Renewable hydrogen transport hub in the City of Mandurah

Public Knowledge Sharing Report

Hazer Group, Hyzon Motors, Macquarie Capital and Macquarie Bank

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GOVERNMENT OF WESTERN AUSTRALIA

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Glossary

Term	Definition
BEV	Battery Electric Vehicle
Charter buses	Private charters buses
COAG	Council of Australian Governments
CO_2-e	Carbon dioxide equivalent
Cornerstone customers	Key fleet operators providing demand for transport hydrogen hub
FCEV	Fuel Cell Electric Vehicle
FID	Final Investment Decision
FTE	Full Time Equivalent
GSP	Gross State Product
ICE	Internal Combustion Engine vehicle
JDAP	Metro Outer Joint Development Assessment Panel
kg	Kilograms
km	Kilometres
L	Litre
M	Million
MW	Megawatt
OEM	Original Equipment Manufacturer
Parties	Hazer Group Limited, Macquarie Corporate Holdings Pty Limited, Macquarie Bank Limited and Hyzon Motors Australia Pty Ltd
(the) Project	Feasibility of establishing a renewable hydrogen refuelling facility and mobility application in the City of Mandurah and the surrounding Peel Region
Project Group	Hazer, Hyzon Motors Australia and Macquarie Group
Public buses	Public transport buses
t	Tonnes
TCO	Total Cost of Ownership
Through trucks	Trucks passing through the study area on regular basis, with their base / depot located outside the study area
WA	Western Australia
Waste trucks	Rubbish collection vehicles

Executive summary

Hazer Group Limited, Hyzon Motors Australia, Macquarie Capital and Macquarie Bank formed a Project Group with grant funding awarded by the WA Government's Renewable Hydrogen Fund to undertake a feasibility study for the development of a renewable hydrogen transport hub in the City of Mandurah and the surrounding Peel region.

While a range of potential cornerstone customers were identified after assessing a wide range of potential hydrogen mobility users in the region, the Project Group have concluded the following:

- In the short term, the overall hydrogen demand from Mandurah and the Peel region's cornerstone customers was estimated to be small relative to other industry projects, leading to relatively high costs of hydrogen production and refuelling for a Mandurah production facility.
- Aggregating short term demand at a common refuelling facility and securing supply from a centralised renewable hydrogen production facility would reduce costs by increasing scale and plant utilisation. The centralised production facility could service demand across regions, with suitable siting locations in close proximity to the Peel region potentially available.

To meet the requirements of the Public Knowledge Sharing Report, an illustrative case study is presented in this report with a centralised production model. The case study presents a renewable hydrogen mobility future for Mandurah and the surrounding Peel region in the medium to long term.

In light of the above conclusions, the Project Group suggests the following recommendations to develop a renewable hydrogen transport hub for Mandurah, Peel and the surrounding regions:

1. **Regional collaboration to develop a large, centralised hydrogen production facility**: The City of Mandurah could work with neighbouring regions, such as Kwinana and/or Cockburn to identify sources of renewable hydrogen demand that could underpin a large centralised renewable hydrogen production facility.
2. **Refuelling station network**: When developing hydrogen refuelling stations, parties should consider the benefits of a network of refuelling stations that will reduce barriers to FCEV adoption.
3. **Incentivising adoption**: The City of Mandurah and WA Government could consider developing incentives to encourage the transition to hydrogen technology in and around Mandurah.

1 Introduction

1.1 Study background

The Western Australian (WA) Government established a $10 million Renewable Hydrogen Fund in late 2019, as a key action from its Renewable Hydrogen Strategy. The fund was launched to drive a new job-creating industry, harnessing WA's renewable resources by supporting feasibility studies, demonstration and capital works projects.

Hazer Group Limited (ASX: HZR) was awarded a grant from the Renewable Hydrogen Fund to undertake this feasibility study, "the Project", for the development of a renewable hydrogen transport hub in Mandurah and the surrounding Peel region. Hazer Group Limited partnered with Hyzon Motors Australia, a global supplier of zero-emission hydrogen fuel cell vehicles, Macquarie Capital and Macquarie Bank to form a **"**Project Group**"**.

Aurecon was appointed by the Project Group for delivery of the Project. The Project's objective was to assess the feasibility of establishing a renewable hydrogen refuelling facility and mobility application within the geographical area of Mandurah and the Peel region.

1.2 Hydrogen's potential

The Western Australian (WA) Renewable Hydrogen Strategy, released in 2019, clearly sets out a vision for the State to be a significant producer, user and exporter of hydrogen. WA would be contributing to a global hydrogen economy forecast to grow to $2.5 trillion by 2050.[1] While electricity markets are rapidly transitioning to a low carbon future, hydrogen presents an opportunity to lower the emissions from hard-to-abate sectors including transport, heavy industry and heating.[2]

There has been increasing global activity and focus aimed at reducing carbon emissions across transport sectors. US, China, Europe and Japan have a combined on-road target of ~50,000 Fuel Cell Electric Vehicles (FCEVs) in 2020 which increases to circa 10,000,000 by 2030.[3]

Estimates indicate that an Australian hydrogen industry could generate 7,600 jobs[4] and $11 billion in Gross Domestic Product by 2050.[5] In this low-carbon future, WA has the advantages of abundant natural resources, a skilled workforce, established energy and resource supply chains and a history of being a net energy exporter to Asia and the rest of the world.

1.3 Scope

The scope of this Public Knowledge Sharing Report is to provide a public version of the study results, providing an overview of a proposed project ("case study") and its key parameters:

- Description and overview
- Location and construction schedule
- Anticipated employment
- Diesel and carbon emission reductions
- Storage facilities
- Production forecast
- Consumption details and other use applications
- Economic benefit
- Vehicle refuelling forecasts
- Regulatory and approval considerations

[1] Hydrogen Council, 2017. *Hydrogen scaling up: A sustainable pathway for the global energy transition*.
[2] Commonwealth of Australia, 2019. *Australia's National Hydrogen Strategy.*
[3] Deloitte and Ballard, 2020. *Fueling the Future of Mobility: Hydrogen and fuel cell solutions for transportation.*
[4] It should be noted that these employment figures cannot be compared to the benefit analysis performed within this report. Underlying assumptions need to be assessed as to the extent of jobs being considered (e.g. direct jobs within the industry, indirect jobs from investment, etc.)
[5] Commonwealth of Australia, 2019. *Australia's National Hydrogen Strategy.*

2 Methodology

2.1 Overview

To determine a case study for Mandurah and the surrounding Peel region, the methodology adopted for the Project had three main steps, which considered the whole hydrogen for transport supply chain as an 'enterprise' (see Figure 2-1). The approach iteratively considered and solved for a number of elements: demand for hydrogen FCEVs, demand for hydrogen as a transport fuel, the infrastructure required to produce, deliver and fuel hydrogen into the vehicles, and the performance and economics of all supply chain elements relative to conventional and battery-electric alternatives.

In this way, the methodology developed and 'stress-tested' a number of hydrogen enterprise concepts, comprising a number of different fleet types, to establish a competitive economic and technical landscape of opportunities for hydrogen in road transport.

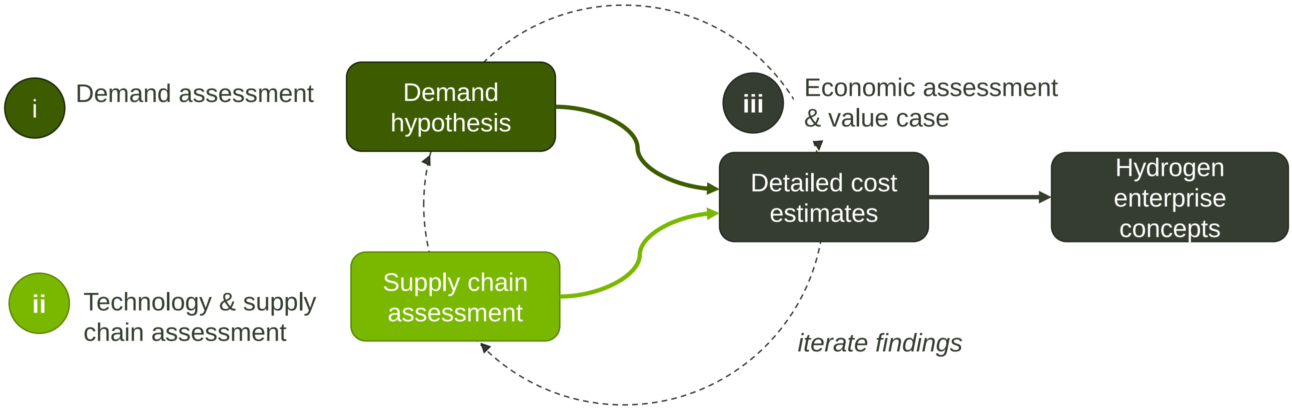


Figure 2-1 Simplified Aurecon execution methodology

A brief overview of the approach taken across these steps is provided as follows:

i. Demand assessment

The demand assessment followed a systematic approach in establishing a demand hypothesis and identifying initial cornerstone customers in the Peel region. Hydrogen vehicle adoption was estimated within the context of existing vehicle fleet sizes, operations and direct engagement with key users and stakeholders.

ii. Technology and supply chain assessment

The supply chain assessment comparatively assessed multiple supply chain permutations and technology selections for hydrogen production, distribution, refuelling and vehicle use cases to perform a high-level optimisation. Hydrogen FCEVs were compared to Battery Electric Vehicles (BEV) and Internal Combustion Engine (ICE) vehicles.

iii. Economic assessment & value case

Financial modelling was performed on the hydrogen supply chain from the renewable resource (e.g. wind, solar and biogas) to propulsion of the FCEV. Macro-economic benefits of the case study were estimated for WA through the application of multipliers in an input-output model.

2.2 The hydrogen supply chain for road transport

In the technology and supply chain assessment, the analysis explored options in the four key steps of developing a renewable hydrogen transport hub: (1.) production, (2.) distribution (3.) refuelling and (4.) end use (see Figure 2-2).

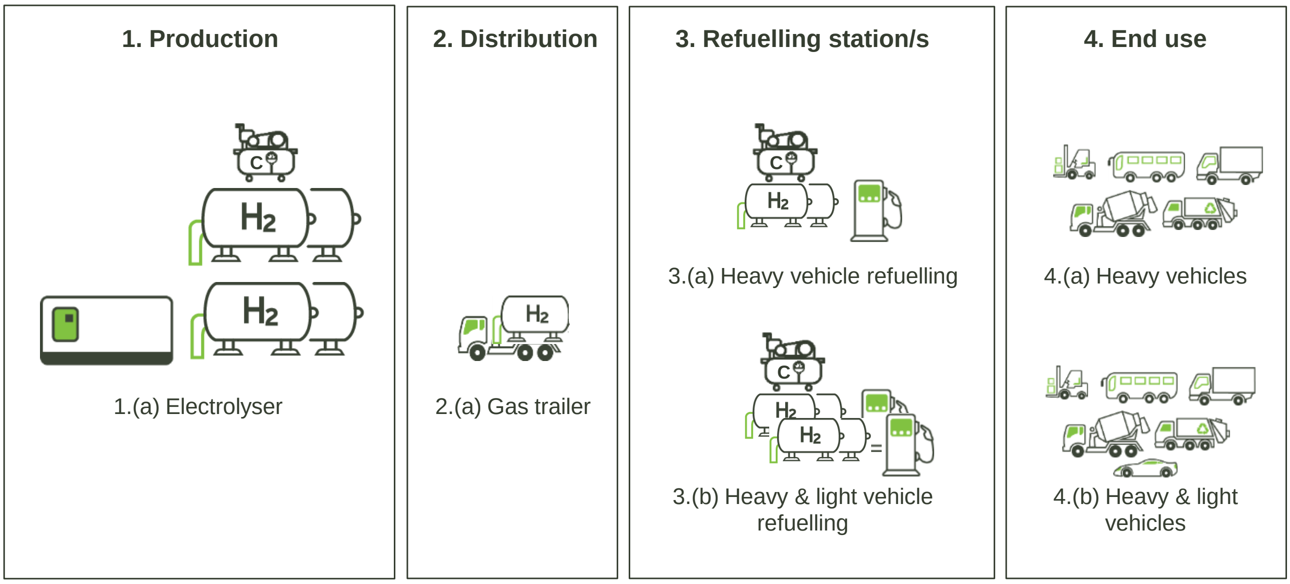
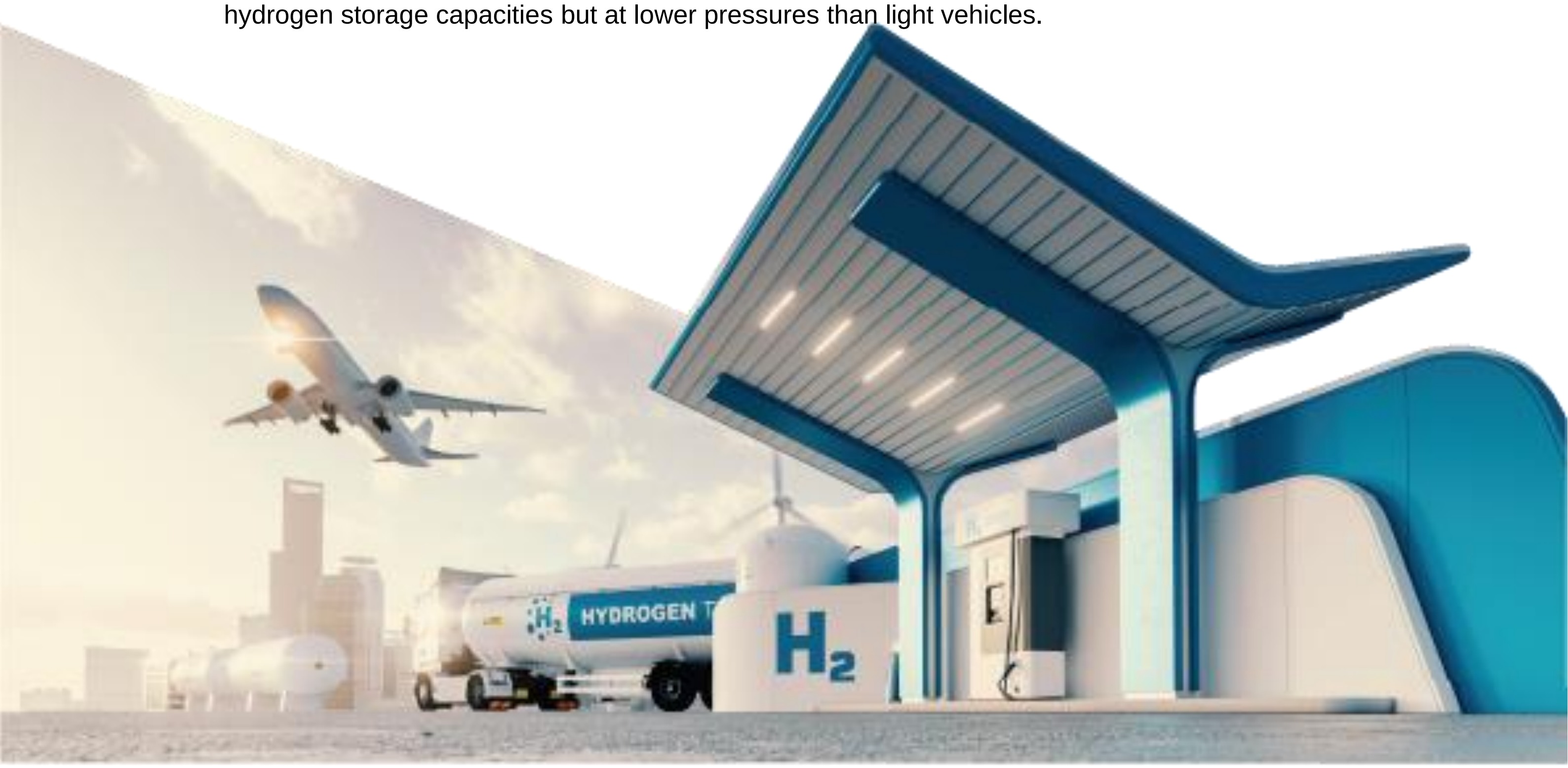


Figure 2-2 **Hydrogen transport hub supply chain**

The Project considered varying technologies and supply chain permutations in each of the key steps. The specific technology options relevant to the case study, shown in Figure 2-2, are as follows:

- **1.(a) Electrolyser**: Alkaline water or proton exchange membrane electrolysis produces renewable hydrogen with net zero emission electricity and water. Storage and compression would be required at the site to balance supply with demand and fill the gas trailers.
- **2.(a) Gas trailer:** Transportation of compressed hydrogen is by a prime mover with storage vessels mounted on a trailer (so-called 'tube trailer'), when production is in a different location to the refuelling station/s.
- **3.& 4. Refuelling station and end use:** The refuelling station infrastructure would be designed to meet the demand and pressure requirements of the end-use applications. Heavy FCEVs have fuel tanks with higher hydrogen storage capacities but at lower pressures than light vehicles.



3 Commercial conclusions

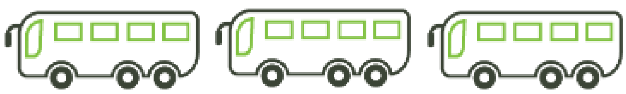
3.1 Identifying cornerstone customers

Mandurah and the Peel region were initially identified as potential locations to site a renewable hydrogen transport hub given:

- Initial work which identified a strong appetite to develop hydrogen mobility projects in the region
- Proximity and connectivity with significant local industrial clusters including Kwinana and Cockburn
- The Peel region is currently undergoing a period of strategic planning and development with significant expected population increases and development of new industries[6]

A period of detailed demand assessment using a mixture of stakeholder engagement and desktop research, identified potential "cornerstone customers" based on their operations being back-to-base, expected demand, strategic drivers and engagement with the Project. The cornerstone customer end uses were the following:

City of Mandurah's combined fleet comprising trucks, light vehicles and street sweepers



Public transport buses ("public buses")

Rubbish collection vehicles ("waste trucks")

Private charter buses ("charter buses")

These cornerstone customers were prioritised from a wider assessment of short, medium and long term hydrogen transport use cases in Mandurah and the Peel region, which included: taxi fleets, truck fleets travelling through the Peel region, drayage trucks, cement trucks, ecotourism and material handling. Barriers identified in the short term for these other mobility uses were the requirement for a network of refuelling stations to support current operations, limited availability of vehicle or equipment and/or estimated demand for FCEV adoption.

3.2 Mandurah demand

Based on the feasibility work completed in the Project, there were two key conclusions in terms of hydrogen demand in Mandurah:

(1) Early stage mobility projects: In the short term, the estimated hydrogen demand from Mandurah and the Peel region's cornerstone customers was estimated to be small relative to other proposed industry projects. Consequently, the costs of hydrogen production and refuelling for a Mandurah production facility is expected to be relatively high due to relatively low economies of scale and utilisation.

[6] City of Mandurah & Shire of Murray, 2018. *Mandurah and Murray: A Shared Economic Future*

(2) Leveraging surrounding demand: Considerations should be given to aggregating shorter term demand at a common refuelling facility and securing supply from a centralised renewable hydrogen production facility that services demand across regions. Potential locations for the siting of a larger production facility identified in the feasibility work include:

- Kwinana's industrial area – positioned as a favourable location for an early hydrogen hub in WA
  - Significant existing hydrogen users, back-to-base (haulage) fleets across a range of sectors
  - Future long term demand growth from Perth's future container port, Westport
- City of Cockburn which has a range of potential sizable industrial hydrogen users.

There are several detailed outcomes from the Project that support these conclusions, including:

- **Requisite scale**: Limited short term hydrogen demand from back-to-base operations in Mandurah, that can support a plant of sufficient scale to be cost competitive with other proposed projects.
- **Cost of hydrogen**: The expected cost of renewable hydrogen in Mandurah is relatively high when compared to other proposed projects, this is due to the low level of potential hydrogen demand in the short term and low infrastructure utilisation. Expanding on this:
  - **Production:** The aggregated demand of Mandurah's cornerstone customers would have a higher relative cost of production when compared to other proposed projects. Aggregating Mandurah's demand with other nearby regions at a large centralised production plant could achieve economies of scale for capital expenditure and lower electricity costs. The scale would enable more sophisticated plant optimisation to lower operational costs, such as: reducing operations during high electricity price periods and participation in demand response mechanisms to lower overall net energy costs.
  - **Distribution:** Cost savings would be expected in the short term by procuring the transport of hydrogen between a centralised production plant and a Mandurah refuelling station from an existing industrial gas supplier. Supplier fleets are multi-purpose and service multiple customers, so can be more highly utilised and 'spread' distribution costs over a larger customer base. As such, these services would be expected to be competitive with the cost of a build, own and operate business model for Mandurah's demand in the short term.
  - **Refuelling:** The individual demand of each cornerstone customer would only support a relatively small refuelling station (which is expensive, per unit of fuel). A means of reducing the cost for Mandurah would be through the aggregation of demand across the cornerstone customers in a single larger refuelling station, which increases economies of scale and utilisation.
- **Technological readiness**: There are few hydrogen transport use cases with technology ready solutions that can be rolled out at significant scale (i.e. vehicles / rolling stock for specific transport applications are still being developed).
- **Appetite to transition fleets**: While operators are generally supportive and interested in hydrogen technologies, there is a lower appetite for operators to transition existing fleets from ICE to low emission vehicles without significant economic or regulatory drivers. Considerations for fleet operators include:
  - The higher capital cost associated with an FCEV compared to an ICE, irrespective of a Total Cost of Ownership comparison.
  - Risk appetite in managing potential downtime from issues with the nascent technology and supply chain.
  - Changes in vehicle refuelling and maintenance.

In the experience of the Project Group early movers in the hydrogen sector are driven by:

- A desire to decarbonise their operations.
- A cost or regulatory landscape that makes the low emission alternative significantly more attractive than the ICE equivalent (or 'Business as Usual').

3.3 Developing a renewable hydrogen industry across regions

The Project has identified a range of areas where the City of Mandurah and industry participants may work together to develop a renewable hydrogen industry:

- **Collaboration:** The City of Mandurah could work with neighbouring regions, such as Kwinana and/or Cockburn to identify sources of renewable hydrogen demand that could underpin a large centralised renewable hydrogen production facility.
- **Refuelling station network**: When developing hydrogen refuelling stations, parties should consider the benefits of a network of refuelling stations that will reduce barriers to wider FCEV adoption.
- **Incentivising adoption:** The City of Mandurah and WA Government could consider developing incentives to encourage the transition to hydrogen technology in and around Mandurah.

4 A renewable hydrogen future in Mandurah and the Peel region

4.1 Overview

In fulfilment of the Public Knowledge Sharing Report requirements, a case study is detailed in this section that highlights a renewable hydrogen future for Mandurah and the surrounding Peel region.

The case study demonstrates the potential scope of a renewable hydrogen transport hub project in a 'scaled-up market', where:

- Each identified cornerstone customer is able to transition its entire existing fleet to FCEVs to support sizable demand.
- Cornerstone customer demand sources are aggregated and can underpin a transport hub (hydrogen production facility) of sufficient scale to support project economics.
- Net energy costs are optimised enabling minimisation of network charges
- Cost reductions in supply chain technologies and performance have been achieved.

Although Mandurah and the Peel region face challenges of sufficient scale of demand for the siting of a renewable hydrogen plant in the shorter term, cost reductions and favourable policies may improve the feasibility of a local production facility in the medium to long term.

The following section illustrates the potential scope of a hydrogen mobility industry for Mandurah in the medium to long term, under scaled-up market conditions.

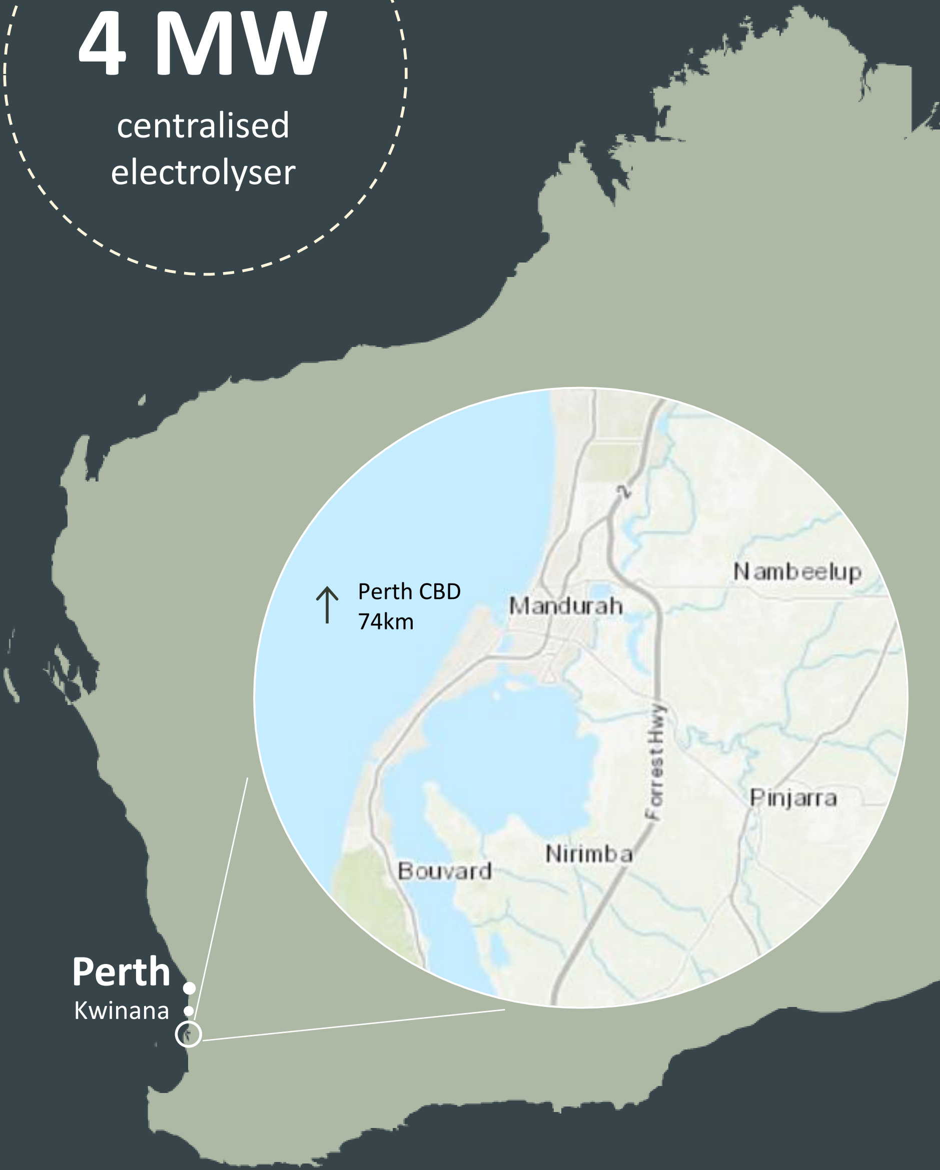
A renewable hydrogen future in Mandurah and the Peel region

270
hydrogen vehicles

4 MW
centralised electrolyser

4
hydrogen refuelling stations

700t
per annum of hydrogen



10,000t
avoided carbon dioxide per year

$440M
economic output

1,300
jobs

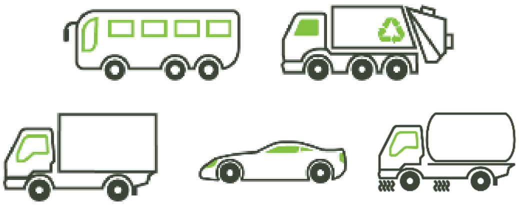
Map sourced from: ESRI, 2019. *ArcGIS Earth (Version 1.9).*

4.2 Mandurah in a scaled-up hydrogen market

4.2.1 Description and characteristics

The case study proposes a renewable hydrogen transport hub for Mandurah and the Peel region with the following characteristics:

- **Description:** A centralised renewable hydrogen production facility utilising electrolysis powered by net zero emission electricity. Hydrogen will then be distributed by gas trailer to four refuelling stations positioned optimally for each cornerstone customers' fleet operations.
- **Production capacity:** 4 megawatt (MW) electrolyser with a production capacity approaching 2,000 kilograms of hydrogen per day (kg/day) to meet daily demand.
- **Vehicles:** A total of ~270 vehicles were assessed across the four cornerstone customer fleets, identified to be the most favourable for FCEV adoption, made up of the following:
  - 65 public buses
  - 60 charter buses
  - 43 waste trucks
  - City of Mandurah
    - 51 light vehicles
    - 45 trucks
    - 5 street sweepers



- **Refuelling capacity:** A total of 2,600 kg/day across the four refuelling sites.
  - *Buses and waste trucks*: The proposed refuelling stations for the buses and waste trucks could perform 25 heavy vehicle fills of 25 kg per day at a vehicle storage tank pressure of 350 bar.
  - *Light vehicles*: Estimated to perform a maximum of 125 light vehicle fills of 5 kg per day, in alignment with Original Equipment Manufacturing (OEM) data, at a vehicle storage tank pressure of 700 bar for the City of Mandurah.
- **Product availability:** A typical plant availability of 96% was assumed for the production facility's electrolyser. With the exception of unexpected failures causing supply disruptions exceeding buffer storage durations, hydrogen is seen as available to customers 100% of the time.
- **Product quality:** Hydrogen purity levels for fuel cells in transport applications are required to be in excess of 99.97%, in compliance with ISO 14687-2:2014 and SAE J2719. These purity levels are achievable with electrolysis.

The cost estimates were developed in line with a Class 5 AACE Cost Estimate, with an expected accuracy range of -50% to +100% for the level of study definition.[7] OEM data, engineering estimates and third-party data were utilised to determine parameterised cost metrics for scaled-up market conditions to estimate the capital costs for the case study.

The estimated capital expenditure for the fleets of FCEVs and infrastructure, utilising the approach discussed above, was $118 million (Australian dollars) in scaled-up market conditions. The achievability of these market conditions is subject to scaling of global supply chains and industry learning with a significant majority of the capital expenditure coming from the acquisition of the FCEVs.

[7] AACE, 2005. *Cost Estimate Classification System – As applied in engineering, procurement, and construction for the process industries.*

4.2.2 Location and construction

The refueling stations for the case study would be expected to be located in optimal locations for the operation of the cornerstone customer fleets. The industry zoned area to the northeast of the City of Mandurah (shown in Figure 4-1) is where a number of the cornerstone customers have their existing depots and back to base operations located.

Siting the centralised production facility would require an optimisation between a number of factors, including:

- Land availability
- Regulations and approvals (see Section 4.2.10)
- Accessibility
- Electricity network connection and capacity
- Capital / leasing costs and conditions

A locally based hydrogen production facility could be located within the same industrial complex or the Nambeelup Business Park. The location would need to be optimised for the plant's construction and operation costs with respect to supplying the cornerstone customers and future demand growth.

The expected duration between the Final Investment Decision (FID) and commissioning is estimated to be between 15 and 24 months, with OEMs yet to be selected. Critical path items would be long lead items (e.g. distribution gas trailers, electrolysers and hydrogen refuelling stations) and the electricity network connection. On selection of OEMs, further information would be provided on procurement lead times. Long lead times could be managed in the shorter term through an early procurement process pre-FID, with durations expected to reduce in the medium to long term.

The onsite construction duration was estimated to be four to six months with a large proportion of plant and equipment expected to be provided in modularised components. Onsite activities, in preparation of plant being delivered, would include earth works, foundations, piping and other services. Commissioning timeframes would be dependent on the level of participation in the electricity market and achieving necessary certifications to be compliant with regulatory requirements. Necessary approvals, permits and electricity network connection agreements (discussed in Section 4.2.10) are assumed to be obtained pre-FID.

Achieving FID approval would be expected to require the securing of grant funding and/or offtake agreements from cornerstone customers. Cornerstone customers, in turn, would require FCEV supply contracts (or fully-wrapped 'as a service' contracts) for the progressive replacement of their ICE fleets.

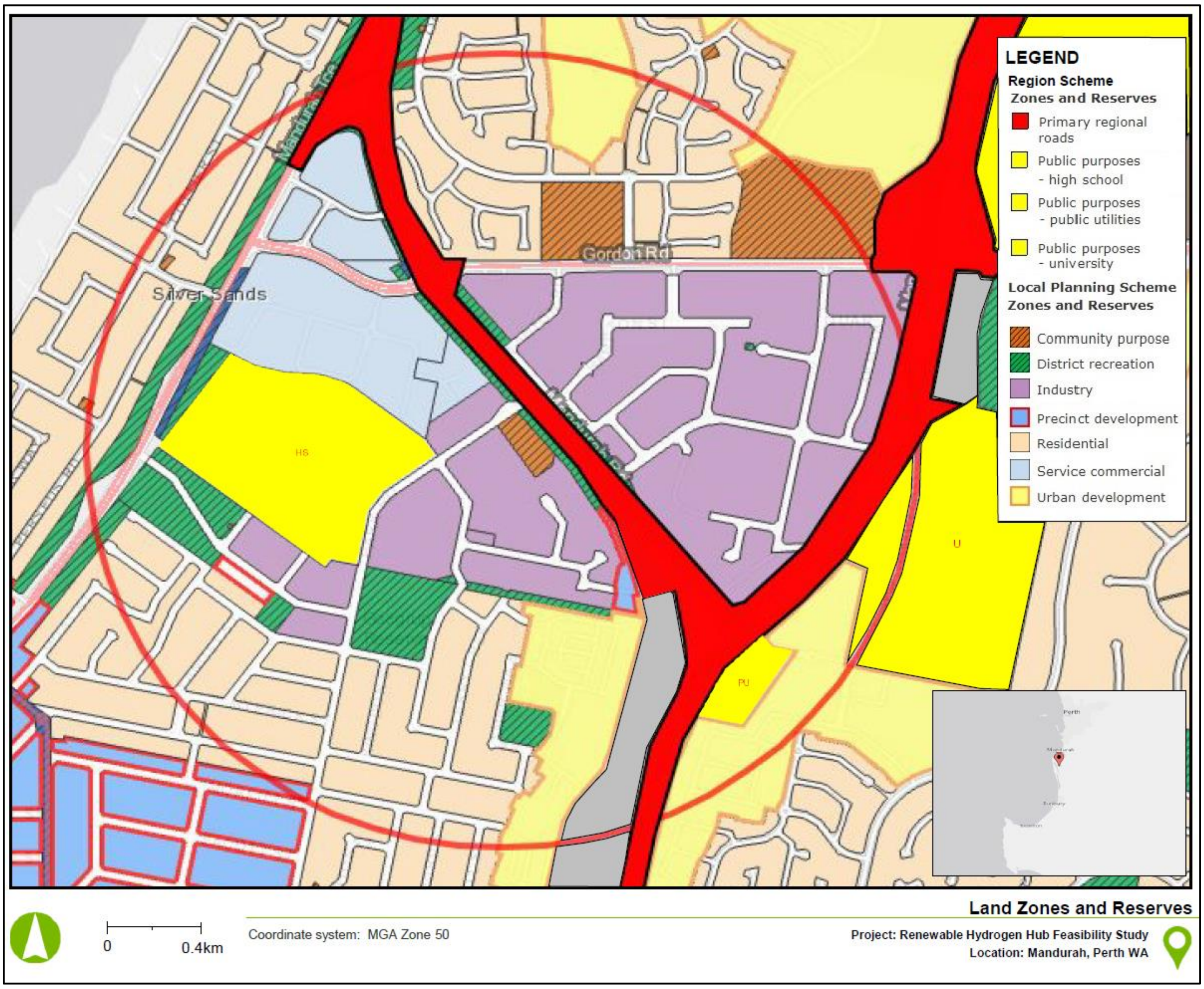


Figure 4-1 **Industrial zoned area northeast of Mandurah**

4.2.3 Employment

Employment figures were estimated by applying economic multipliers in an input-output model. The modelling applies economic multipliers to capture both direct and indirect economic benefits. **The estimated number of jobs created in WA over the project's 20 year lifecycle exceeded 1,300 jobs**. With 890 jobs in the construction phase and 410 during operation, the project would increase WA's employment by 0.10%.

Jobs would include engineers, technicians, gas fitters, plumbers and builders and other associated trades and professional services. While many skills will be transferable from other sectors, 'hydrogen-ready' workers will have to be qualified and licensed to work with hydrogen safely and legally.[8]

Additional capability would be needed to support and maintain the FCEV fleets. This includes skilled persons who are able to complete vehicle maintenance tasks and safety inspections. There will also be a requirement for skilled persons to complete condition assessments and asset integrity assurance on the infrastructure at each location (e.g., storage and refuelling equipment).

Formal technical and professional education and accreditations for the relevant expertise (engineers, technicians, etc.) will be required to transfer skills of the current workforce. Governments, industry, educational institutions and registered training organisations will need to work together to develop and deliver quality education and training. Courses and qualifications will need to take into account progressive updating of standards and codes as they are developed and reviewed over time, both internationally and domestically.

[8] Commonwealth of Australia, 2019. *Australia's National Hydrogen Strategy.*

4.2.4 Diesel displacement

FCEVs with renewable hydrogen provide environmental and health benefits through the avoidance of diesel demand. **The diesel displaced by the case study was estimated to be 3.7 million litres (ML) of diesel per year.**

When applying an emissions factor of 2.72 kg of carbon dioxide equivalent per litre (CO_2-e/L), in alignment with the National Greenhouse and Energy Reporting (Measurement) Determination 2008, the displaced diesel **reduces carbon dioxide emissions by 10,000 tonnes of CO_2-e/year.**

It should also be noted that the benefits of substituting ICEs with FCEVs extend to community health benefits from reductions in other pollutants, such as particulate matter, nitrogen and sulfur oxides, as well as improvements in amenities due to the reduction of negative impacts caused by noise and vibration by heavy vehicles.

4.2.5 Storage facilities

Storage enables the time-varying supply and demand of hydrogen to be balanced as well as a risk mitigation from unplanned outages. The optimum storage pressure is a trade-off between the capital and operating cost of compression, the storage footprint and the cost of storage equipment.

A storage quantity equivalent to a duration of 48 hours of demand was applied to the case study. The duration reduces distribution costs by enabling refuelling stations to operate for one to two days between gas trailer deliveries. The storage duration would also provide time to respond and/or resolve supply chain disruptions from contingency events (e.g. transport issues) and unplanned maintenance. Further supply chain and logistical planning would be performed at later stages of development to optimise the storage duration in relation to other plant requirements.

Both steel and composite vessels were considered at each stage of the supply chain. The vessel types selected were based on a high level optimisation of the relative operational and capital cost contributions between compression requirements and storage pressures. The storage properties for the case study are presented in Table 4-1, where a single gas trailer with a ~1,000 kg storage capacity could service the four refuelling stations.

Table 4-1 Storage properties

Location	Pressure (bar)	Duration (hrs)	Materials
Production facility (electrolyser)	50	48	Steel
Distribution (gas trailer)	300[9]	N/A	Composite fibre materials
Refuelling (buffer storage)	200	48	Steel

The refuelling station will have buffer storage onsite to manage hydrogen supply from the production facility. In addition to this, the refuelling station will have a cascade storage system to manage FCEV refuelling times. The storage pressure of the cascade storage will likely be determined by the technical specification of the OEM's offered products and will be made from composite fibre materials.

4.2.6 Hydrogen production

The annual hydrogen production from electrolysis at the centralised production facility was modelled to be 700 tonnes/year to supply demand. Further refinement of the production capacity at later stages of development, could consider the following factors:

- Additional capacity of the electrolyser to enable reductions in utilisation for demand response and/or avoidance of high market prices
- Sizing requirements for distribution gas trailer filling schedules and requirements for distribution

[9] For the purpose of costing the storage a 300 bar storage vessels was utilised, while the storage capacity was estimated used a 380 bar pressure. The OEM engaged expected the current 300 bar vessels to be recertified to 380 bar with revisions to European Standards.

- Contingency events, unplanned maintenance and plant redundancy

These are potential considerations for increasing the capacity of the electrolyser, which would increase the maximum potential hydrogen production capacity.

4.2.7 Hydrogen consumption and alternative uses

The primary focus of the Project was to identify hydrogen demand from transport applications in Mandurah and the surrounding Peel region from cornerstone customers. As such, the annual hydrogen production in the case study was sized to match the demand from the cornerstone customer vehicle fleets.

Other potential use applications identified from the desktop research and stakeholder engagement within Mandurah and the Peel region were:

- **Location:** Peel Business Park: 1,000 ha industrial development located in the Shire of Murray in the Peel region, proposed to become the new home of agri-innovation in WA. It could potentially support FCEV trucks and is readily accessible to the ports of Kwinana, Fremantle and Bunbury.
- **Use cases:**
  - Delivery and through trucks
  - Taxi fleets
  - Drayage trucks
  - Concrete trucks
  - Ecotourism vessel
  - Material handling

As noted above, these use cases were considered challenging in the short term given limited expected demand profiles, refuelling station requirements and/or limited availability of vehicle or equipment for the respective use case. However, as networks of hydrogen refuelling stations begin to develop, barriers to adoption will reduce for fleets that do not have a back-to-base operation (e.g. through trucks and drayage). Through trucks and drayage trucks are use cases with highly utilised vehicles, which would be expected to have a relatively favourable Total Cost of Ownership (TCO) comparison for FCEVs. Positioning of hydrogen refuelling stations should consider formation of a future network and additional demand from these other use cases.

4.2.8 Economic benefit

The input-output modelling and employment estimates provided an indication of the potential macroeconomic benefits to the Western Australian Economy and the Peel region. **The domestic proportion of the capital (i.e. aforementioned $118M) and operating investment from the renewable hydrogen hub would generate economic output of $440M to WA**, comprising $265M and $178M during the construction and 20 year operational life, respectively. These modelled contributions would increase WA Gross State Product by 0.16%.

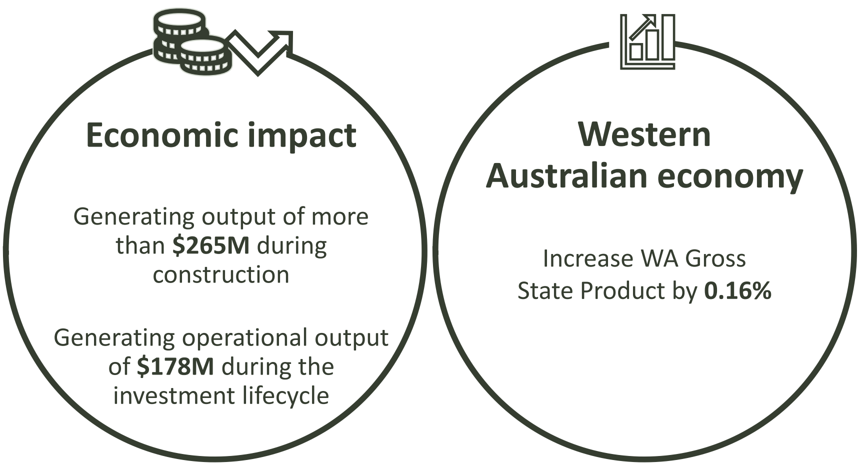


Figure 4-2 Estimated economic benefit

4.2.9 Vehicle refuelling

The demand from the cornerstone customer vehicle fleets was the key driver for the sizing of the production facility. As a result, the annual vehicle refuelling matches hydrogen production and consumption for the case study. The demand was estimated by determining the average duty cycle and characteristics of the respective vehicle types of each fleet from stakeholder provided data and desktop research.

Factors influencing the estimated hydrogen demand and refuelling logistics for vehicle fleets in the case study were:

- Distances travelled / engine hours
- Average diesel consumption
- Equivalent hydrogen demand
- Vehicle refuelling schedules

At later stages of development, the vehicle refuelling infrastructure would need to be optimised to meet peak refuelling times (i.e. highest number of back-to-back filling events) at each respective station.

4.2.10 Regulations and approvals

The case study would be required to meet legal and statutory requirements to obtain necessary approvals and permits from determining bodies. Considerations for further development of the case study and future site selection include:

- **Approvals:** The case study is likely to be subject to several planning gateways, with assessment expected to be by the independent decision making body, the Metro Outer Joint Development Assessment Panel (JDAP). The JDAP is comprised of technical experts and elected government members who determine the acceptability of proposals made under the Western Australia (WA) local and regional planning schemes, in the place of The City. The JDAP's main objective is to provide transparency, consistency and reliability in decision making on complex Development Approvals.
- **Land use classifications:** At the local level, careful interpretation of land use classifications under the Local Planning Scheme is required to determine the permissibility of potential sites for the production and refuelling locations. Early engagement is recommended with the determining body during site selection to provide clarity on the land use application definition.
- **Environmental approvals:** The principal piece of legislation governing environmental protection in WA is the Environmental Protection Act. A desktop review of the industrial area northeast of Mandurah (see Figure 4-1) presented specific locations with minimal ecological value. Risks to development, environmental and heritage approvals should be appropriately mitigated through careful site selection and case by case assessment.
- **Regulation and legislation:** Australia's hydrogen industry is rapidly developing in tandem with the legislative framework for governing the industry. In 2019, the COAG Energy Council commissioned Clayton Utz to review legislation, regulations and standards that could be relevant to hydrogen projects and the industry. Under WA legislation, hydrogen has specific requirements for handling, transport and storage.[10] These and other legislative requirements will need to be met by the case study.

[10] McDonald, 2019. *Renewable Hydrogen Vehicle Refuelling Stations: An overview of the regulatory landscape*.

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