydrogen industry.

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