Government of Western Australia
Department of Mines, Industry Regulation and Safety
Energy Policy WA

Renewable Hydrogen Target for electricity generation in the South West Interconnected System

Consultation Paper
October 2022

Working together for a brighter energy future.

Foreword

Western Australia is committed to achieve net zero emissions by 2050 and to working with all sectors of the Western Australian economy to achieve this goal. Renewable hydrogen offers an incredible opportunity to reduce emissions while supporting local jobs and delivering on long term wealth for Western Australians. The WA Government is implementing the Renewable Hydrogen Strategy to support the growth of the renewable hydrogen industry in Western Australia. A key component of implementing the Strategy is to stimulate local demand for hydrogen to develop our domestic hydrogen industry, including the incentives across the energy industry and transport sectors and supporting policy such as renewable hydrogen certification. As a part of this work, the McGowan Government is currently investigating a Renewable Hydrogen Target for electricity generation in the South West Interconnected System (SWIS). Through this consultation paper, we are encouraging stakeholders to provide comment on the potential design of this Scheme. Stakeholder input will be crucial to maximising the benefits to WA and support the long-term growth of a local renewable hydrogen industry.	Hon. Bill Johnston MLA Minister for Energy Hon. Alannah MacTiernan MLC Minister for Hydrogen Industry

Contents

Energy Policy WA

Level 1, 66 St Georges Terrace
Perth WA 6000

Locked Bag 100, East Perth WA 6892

Telephone: 08 6551 4600

www.energy.wa.gov.au

Glossary and Abbreviations

Glossary

Term	Definition
Levelised Cost of Hydrogen	Levelised Cost of Hydrogen (LCOH) is a conceptual approach to estimating the cost of hydrogen production in a way which makes it comparable between hydrogen technology stacks, and across other forms of energy (such as natural gas). The approach considers capital and operating costs of the selected technology stack, and converts these into a unit cost which would be required to ensure all costs are recovered. This includes the cost of capital.
Renewable Hydrogen Electricity Generation Certificate	For the purpose of this Consultation Paper, an instrument which represents one unit of a permitted creation electricity through the use of renewable hydrogen. Renewable hydrogen will also need to be certified as such under a separate guarantee of origin certificate scheme.
Renewable hydrogen or green hydrogen	Molecular hydrogen (H_2) produced via electrolysis of water, utilising renewable electricity generation for all energy input requirements.
Sectoral Emissions Reductions Strategies ('SERS')	A Western Australian Government initiative designed to provide robust and credible emissions reduction pathways for Western Australia with tangible actions for reducing emissions consistent with the government's target of net zero emissions by 2050.
South West Interconnected System Demand Assessment ('SWISDA')	A Western Australian Government initiative designed to identify the size, location and timeframe of anticipated electricity demand on the South West Interconnected System to 2030 and beyond. The process has a focus on identification of renewable electricity demand and supply, to enable the State Government to form a consolidated view of the future network.
The Strategy	The Western Australian Renewable Hydrogen Strategy.
The Scheme	Refers to the overall Renewable Hydrogen Target for electricity generation in the SWIS policy and regulatory design which is the subject of this Consultation Paper.

Abbreviations

Abbreviation	Definition
AEMO	Australian Energy Market Operator
CH4	Methane
CO2-e	Carbon dioxide equivalent
EITE	Emissions intensive, trade exposed
GEC	Queensland Gas Electricity Certificate Scheme
GGAS	New South Wales Greenhouse Gas Abatement Scheme
GJ	Gigajoule

Abbreviation	Definition
GW	Gigawatts (1,000 MW)
GWh	Gigawatt hours
H_2	Molecular hydrogen
kW	Kilowatts (1,000 watts of electricity)
kWh	Kilowatt hours
MW	Megawatts (1,000 kW)
MWh	Megawatt hours
NGAC	NSW Greenhouse Abatement Certificates
NGER	National Greenhouse and Energy Reporting
PJ	Petajoule (1,000,000 gigajoules)
RCM	Reserve Capacity Market
RET	Commonwealth Renewable Energy Target
SERS	Sectoral Emissions Reduction Strategies
SWIS	South West Interconnected System
SWISDA	South West Interconnected System Demand Assessment
TW	Terawatts (1,000 GW)
TWh	Terawatt hours
VRE	Variable Renewable Energy
WEM	Wholesale Electricity Market

1. Western Australia's Renewable Hydrogen Ambition

1.1 Renewable Hydrogen Strategy

As the world moves towards decarbonisation, renewable hydrogen is increasingly being looked to as a clean fuel source. Large economies such as Japan, South Korea, the United Kingdom and the European Union have published strategies signalling their intent to use renewable hydrogen for a broad range of activities such as power generation, transportation, and industrial processes. To achieve the scale required for success, these countries are expected to import renewable hydrogen.

Western Australia has a number of competitive advantages that will enable it to compete in the renewable hydrogen production market, including world-class renewable energy resources in the form of abundant wind and sun, vast land mass for the building of renewable energy, and a history of exporting energy reliably and cheaply to international markets.

In July 2019, the *Western Australian Renewable Hydrogen Strategy* (the Strategy) was launched. The Strategy outlines the Government's vision for the State to be a significant producer, exporter and user of renewable hydrogen through developing capability in four strategic focus areas: export, remote applications, hydrogen blending in natural gas networks, and transport.

Since the launch of the Strategy in 2019, there have been a number of zero emission renewable hydrogen production projects announced in Western Australia focused on the identified strategic focus areas, with more in development to assist the State in achieving its goals.

The Strategy established a vision and mission, as defined below.

Western Australian Renewable Hydrogen Strategy (2021 update)

Vision

Western Australia will be a significant producer, exporter and user of renewable hydrogen

Mission

Western Australia will develop industry and markets to be a major exporter of renewable hydrogen. To facilitate the export of renewable hydrogen, Western Australia will develop domestic production capabilities and applications of renewable hydrogen, improving the State's hydrogen industry expertise, contributing to global decarbonisation and decarbonising the State's economy. It will also contribute to improving air quality across the State.

1.2 Scope of consultation paper

The scope of this consultation paper is to investigate a Renewable Hydrogen Target for electricity generation in the SWIS, which would introduce an obligation on electricity retailers and potentially large users to purchase a portion of their electricity from hydrogen-fuelled generation. This would be achieved through a Renewable Hydrogen Electricity Generation Certificate.

A Renewable Hydrogen Target for electricity generation could play a role in demand stimulation by creating a domestic renewable hydrogen market. In this way, it may contribute to meeting the objectives of the Strategy and broader industry growth and development objectives held by the public and private sector in Western Australia.

Energy Policy WA has engaged ACIL Allen to assist in the development of the Scheme, and to assess the potential benefits and costs in a Western Australian context.

This work is being undertaken in the context of a number of other Government initiatives and investigations, including:

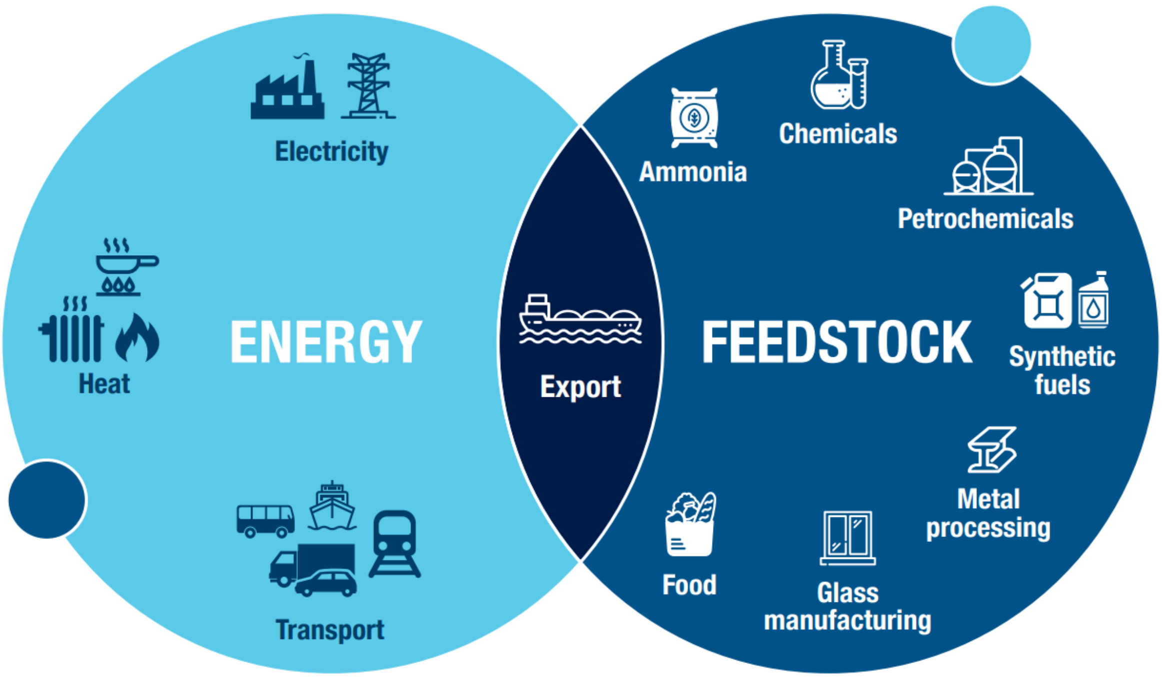
- program of works under the Strategy undertaken by the Department of Jobs, Tourism, Science and Innovation, including demand stimulation initiatives, a legal frameworks review and hydrogen value chain modelling;
- a technical and commercial study to assess the feasibility and costs of utilising a hydrogen and natural gas blend in existing gas turbines;
- the South West Interconnected System Demand Assessment (SWISDA) to ascertain renewable energy demand and enable Government to form a consolidated view of the future network; and
- the Sectoral Emissions Reductions Strategies (SERS) to provide credible emissions reductions pathways for Western Australia.

Stakeholders should not view the possible implementation of a Renewable Hydrogen Target for electricity generation in the SWIS as being the sole measure that Government is pursing to support and stimulate the development of a vibrant hydrogen industry in Western Australia, but rather one element that could be introduced relatively quickly and be built upon where appropriate.

The Government recognises there may be other opportunities to stimulate demand for hydrogen.

Another option being considered is a use-agnostic renewable hydrogen certificate scheme which could be available to multiple sectors. This would be similar to the Renewable Hydrogen Target for electricity generation, in that it would place an obligation on liable entities (such as electricity and gas retailers) to purchase certificates, but the hydrogen produced could be used for any purpose, such as to displace diesel, natural gas and grey hydrogen used as a feedstock for chemical processing. These opportunities for renewable hydrogen use have been identified under the Strategy (refer Figure 1.1), and may provide a greater degree of demand stimulation than hydrogen's use in electricity generation.

Figure 1.1: Uses of hydrogen



Source: Western Australian Renewable Hydrogen Strategy

1.3 Making a submission

This paper has been developed to seek views from stakeholders on the broader objectives of the Renewable Hydrogen Target, the key design considerations, and the benefits, costs and risks associated with its introduction.

Stakeholder input on the policy and design considerations for the Renewable Hydrogen Target for electricity generation will provide critical input into Government's decision as to whether to pursue the introduction of a Renewable Hydrogen Target for electricity generation and subsequent critical design elements should it proceed.

Energy Policy WA and the Department of Jobs, Tourism, Science and Innovation are seeking written submissions of the specific questions raised in this paper, as well as other matters that respondents believe should be considered in the context of the proposed reform. **The deadline for submissions is 5pm (WST) on 10 November 2022.**

Written submissions should be emailed to: **EPWA-info@dmirs.wa.gov.au.**

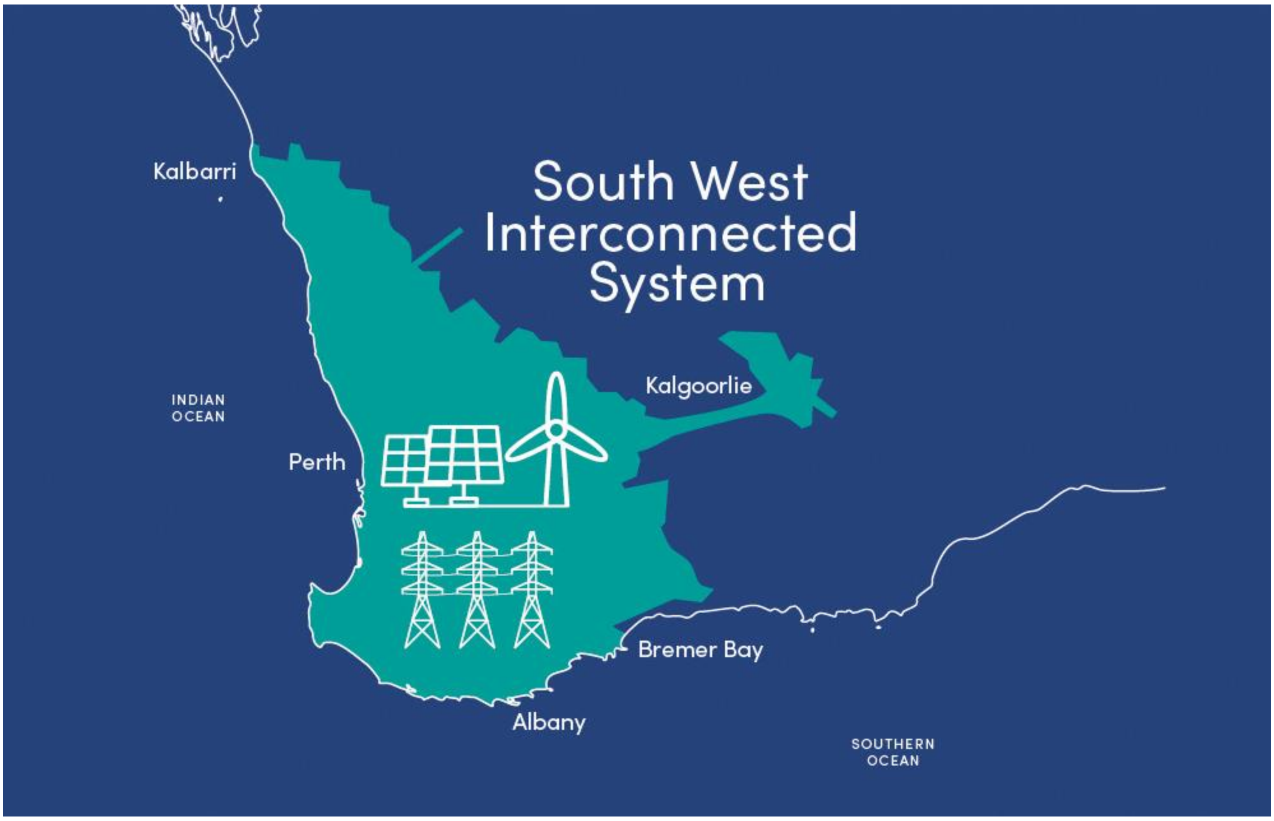
2. Renewable Hydrogen for electricity generation in the SWIS

2.1 The South West Interconnected System

Western Australia's main electricity network is the SWIS, which covers Western Australia's south western corner, extending to Kalbarri to the north, Albany to the south and Kalgoorlie to the east. It is an integrated network which facilitates the operation of an energy market (the Wholesale Electricity Market) and a capacity market (via the Reserve Capacity Mechanism).

The grid serves the vast majority of Western Australian households, and a significant share of industry, through a combination of coal, natural gas, wind, solar and other fuels, and has developed progressively over time. A map of the SWIS is provided below.

Figure 2.1: South West Interconnected System

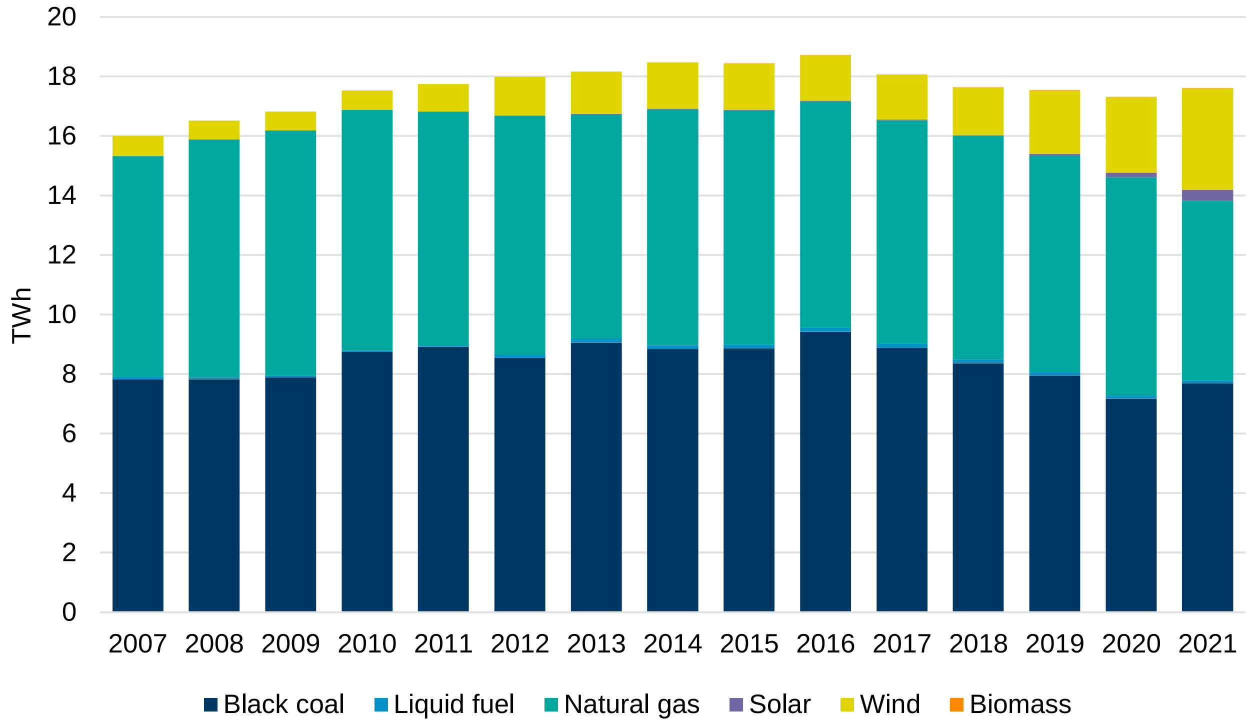


Electricity demand in the SWIS can be characterised a "peaky" system with a load factor (average demand as a ratio of peak demand) of around 50% to 55%. Peak demand is around 4,000 MW, while average demand is around 2,000 MW. Overall this results in just under 18TWh of electricity demand across the SWIS grid on an annual basis.

According to the Australian Energy Market Operator (AEMO), natural gas has accounted for around 40% of electricity generation on the grid over the past 20 years (Figure 2.2). Natural gas plays an important role in electricity generation in the SWIS in part due to the existence of globally significant petroleum projects in Western Australia's north, and a domestic gas reservation policy which provides a framework for local demand to be served through an allocation of the reserves associated with LNG production.

The capacity of gas-fired generators is currently around 2,900 MW, with gas typically being the technology of choice for intermediate, peaking and backup roles. This is due to the continued presence of coal-fired power generation in the SWIS, which provides the vast majority of baseload electricity generation. A table of the current natural gas electricity generation infrastructure installed in the SWIS is provided in Appendix A (Table 4).

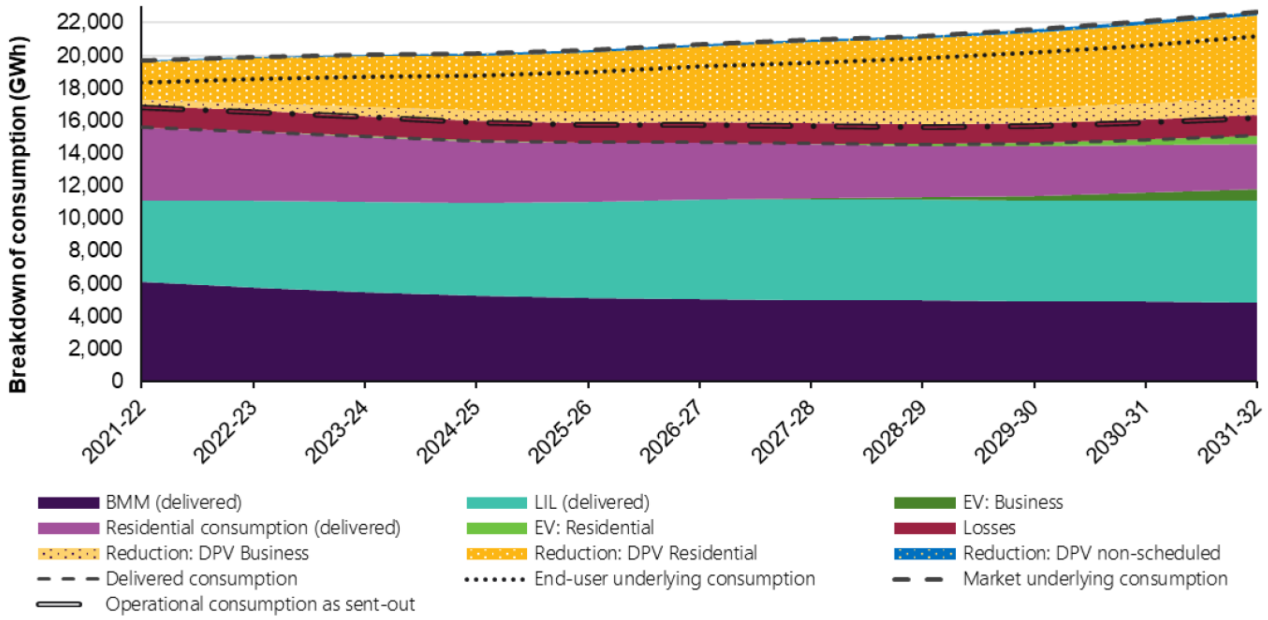
Figure 2.2: Historic electricity dispatch in the South West Interconnected System, by fuel type, TWh sent out



Source: ACIL Allen, from AEMO

AEMO forecasts operational consumption (total electricity demand less that supplied by distributed solar PV) for the SWIS to remain relatively flat as shown in Figure 2.3. With the addition of increasing quantities of intermittent renewable generation capacity, flexible technologies such as energy storage and gas-fired generation are required to balance supply with demand. Unlike the area covered by the National Electricity Market, the geographical make-up of the SWIS region cannot accommodate large quantities of pumped hydro energy storage. Without this longer-duration storage, the SWIS may continue to rely on natural gas to meet demand, which will make it difficult to fully decarbonise the electricity sector – and therefore other sectors of the economy that may rely on process electrification to reduce emissions.

Figure 2.3: Projected annual consumption forecasts under expected demand growth scenario



Source: AEMO 2022 WA ESOO

The Western Australian Government recently announced the South West Interconnected System Demand Assessment (SWISDA), a process designed to identify the size, location and timeframe of anticipated electricity demand on the SWIS to 2030 and beyond. The process has a focus on identification of renewable electricity demand and supply, to enable the State Government to form a consolidated view of future network requirements.

2.2 Objectives of the Renewable Hydrogen Target for electricity generation

When considering a Renewable Hydrogen Target for electricity generation in the SWIS, there is a need to determine one or more overarching objectives the Scheme would seek to achieve. This sets the basis for how the Target could be assessed, set, managed and evaluated in the future.

In early work on the Renewable Hydrogen Target, Energy Policy WA worked with ACIL Allen to consider and define a series of objectives and options parameters to inform the initial analysis of the Target and the development of this paper. The objectives for the Renewable Hydrogen Target for electricity generation have been defined as (in order of importance to the Scheme).

Table 1: Renewable Hydrogen Target for electricity generation in the SWIS policy design objectives (ranked by importance in Scheme design)

Objective / outcome	Description
Industry development	A Renewable Hydrogen Target for electricity generation could create a source of demand for renewable hydrogen produced in Western Australia, acting as a catalyst for broader industry development. A Renewable Hydrogen Target for electricity generation is also likely to have strong signalling benefits to both investors and other stakeholders regarding delivery of a renewable hydrogen industry.
Decarbonisation of the electricity grid	A Renewable Hydrogen Target for electricity generation could play a role in decarbonising the target electricity grid by displacing carbon-intensive electricity generation, to the extent renewable hydrogen displaces this form of generation.

Objective / outcome	Description
Electricity grid reliability and stability	A Renewable Hydrogen Target for electricity generation could contribute to electricity grid stability and reliability, particularly in the long run as technologies advance and hydrogen can play a firming role in a fully decarbonised / no carbon-based generation electricity grid. Hydrogen's role in support of Essential System Services is also important in this context.
Reducing the risk of fuel cost escalation in a carbon constrained world	A Renewable Hydrogen Target for electricity generation could reduce the cost of electricity generation in the long run to the extent the feedstock can be produced at a lower cost than the next best alternative fuel / technology. A Target could assist in earlier penetration of hydrogen as a fuel source for electricity generation, with associated impact on the slope of the technology cost reduction curve.
Decarbonisation of the Western Australian economy	A Renewable Hydrogen Target for electricity generation could contribute to decarbonisation beyond the target electricity grid as a secondary benefit to industry demand stimulation and the associated impact on hydrogen economics.

The project team is seeking higher level stakeholder views regarding the objectives for the Renewable Hydrogen Target for electricity generation.

Consultation Questions: Renewable Hydrogen Target for electricity generation

Question 1

What are some examples of an objective or objectives that could be used to assess the benefits, costs and impacts of a Renewable Hydrogen Target for electricity generation?

Question 2

How might other uses of renewable hydrogen be accommodated under a Renewable Hydrogen Target certificate scheme? How might Government otherwise support and/or encourage other use cases for hydrogen?

The options developed for the Renewable Hydrogen Target for electricity generation will be quantified and analysed in a cost benefit analysis with the results to inform advice to the State Government on the path forward. The cost benefit analysis will also include consideration of administration and compliance costs to government and industry.

Some initial analysis of the hydrogen required to meet various targets, and the associated investment and cost implications, are discussed in Section 4.2.

2.3 Renewable hydrogen in the electricity sector

Defining hydrogen

Hydrogen is the most abundant chemical element. While abundant, it exists very rarely as a gas and needs to be produced from more complex elements.

Renewable hydrogen is taken to mean molecular hydrogen (H_2) (hereafter referred to as hydrogen) produced via electrolysis, utilising renewable electricity generation for all energy input requirements. As renewable hydrogen demand stimulation is a key goal of the Renewable Hydrogen Target for electricity generation, hydrogen produced via other methods is not considered for inclusion in this Scheme.

Renewable hydrogen is produced through electrolysis, which involves the use of an electrical current to split water into hydrogen and oxygen. Mature technologies include Polymer Electrolyte Membrane (PEM) and Alkaline Electrolysis (AE) and when the electricity input is sourced from renewable generation, the resulting hydrogen produced is essentially zero emission and termed renewable or green hydrogen.

An accreditation mechanism must be in place to verify that electricity inputs are from renewable sources such as wind and solar PV. The establishment of a hydrogen Guarantee of Origin certification scheme is a priority under Australia's National Hydrogen Strategy. This work is being led by the Department of Climate Change, Energy, the Environment and Water in consultation with the Clean Energy Regulator.

Renewable hydrogen in the electricity system

When it comes to electricity generation, hydrogen can be used in three specific contexts, being:

- blending with natural gas fuel sources used to supply existing or new gas turbines;
- generation in gas turbines as the sole fuel source; and/or
- direct generation of electricity when used in fuel cells.

The ramping up and down of grid connected electrolysers to help manage grid stability is not a form of electricity generation and as such is not considered for inclusion under this scheme.

Blending renewable hydrogen with natural gas presents a potential opportunity to reduce the environmental impact of natural gas over time, as well as extend the life of existing gas infrastructure.

Commercial gas turbines have been capable of operating using fuel mixes that contain 5% to 95% hydrogen (by volume) for decades. This has been mainly driven by situations where waste gas from primary generation or production that contains hydrogen can be reused to generate electricity.[1]

While a 100% hydrogen fuel would reduce CO_2 emissions by approximately 99.9% compared to methane (the largest component of natural gas), the relationship is non-linear due to the lower energy density of hydrogen against natural gas. For instance, a 10% hydrogen blend (by volume) will reduce emissions by approximately 2-3%, while a 50% blend (by volume) would reduce emissions by just over 20%.

A potential offsetting factor is the emission of Nitrogen Oxides, or NOx (produced in small quantities by gas turbines today) increase significantly as the percentage of hydrogen in the fuel mix increases (in some cases doubling at 100% hydrogen relative to operating on natural gas).[2] Filters and catalysts are currently used to control NOx emissions.

Generators using hydrogen as a fuel source can take on a range of roles within the system including:

- intermediate/peaking generation roles;
- provision of Essential System Services (ESS) and other ancillary services;
- as a form of energy storage on the system; and
- in a reserve capacity role.

Hydrogen systems can provide both electricity grid stability (i.e. seconds to hourly storage) and grid reliability (seasonal storage) services. There is likely to be an increasing demand for these

1 See GE, *Power to Gas: Hydrogen for Power Generation*. Accessed online at http://www.ge.com/gas-power/future-of-energy/hydrogen-fueled-gas-turbines

2 NOx is generated when air is heated to high temperatures and the N_2 and O_2 in air start to react with each other. While NOx is less prevalent than CO_2, it is far more potent by volume in its effects on atmospheric warming with a Global Warming Potential of 265 times CO_2.

services as the proportion of variable renewable electricity (VRE) in the network increases over time.

However, for grid reliability, hydrogen systems, including fuel cells, along with gas turbines present one of a short list of technological solutions to overcoming challenges with seasonal intermittency, alongside large scale storage hydro and pumped hydro. While gas turbines are likely to be cheaper, the price differential could be reduced when considering carbon and natural gas supply risks associated with building new natural gas assets.

Renewable hydrogen's role as a source of baseload generation is less clear in the short term, on account of the round trip inefficiencies associated with using VRE to produce hydrogen to then combust to create electricity – with energy losses in each step. However, in the long run, as the dynamics of the energy system change this may no longer be the case.

Consultation Questions: Considering hydrogen

Question 3

What role do you believe renewable hydrogen can play in the decarbonisation of electricity generation? To what extent will a Renewable Hydrogen Target for electricity generation in the SWIS assist in achieving the decarbonisation objectives of the State Government?

Question 4

What role can the infrastructure associated with the production of renewable hydrogen (i.e. renewable electricity generation facilities, electrolysers, transport and storage infrastructure) play in the broader SWIS?

Technical considerations for hydrogen use in gas turbines

Theoretically, most existing gas turbines can be converted to operate on a fuel mix of natural gas and hydrogen, although the class of turbine (for example aeroderivative or heavy frame) will determine the upper limit of hydrogen able to be utilised. Key considerations include flame speeds, gas volume flow (with three times more volume flow of hydrogen required to provide the same heating input as methane), safety issues and unique characteristics of each generator. Alterations are typically required in the fuel handling systems, valves and piping, and combustor hardware. The costs of these alterations would likely vary significantly across different generators.

However, gas turbine manufacturers are increasingly recognising the potential future need for dual fueling/blending with hydrogen in new turbine models.[3] The recent development of Tallawarra B in NSW is one such example.

[3] GE has set an ambition to achieve 100% hydrogen capability in all turbine classes given the increasing interest in hydrogen globally.

Tallawarra B Case Study

EnergyAustralia has commenced construction of the Tallawarra B power station alongside its existing Tallawarra A natural gas power station near Wollongong, NSW.

Tallawarra B is intended to provide more than 316 MW of peaking power utilising GE's 9F.05 gas turbine fueled by a blend of renewable hydrogen and natural gas. The plant is due to be operational by 2023-24 and forecast to start utilising a 5% hydrogen blend by 2025.

The NSW State Government is providing funding of $78 million, with the Federal Government contributing $5 million to the project to cover the costs of making it hydrogen ready.

Renewable green hydrogen will not be produced on-site but EnergyAustralia will offer to buy 200 tonnes of renewable-based hydrogen per year from 2025. EnergyAustralia is looking for a third-party supplier to process and deliver the fuel.

Tallawarra B is planned to be operational in the Australian summer of 2023-24, ahead of the scheduled retirement of the 1,680 MW Liddell power station in the Hunter Valley.

The Western Australian Government is undertaking a technical and commercial study centred on understanding the impact of making use of a hydrogen / natural gas blend in gas turbines in a local context.

Consultation Questions: Technical feasibility

Question 5

To the extent you are able please reflect on some of the technical issues, challenges and considerations in the utilisation of hydrogen in the generation of electricity. To what extent can these technical issues and challenges be overcome? How should this impact on the consideration of a Renewable Hydrogen Target for electricity generation in Western Australia?

3. Considering a Renewable Hydrogen Target for electricity generation in the SWIS

3.1 Review of previous Energy System Objective schemes

Over the past 20 years there have been three significant and high profile Energy System Objective schemes, where governments have sought to deliver public policy outcomes through the development of **certificate-based schemes**.

In general, certificate schemes in the energy sector are designed to create a market for a service delivered in the electricity system, by imposing conditions and constraints on certain market participants, and granting rights to meet the conditions and constraints to other participants (including those who are impacted by the conditions and constraints). Entities which have conditions and constraints imposed must take action to address the conditions and constraints, or face penalties for non-compliance.

A certificate scheme relies upon the ability for an independent oversighting body to certify that a transaction has taken place which meets a series of rules and regulations set by government.

In the development of this Consultation Paper, three Energy System Objective schemes which have operated in Australia over the past 20 years were reviewed. These are:

- the Commonwealth Government's **Renewable Energy Target** (RET);
- the New South Wales Government's **Greenhouse Gas Abatement Scheme** (GGAS); and
- the Queensland Government's **Gas Electricity Certificate Scheme** (GEC scheme).

The recently-announced **New South Wales Renewable Fuel Scheme** is also expected to operate as a certificate scheme. A review of the three Energy System Objective schemes which are operating or were in operation in Western Australia is provided in Appendix B. Relevant details of this review are provided below (Table 2).

Table 2: Review of Energy System Objective schemes in Australia (2001-present)

Scheme	Objective/s	Mechanism	Market size and other details
Commonwealth Government Renewable Energy Target 2001-present	Increase the use of renewable energy generation technology above existing generation	Certificate scheme. Initially singular certificates, broken into two in 2011 (LRET, SRES). Certificates are created, issued and traded through a central platform	Initial target (2001) was set at 2% of electricity generation by 2010. This was expanded to 20% by 2020 in 2009. The scheme was amended, and target reduced, in 2014.
New South Wales Government Greenhouse Gas Abatement Scheme 2003-2012	Reduce greenhouse gas emissions at a State-wide electricity sector level, through electricity retailers and large electricity users.	Cap and trade scheme, with certificates. Certificates created when an eligible entity undertook a certified activity.	Designed to impose an emissions constraint on electricity generation, to reach 7.27t CO2-e per person per annum. Individual targets were imposed on retailers. The scheme was ended due to the impact of the RET on the price of GGAS certificates.
Queensland Government Gas Electricity Certificate Scheme 2005-2012	Increase the use of gas fired power generation in Queensland (substituting coal fired power).	Certificate scheme. Retailers were required to procure a given level of gas-based electricity in a given year, with certificates issued to generators.	Initial target (2005) was for 13% of electricity generation fuelled by gas by 2012. This was scaled up to 15% in 2010. Scheme ended due to market forces driving gas use.

Source: ACIL Allen, from various sources

It is the project team's view that the current market dynamics and intent of the Renewable Hydrogen Target for electricity generation in the SWIS most closely resembles the pre-conditions which existed prior to the introduction of the Queensland GEC scheme.

3.2 Renewable Hydrogen Electricity Generation Certificate

The initial investigation into a Renewable Hydrogen Target for electricity generation in the SWIS assumes the development and operation of a certificate scheme. The certificate scheme would be based on the consumption of electricity generated utilising renewable hydrogen.

A Renewable Hydrogen Electricity Generation Certificate for the SWIS would be generated for every MWh of electricity generated via the combustion of renewable hydrogen (i.e. 1 credit = 1MWh of renewable hydrogen-based electricity).

It is expected a certificate scheme of this kind would facilitate the creation of a market for renewable hydrogen-based electricity generation in a transparent and accountable manner through a centralised authority. In turn, this would be expected to create a market (and revenue pathway) for renewable hydrogen production through the transacting of renewable hydrogen electricity generation certificates.

A Renewable Hydrogen Electricity Generation certificate scheme for the SWIS also provides flexibility to adjust the level of the Target higher or lower over time as the economics of renewable hydrogen production change.

It should be noted that this consultation paper as stated in Section 1.2, Scope of consultation paper, only covers a Renewable Hydrogen Target for electricity generation in the SWIS.

Consultation Questions: Certificate schemes for Renewable Hydrogen Target for electricity generation in the SWIS

Question 6

Do you believe a renewable hydrogen electricity generation certificate-based scheme represents an efficient and effective means to deliver a Renewable Hydrogen Target for electricity generation in the SWIS? Please explain your answer.

Question 7

What are some other approaches which could be considered alongside a renewable hydrogen electricity generation certificate scheme that would provide a framework to deliver on the objectives or outcomes sought?

3.3 Guarantee of Origin Scheme

Whilst not within scope of this consultation paper, an accreditation mechanism must be in place to verify the source of the hydrogen production, which will be a Guarantee of Origin (GO) certification scheme. The GO certification scheme will work in conjunction with the proposed Renewable Hydrogen Electricity Generation Certificate.

The establishment of a hydrogen GO certification scheme will measure and track the carbon emissions from hydrogen production, enabling customers who buy hydrogen in the future to choose the product best suited to their needs.

Australia is playing a leading role internationally, represented by the Department of Climate Change, Energy, the Environment and Water, in developing methods with our trading partners to determine emissions associated with hydrogen production. This will ensure Australia's hydrogen Guarantee of Origin framework will be robust, globally recognised and supported by our markets.

4. Scheme design considerations

The process of designing the Renewable Hydrogen Target for electricity generation in the SWIS assumes the policy will be delivered via certificate scheme. There are other critical elements of the policy which are under consideration and where the project team is seeking the views of potential market participants. This section provides an overview of these design considerations, and requests feedback on the merits, costs, benefits, impacts and implications of a suite of options.

4.1 Design considerations

4.1.1 Liable entities

At this time it is expected the Renewable Hydrogen Target for electricity generation would apply to electricity retailers and large electricity consumers in the SWIS. That is, all electricity retailers and large electricity consumers connected to the SWIS would be required to purchase certificates equal to a targeted percentage of their annual electricity sales or consumption.

Electricity generators will apply to become certified producers of renewable hydrogen-based electricity, and will be able to create certificates equal to the amount of renewable hydrogen-based electricity generated.

Retailers and large electricity consumers will then be required to purchase certificates from generators to meet their obligations, and surrender these certificates at a designated date. It is envisaged that a retailer or large electricity consumer which owns and/or operates eligible generation infrastructure would be able to both create and surrender certificates if this was deemed by the entity to be a more efficient means to meet its obligations.

A critical design feature of the system is the definition of what constitutes a large electricity consumer. Under the RET, a liable entity is considered to be any purchaser of electricity from an electricity grid or directly from the point of generation (except under certain circumstances). This definition brings in all wholesale electricity providers, plus large users who purchase electricity directly from generators. There is an exclusion for own-source generation where the electricity is consumed within one kilometre.

Consultation Questions: Liable entities

Question 8

Is the proposed approach of certification, deemed liability and certificate transfer an efficient and effective way to deliver on the intent of the Renewable Hydrogen Target for electricity generation? Are there alternative approaches which could better deliver on the objectives?

Export-oriented industries, and the impact of a certificate scheme on the cost of energy for business, are often considered alongside the definition of eligibility and liability under these kinds of schemes. The RET contains concessions for so-called Emissions Intensive-Trade Exposed (EITE) industries through a regulatory instrument which defines 54 industrial activities which are eligible for partial exemption from the scheme. The exemption is given effect through granting of exemption certificates, which can be surrendered to a liable entity and permit a reduction in that entity’s annual target.

Exemption could substantially reduce the base available for the Scheme. Similarly, renewable hydrogen has the potential to be a source of energy, heat or chemical feedstock for many of these industries in the future – noting the Scheme is currently targeting electricity generation.

Consultation Questions: Exemptions

Question 9

What are the benefits, costs and impacts of an exemptions regime for a Renewable Hydrogen Target for electricity generation?

4.1.2 Other renewable fuels

As discussed previously, while hydrogen itself can be harnessed as a source of energy for the generation of electricity, there are a number of other renewable gas products that can perform a similar role and that have zero carbon missions. All of these renewable gases could be blended with natural gas to reduce the carbon intensity of a generation fuel at the point of combustion.

One of the critical considerations of the scheme is the extent to which the use of other renewable fuels could or should be eligible.

Consultation Questions: Renewable fuels

Question 10

Should the Renewable Hydrogen Target for electricity generation consider alternative renewable fuels as eligible for the creation of Renewable Hydrogen Electricity Generation Certificate? Why or why not?

4.1.3 Target level and associated mechanisms

Setting a target

One of the central variables for the Scheme is the level of electricity consumption which should be used to set the target for entities. At this stage there is no firm view of what level of electricity consumption should be subject to the target, other than it is likely a target will be set at an individual entity level and based on a percentage of electricity consumption (likely on a one year annual lagged basis).

To a certain extent, the level of the target will be set in a way which maximises the benefits and minimises the costs of the scheme. This will be assessed through a cost benefit analysis which is expected to consider the following targets as a series of strawman options:

- 1% of electricity consumption in the SWIS;
- 5% of electricity consumption in the SWIS; and
- 10% of electricity consumption in the SWIS.

In a general sense, a 10% target would be expected to provide a substantially larger demand stimulation effect than the smaller targets, which would address the highest order objective of the Renewable Hydrogen Target for electricity generation in the SWIS (as defined in Table 1). This would be expected to increase the nominal gross cost of hydrogen produced, but may result in a reduction in the unit cost of hydrogen through economies of scale and other effects (such as reducing the cost of capital and accelerating industry learning curves). However, it is clear this would also represent the highest cost option. By contrast, a 1% target would be expected to deliver a Renewable Hydrogen Target for electricity generation in the SWIS at a lower cost to the State than the higher options but would also provide less substantial demand stimulation effects. These effects will be an important consideration in the cost benefit analysis.

A higher target is also likely to result in a longer ramp up period in recognition of the current status of the hydrogen industry in Western Australia (and globally). This is discussed in Section 4.1.4.

Consultation Questions: Setting a target

Question 11

Please consider the benefits, costs and implications of a 1%, 5% and 10% Renewable Hydrogen Target for electricity generation in the SWIS on your business or industry, and provide commentary on how you would expect to react from a commercial and investment perspective to each target level.

Question 12

At a whole-of-economy and / or sectoral level, what do you consider to be some of the benefits, costs and implications of a 1% target, a 5% target, and a 10% target?

Target-setting, and banking and borrowing certificates

It is envisaged the Renewable Hydrogen Target for electricity generation would operate over a medium term period of time (of at least 10 years), to allow for certainty of demand for Certificates and capacity for the upstream side of the market to respond. However, targets for individual entities would be set on an annual basis with associated penalties for non-compliance.

Individual entities would be required to surrender certificates to a regulator equivalent to at least a certain percentage of their annual target, with a penalty set at such a level to provide an appropriate incentive to fulfil an obligation through the purchase and surrender of certificates.

It is also envisaged liable entities will have the capacity to both bank (i.e. carryover) and borrow certificates on an annual basis. This approach provides flexibility for liable entities to balance a need to meet obligations over a multi-year period with various other commercial and economic drivers. However, the capacity to “borrow” certificates requires careful consideration so as to provide appropriate incentives to fulfil an obligation.

- **Banking:** In this instance, it is envisaged a liable entity would be permitted to purchase as many certificates as it deems feasible in a given year, and for those which are not required to be surrendered to meet an annual obligation allowed to carry over in perpetuity.
- **Borrowing:** In this instance, it is envisaged a liable entity would be permitted to borrow certificates it would be expected to surrender in a future year, up to a certain defined limit of its annual obligation. The share of borrowing permitted, and mechanism for enacting a borrowing framework, are to be determined. On the latter, it would be expected a liable entity would still face a penalty for failing to meet its annual obligations in a given year, but that this would be refundable in the event certificates over and above a future annual obligation (up to the number of borrowed certificates, at the capped level of borrowing) were surrendered.

Consultation Questions: Target terms

Question 13

Is the suggested approach of a medium term aggregate target, with annual entity targets, an efficient and effective means to achieve the objectives of the Renewable Hydrogen Target for electricity generation in the SWIS? Why or why not?

Question 14

To what extent should banking and borrowing of liabilities be permitted under the scheme? What are the benefits and costs of a borrowing mechanism as described in the paragraph above?

4.1.4 Scheme commencement and ramp up

A central objective of the Renewable Hydrogen Target for electricity generation is its capacity to provide demand stimulation for renewable hydrogen produced in Western Australia. Therefore, the sooner a scheme can be designed and a target defined, the sooner the associated markets can develop and the demand stimulation effects can begin.

However, as of today, there are no commercial-scale renewable hydrogen production projects operating in Western Australia. Therefore an important consideration for the design of the Renewable Hydrogen Target for electricity generation is the timing of when the target would commence, and the time period which would be made available for the target to ramp up to its ultimate level.

Signalling the introduction of a scheme of this nature can provide strong incentives and market signals to industry, which may assist in progressing renewable hydrogen production projects in the State. By way of example, the Commonwealth Government's original RET scheme was first announced in a statement to Parliament made by Prime Minister John Howard in November 1997,[4] with the scheme commencing in 2001.

The Renewable Hydrogen Target for electricity generation in the SWIS is expected to operate over at least 10 years, with intermittent reviews, to provide an appropriate timeframe for hydrogen producers to recover their capital and for the industry to develop alongside the Target. This approach aligns with other certificate schemes which have been used in Australia to drive public policy outcomes.

Consultation Questions: Scheme commencement and ramp up

Question 15

How soon do you believe a Renewable Hydrogen Target for electricity generation in the SWIS could be feasibly delivered from a technical perspective (i.e. if cost was not a consideration)? Please reflect on your own organisation and/or sector when providing your answer.

Question 16

Similar to the above, how soon do you believe a Renewable Hydrogen Target for electricity generation in the SWIS could be feasibly delivered from a commercial or economic perspective (i.e. if cost was a consideration)? Please reflect on your own organisation and/or sector when providing your answer.

Question 17

Over what period of time do you believe is an appropriate ramp up period for the Renewable Hydrogen Target for electricity generation in the SWIS? In providing your answer reflect on the actions your organisation and / or sector would need to take to participate in the scheme.

4.2 Assessing the impact of a Renewable Hydrogen Target for electricity generation

To provide further context regarding the proposed Renewable Hydrogen Target for electricity generation, analysis of the implications for volumes, electrolyser capacity, and the cost of supply are provided in this final section. The project team is seeking stakeholder perspectives on how various levels of hydrogen demand could be serviced, and how the cost of supply is expected to change over time.

4 Commonwealth of Australia Hansard. Ministerial Statements: Safeguarding the Future: Australia's Response to Climate Change. Thursday, 20 November 1997, Page: 10921.

4.2.1 Projecting the cost of renewable hydrogen production

The most critical input into the cost benefit analysis (alongside the estimated volume of hydrogen required to meet a target) is the cost of renewable hydrogen production, shipping and use in the creation of electricity.

There are a range of estimates of what a reasonable long term cost of production may look like, as well as so-called "stretch goals" intended to drive industry development and learning towards improvements in capital and operational efficiency.

The project team is keen to receive views from industry members regarding short (<5 years), medium (5-15 years) and long (15+ years) term hydrogen cost of production projections and a rationale for these. This will assist the project team to validate its own modelling, and to calibrate cost of production scenarios for use in the cost benefit analysis.

The Western Australian Government has commissioned the development of a Hydrogen Value Chain model which can be used to estimate the cost of hydrogen production in a variety of contexts around the State, however, this work is not yet available for use.

The project team has therefore developed a hydrogen cost of supply model, and expects to utilise this as the basis for the cost benefit analysis to be undertaken following feedback on the consultation paper.

The cost of supply model utilises AEMO's 2022 *Integrated System Plan* assumptions book which provides a range of technical assumptions regarding the capital cost, operating cost and roundtrip efficiency factors for PEM electrolyser-based renewable hydrogen production. This has been combined with internal estimates of the cost of grid-based electricity, and a Greenfield renewable electricity generation cost model, alongside capacity factor and electrolyser utilisation assumptions, to provide a perspective on how hydrogen production costs can be expected to change over time.

This model suggests, on current information, the Levelised Cost of Hydrogen[5] (LCOH) production sits anywhere from $6.87/kg to $9.36/kg at the plant-gate, prior to consideration of storage and shipping and assuming a relatively modest Weighted Average Cost of Capital.[6]

This converts to an effective electricity generation fuel cost of up to $78.02/GJ[7] on an energy equivalent basis with natural gas. The current spot price for natural gas in Western Australia is $5.60/GJ.[8] Initial modelling outputs which consider the implications of this differential, and the projected differential between the current modelled LCOH and projected natural gas price, is summarised below (Table 3:). While not detailed in the table below, initial modelling indicates that the cost of hydrogen at potential Scheme commencement in 2024 is projected to be a median of $6.60/kg or $50.72/GJ.

5 Levelised Cost of Hydrogen is a conceptual approach to estimating the cost of hydrogen production in a way which makes it comparable between hydrogen technology stacks, and across other forms of energy (such as natural gas). The approach considers capital and operating costs of the selected technology stack, and converts these into a unit cost which would be required to ensure all costs are recovered. This includes the cost of capital.

6 This estimate is an output of ACIL Allen's cost of supply model. A pre-tax WACC of 7% real (9.5% nominal) is used. The cost of capital for renewable hydrogen projects is likely to be higher in the short term but is modelled at 7% due to general convention.

7 Conversion made utilising Lower Heating Value of hydrogen in combustion (120MJ/kg), sourced from University of New South Wales.

8 GasTrading Australia. *Historic gas prices in Western Australia spot gas market, August 2022*. Accessed online at http://www.gastrading.com.au/

Table 3: Initial projected cost of fuel / net cost of fuel substitution in SWIS by target scenario and year

	2030			2040		
	H2 mass or energy required[1]	H2 median expected cost[2]	Projected net cost[3] ($m in year & % of grid[4])	H2 mass or energy required[1]	H2 median expected cost[2]	Projected net cost[3] ($m in year & % of grid[4])
1% target	5.97kt	$4.71/kg	$20.82m	7.35kt	$3.52/kg	$16.10m
	0.72 PJ	$36.23/GJ	1.8%	0.88 PJ	$27.05/GJ	1.1%
5% target	29.87kt	$4.71/kg	$104.09m	36.75kt	$3.52/kg	$80.52m
	3.58 PJ	$36.23/GJ	8.9%	4.41 PJ	$27.05/GJ	5.4%
10% target	47.79kt	$4.71/kg	$166.55m	73.51kt	$3.52/kg	$161.03m
	5.73 PJ	$36.23/GJ	14.2%	8.82 PJ	$27.05/GJ	10.7%

Source: ACIL Allen

Note 1: Calculations based on energy for energy swap utilising Lower Heating Value for hydrogen (~120MJ/kg) and assuming hydrogen fuel thermal efficiency = natural gas thermal efficiency at point of combustion (ie pure energy for energy comparison).

Note 2: "H2 median expected cost" is based on ACIL Allen's LCOH model, built utilising AEMO's 2022 Integrated System Plan Assumption Book (Step Change scenario) with respect to hydrogen electrolyser cost, technology learning rate and efficiency assumptions. H2 produced through standalone electricity generation infrastructure, 50/50 solar/wind generation mix with 43% capacity factor, which is applied to the electrolyser. Cost is "at the plant gate" and does not include transportation or storage costs.

Note 3: "Projected net cost" is based on ACIL Allen WEM Reference Case outlook & includes cost of generation sent out only (ie does not include network, wholesale or retail margin). Costs also exclude any additional capital expenditure required by generators to retrofit or invest in new generation infrastructure to support hydrogen fuel use. Cost is based on assumed displacement of natural gas only.

Note 4: "% of grid" is an estimate of the net cost of the scenario (being the net cost of substitution of natural gas for renewable hydrogen fuel) compared to the cost of generation sent out on the SWIS in ACIL Allen's WEM Reference Case. The percentage is intended to provide context only, as the Renewable Hydrogen Target has not yet been modelled within ACIL Allen's electricity market model and there may be additional changes to the future generation mix with a Renewable Hydrogen Target included in the scope of the modelling parameters.

Consultation Questions: Hydrogen cost outlook

Question 18

In the short (<5 years), medium (5-15 years) and long (15+ years) term, where do you expect the cost of production of renewable hydrogen to move from the estimated levels of today? What do you expect to be the drivers of this change?

4.2.2 Hydrogen volume and electrolyser requirements to meet targets

ACIL Allen has modelled the hydrogen requirements to service a Renewable Hydrogen Target for electricity generation for the SWIS over a medium term time horizon, under the target size options described in Section 4.1.3. These were 1%, 5% and 10%. The analysis is presented below.

Hydrogen demand in the SWIS

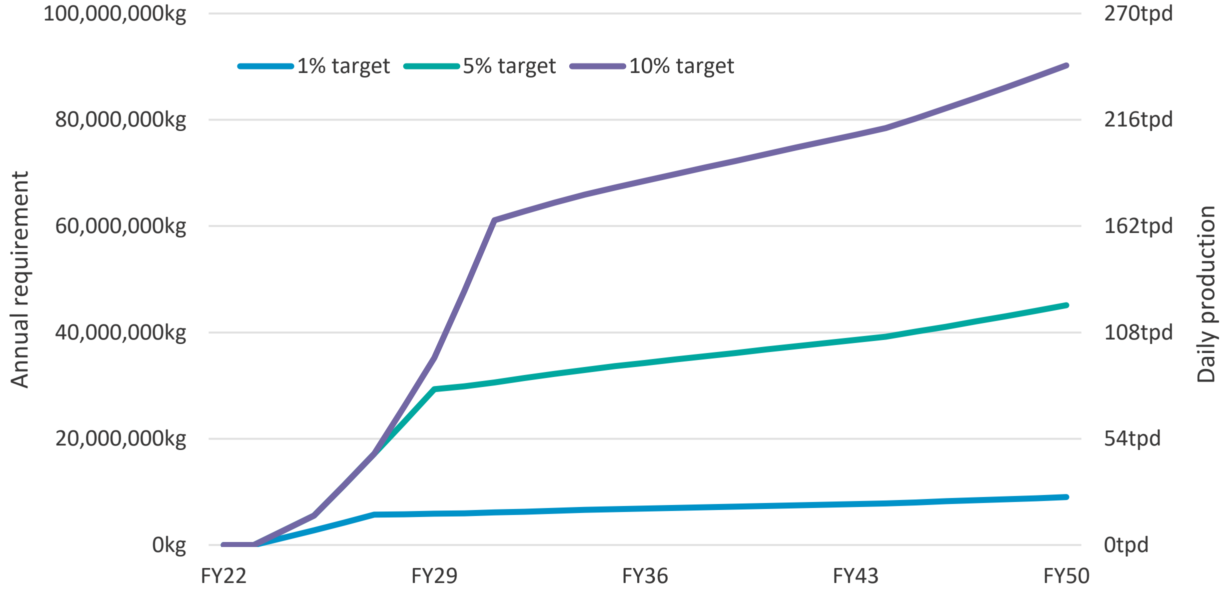
Analysis of the demand for hydrogen under the three target scenarios discussed is provided in this section. ACIL Allen's estimated hydrogen demand under the initial scenarios is visualised below (Figure 4.1).[9]

The projections suggest a 1% target would require the production of an initial ramp up to approximately 16 tonnes per day, with steady growth towards 25 tonnes per day by 2050. By contrast, the 5% target increases to over 80 tonnes per day from commencement to peak,

9 Other critical assumptions include the commencement of the target being FY24, and the ramp up to maximum target being 3, 5 and 7 years for the 1%, 5% and 10% targets respectively.

increasing further to 124 tonnes per day by 2050. Finally, a 10% target would see the demand for renewable hydrogen grow to 131 tonnes per day by the end of the decade, then nearly double again through to 2050.

Figure 4.1: Projected hydrogen required to service a Renewable Hydrogen Target for electricity generation in the SWIS, by target size, kg p.a. and tpd of H_2



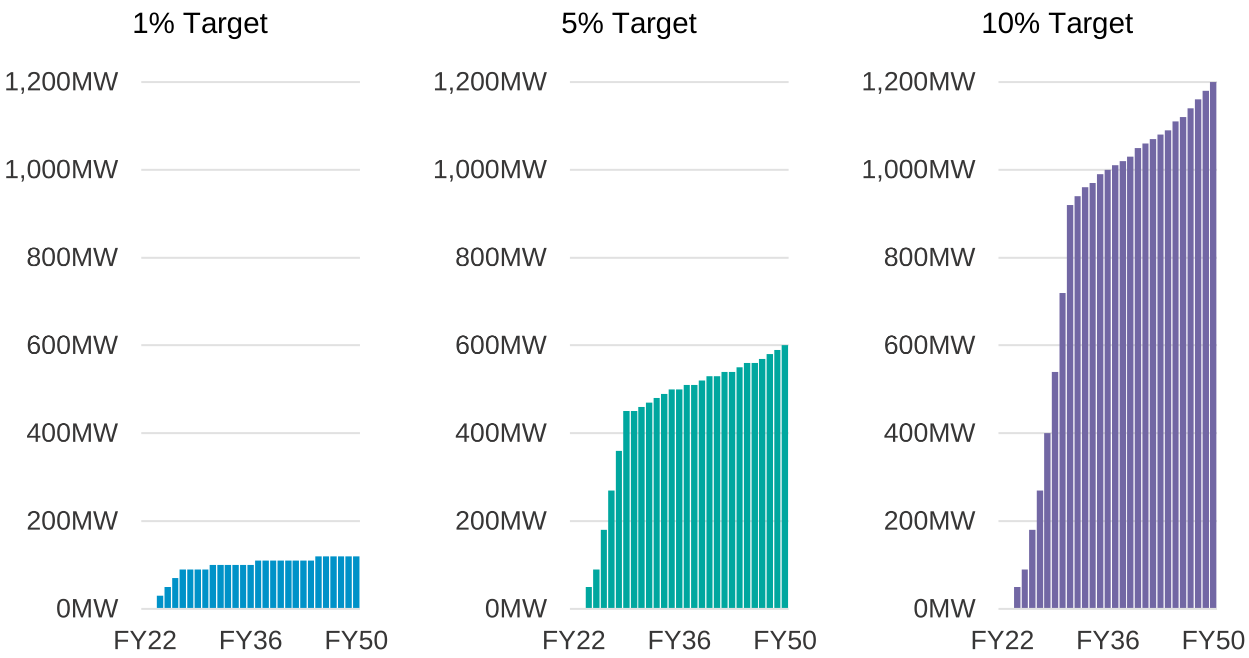
Source: ACIL Allen

Note 1: Modelling based on AEMO expected electricity demand growth scenario (Figure 2.3) and ACIL Allen modelling.

The demand for hydrogen in turn creates demand for electrolysers. ACIL Allen has modelled the requirement for investment in electrolyser capacity, based on an assumed 10MW production module, to provide context as to what the Renewable Hydrogen Target in electricity generation means relative to other renewable hydrogen projects which have been discussed for Western Australia. This analysis is presented in Figure 4.2.

This analysis suggests in the 1% scenario electrolyser capacity would build to an estimated 90MW by FY30, rising to 120MW by 2050. As presented in Figure 4.2, electrolyser requirement increases significantly in the 5% scenario, with 450MW of capacity required by FY30 and 600 by FY50. And as expected the scale increases again in the 10% scenario, with 720MW of capacity by FY30 and 1,200MW by 2050.

Figure 4.2: Projected hydrogen electrolyser capacity required to produce projected renewable hydrogen demand under a Renewable Hydrogen Target for electricity generation in the SWIS, MW of capacity by year



Source: ACIL Allen

Consultation Questions: Hydrogen demand and electrolyser capacity

Question 19

To what extent to you believe the above scenarios are reasonable and achievable? Please explain your answer with reference to your previous answers regarding the objectives of the scheme.

Question 20

How would you expect the levels of hydrogen demand for electricity generation in the SWIS to be met at various points in the supply chain? Would you expect a single generator would emerge and provide all certificates?

Question 21

Would you expect one very large renewable hydrogen producer, a number of very small renewable hydrogen producers, or some other combination, to emerge in the State as a result of the scheme? Alternatively, would a domestic-focused producer have sufficient scale to operate in a domestic market only?

Appendices

Appendix A. Gas-fired power generation infrastructure in Western Australia

The following table provides a summary of gas fired power generation infrastructure in Western Australia in the SWIS.

Table 4: Natural gas based power stations in the SWIS, 2022

Name	Owner	Type	Alternative fuel	Capacity (MW)
Wagerup Bauxite Mine and Alumina Refinery	Alcoa of Australia Ltd	Gas Turbine	Null	98
Kwinana (Alcoa Refinery)	Alcoa of Australia Ltd	Gas Turbine	Null	74.5
Wagerup	Alinta Energy	Gas Turbine	Distillate	380
Pinjarra Bauxite Mine and Alumina Refinery	Alinta Energy	Gas Turbine	Null	280
Solomon Iron Ore Mine	FMG	Gas Turbine	Null	125
Cawse Nickel Mine	FMG	Gas Turbine	Null	21
Kwinana Cogeneration	International Power Plc & Mitsui & Co Ltd & Transfield	Gas Turbine	Null	123
Merredin	Merredin Energy	Gas Turbine	Oil	82
Neerabup	NewGen Neerabup Partnership	Gas Turbine	Null	330
Kwinana NewGen	NewGen Power Kwinana Partnership	Gas Turbine	Null	320
Kalgoorlie (Parkeston)	Newmount Australia / TransAlta	Gas Turbine	Distillate	110
Kalgoorlie Nickel Smelter	Southern Cross Energy	Reciprocating Engine	Null	42
Kambalda	Southern Cross Energy	Combined Cycle	Null	42
Pinjar	Synergy	Gas Turbine	Distillate	576
Cockburn	Synergy	Combined Cycle	Null	240
Kwinana High Efficiency Gas Turbine Plant	Synergy	Gas Turbine	Distillate	200
Geraldton	Synergy	Gas Turbine	Null	21
West Kalgoorlie	Synergy	Gas Turbine	Distillate	64.5
Mungarra	Synergy	Gas Turbine	Null	77.5
Kemerton	Transfield Services Infrastructure Fund	Gas Turbine	Null	260.9

Name	Owner	Type	Alternative fuel	Capacity (MW)
Tiwest	Tronox Pty Ltd	Reciprocating Engine	Null	36
Kwinana Swift	Western Energy Pty Ltd	Gas Turbine	Null	120
Worsley Cogeneration	Worsley Alumina Pty Ltd	Gas Turbine	Null	106
Wagerup Bauxite Mine and Alumina Refinery	Alcoa of Australia Ltd	Gas Turbine	Null	98

Source: ACIL Allen, from AEMO Gas Bulletin Board

Appendix B. Review of Energy System Objective schemes

Additional details regarding the Energy System Objective schemes considered in the formation of the Consultation Paper are provided below.

B.1 Renewable Energy Target

The Renewable Energy Target (“RET”) is a national scheme originally introduced as the Mandatory Renewable Energy Target by the Howard Government in 2001 the scheme sought to increase renewable electricity generation by an additional 2% by 2010 (9,500 GWh target), on top of existing generation. Enabling legislation was the Renewable Energy (Electricity) Act 2000

The target was subsequently expanded in 2009 by the Rudd Government, to increase to 20 per cent of all electricity generation by 2020 (45,000 GWh target).

In January 2011 the RETwas split into two parts: the Large-scale Renewable Energy Target (LRET) and Small-scale Renewable Energy Scheme (SRES), due to a very large increase in the installation of small-scale systems through 2009 and 2010. The LRET target was reduced to 41,000 GWh accordingly. This led to a very large surplus of banked certificates which remained in the system for some time.

An independent review in 2014 recommended scaling back the RET due to its impact on the electricity sector and consumers and in June 2015, the Australian Parliament passed the Renewable Energy (Electricity) Amendment Bill 2015. As part of the amendment bill, the LRET was reduced from 41,000 GWh to 33,000 GWh in 2020 with interim and post-2020 targets adjusted accordingly.

The scheme is administered by the Clean Energy Regulator and there is now sufficient capacity accredited to meet and exceed the mandated targets through to 2030.

LGCs are now also used for voluntary actions by Governments and Corporations to meet greenhouse gas abatement goals as a means of verifying actions.

Liable entities are electricity retailers and large electricity users (Electricity Intensive Trade Exposed Industry can be exempted). Targets are translated into individual liabilities based on the calculated annual Renewable Power Percentage (RPP) which sets a percentage of LGCs which are required to be surrendered to meet obligations.

Targets are set on a calendar year basis and LGC surrender deadline is 14 February each year for the previous calendar year

Liable entities that surrender fewer LGCs than their required surrender amount will be in shortfall. For LGC shortfall larger than 10% of the total LGC liability, a non-tax-deductible renewable energy shortfall charge of $65 certificate not surrendered is applied. All shortfalls are carried forward into future year liabilities. Any penalties paid can be refunded if shortfalls are made up within 3 years (effectively enabling a 3-year borrowing provision)

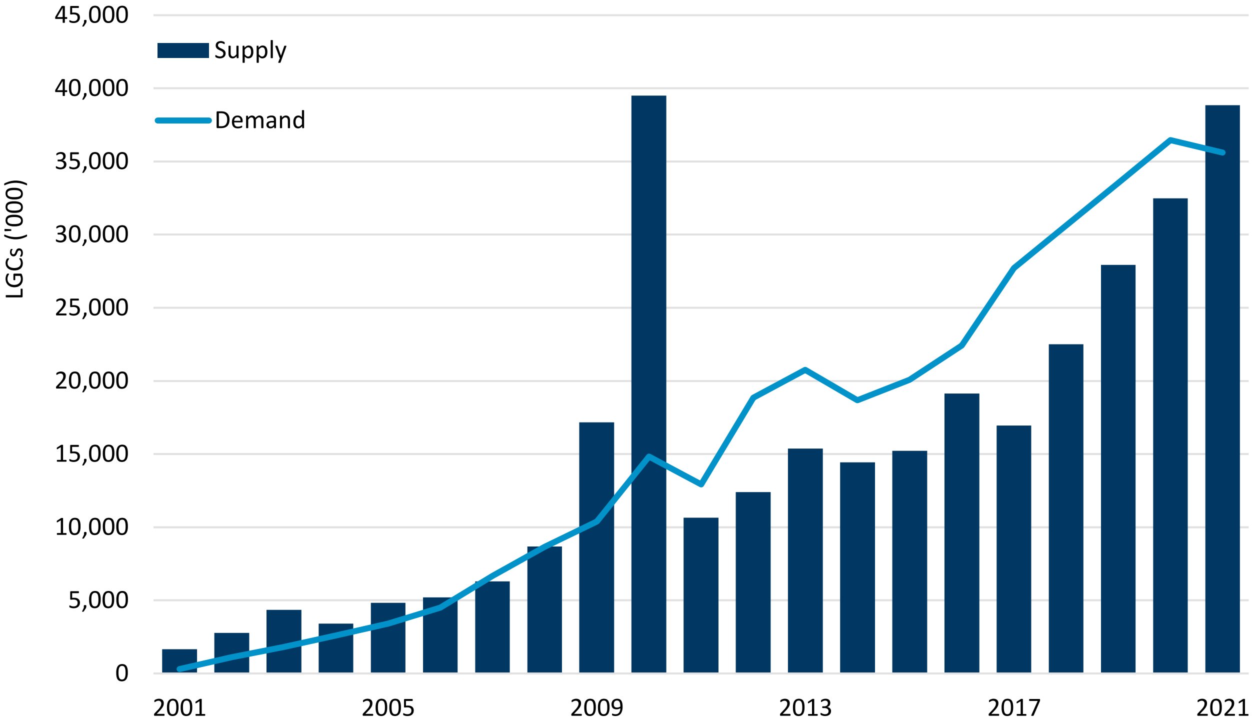
Eligible generators (based on fuel source) become accredited by the CER and submit claims for creation of tradable certificates (LGCs) based on sent-out MWh generated on a monthly basis, adjusted for loss factors. Wind has accounted for over 50% of all LGCs created to-date (when including small-scale systems prior to the scheme split).

Certificates are created, issued and traded through the REC Registry an online trading platform. Unlimited banking of LGCs is permitted (i.e., vintage and fuel type for each LGC is irrelevant for surrender purposes).

The CER validates all energy acquisition statements and conducts audits of liable entities and accredited generators. The scheme allows for voluntary surrender of certificates.

Despite a multitude of changes to the scheme over its history, it has been successful in accelerating the deployment of renewable generation across Australia.

Figure A.1: Demand and supply of Large-scale Generation Certificates under the Renewable Energy Target (000s of Certificates in year)



Source: ACIL Allen

B.2 NSW Greenhouse Gas Abatement Scheme (GGAS)

GGAS commenced on 1 January 2003 and was the first mandatory greenhouse gas emissions trading scheme in the world. The Scheme imposed obligations on all NSW electricity retailers (and separately, large electricity users), known as Benchmark Participants, to reduce a portion of the greenhouse gas emissions attributable to their sales/consumption of electricity in NSW. For each NGAC, an obligated business is short of their target they must pay a penalty which equates to $13-$15 (incorporating tax impacts due to non-tax deductibility).

They did this by purchasing and acquitting NSW Greenhouse Abatement Certificates (also known as NGACs) created by accredited Abatement Certificate Providers (ACPs) who undertook activities that:

- reduced emissions from existing generators
- generated electricity using low emission technologies
- improved energy efficiency
- sequestered carbon in forests
- reduced emissions from industrial processes in large energy consuming industries.

The Scheme set a state-wide electricity emissions target of 7.27 t CO2-e per person. An NGAC is awarded for each tonne of CO2-e abatement an activity is deemed to have contributed towards the target. In reality there are a range of complexities in setting baselines that mean the amount of abatement per certificate is substantially less than a tonne of CO2-e.

The Greenhouse Gas Reduction Scheme (GGAS) closed on 1 July 2012. Over 144 million abatement certificates were created in total.

NSW's IPART estimated the cost of administering GGAS over its 10-year lifetime to be around $18 million (~$0.125 per certificate created). These costs were recovered through fees charged for the registration of each certificate, as well as the accreditation application fees. This excludes the compliance costs of liable entities.

GGAS's cost impact on NSW electricity prices was relatively low. IPART analysis suggests that the average increase in the delivered cost of electricity as a result of the scheme was between $1.20 and $2.40 per MWh

Large volumes of NGACs were created through the provision of energy efficient light bulbs and efficient showerheads under the DSA rule. This triggered a surge in supply of certificates in 2006 and 2007, creating a large surplus and a price collapse in 2007. This led to the creation of a separate scheme, the NSW Energy Savings Target

The GGAS demand reduced after 2009 because the increase in the RET reduced emissions reductions required to achieve the NSW emissions target. This resulted in price collapsing in early 2011 and the scheme being closed in 2012 as the emissions objective had been achieved.

GGAS has recognised a wide variety of abatement activities not just restricted to NSW and ACT, including improved energy-efficiency of coal fired generators (across all states within the NEM); Generation from lower emission gas-fired generation (across all states within the NEM); Sequestration of carbon in trees

NGAC prices were initially high in the first few years, a consequence of a concentrated market in which only a few companies could supply substantial volumes of NGACs (five organisations created almost 80% of NGACs in 2003)

B.3 QLD Gas Electricity Certificate (GEC) Scheme

The Queensland Gas Scheme (QGS) was created via a new chapter 5A inserted into the Electricity Act 1994. The Scheme commenced on 1 January 2005 with the aim of maturing the gas industry in Queensland, reducing greenhouse gas emissions, diversifying the State's energy mix towards the greater use of gas in electricity generation and encouraging the development of new gas sources and gas infrastructure to meet the State's future energy requirements.

Initially it was developed as a demand support mechanism to help facilitate the development of the PNG Gas Pipeline, however the scheme ended up facilitating the local coal seam methane industry instead.

It required electricity retailers and other liable parties to source 13 percent of the electricity they sell or use in Queensland from gas-fired generation (target was increased to 15% in 2010). Gas Electricity Certificates (GECs) were issued to producers of gas-fired electricity with one certificate equating to a megawatt-hour of generation.

GEC prices traded at the penalty level in the first two years but quickly fell as the supply of gas certificates outstripped demand and GEC prices fell to very low levels in around 2010. It was proposed that targets be progressively increased over time up to 18% by 2019, however the scheme was discontinued in 2012.

Each GEC equated to a MWh of eligible gas-fired electricity generated in Queensland.
The effective subsidy sought to bridge the gap between gas and coal-fired electricity generation in QLD

The Scheme is administered by a web-based GEC Registry which allows participants to create, transfer and surrender GECs online. The registry also assists the regulator (the Director-General of the department) in monitoring compliance.

On 8 March 2013, the Queensland Government announced the closure of the Scheme from the end of 2013 in order to remove the administrative burden for liable entities as Queensland's gas industry had matured, gas-fired generation was growing strongly, and GEC prices were very low. The QGS was also superseded by the Commonwealth Government's carbon pricing mechanism which commenced in July 2012 in that it duplicated the impacts of the carbon price by supporting lower emission forms of generation over coal.

The scheme was allowed to run through until the end of calendar year 2013.

Energy Policy WA
Level 1, 66 St Georges Terrace, Perth WA 6000
Locked Bag 100, East Perth WA 6892
Telephone: 08 6551 4600
www.energy.wa.gov.au

We're working for Western Australia.