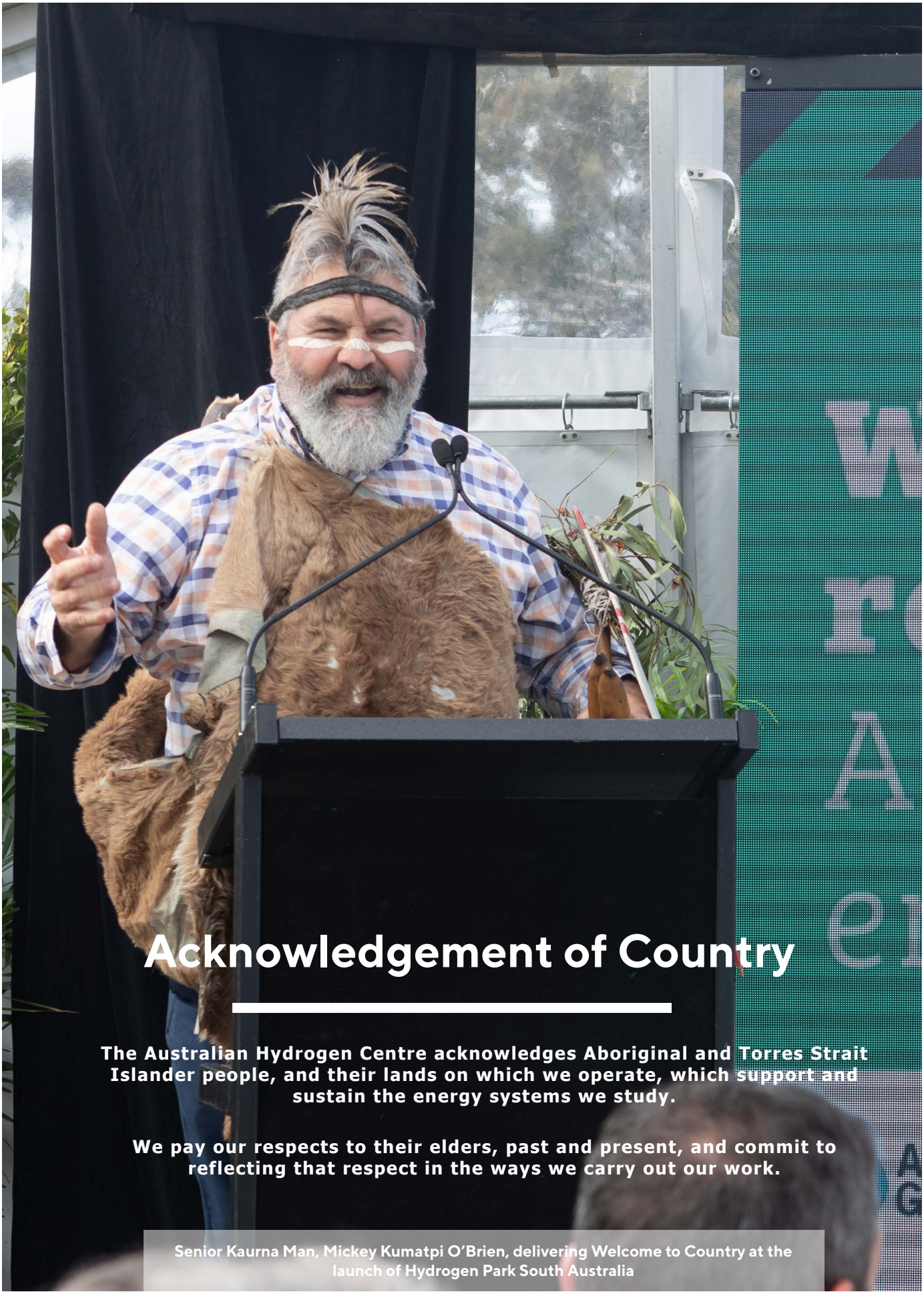
Australian Hydrogen Centre


# Hydrogen Park South Australia (HyP SA)

## PUBLIC KNOWLEDGE SHARING REPORT

MAY 2023



# Acknowledgement of Country

**The Australian Hydrogen Centre acknowledges Aboriginal and Torres Strait Islander people, and their lands on which we operate, which support and sustain the energy systems we study.**

**We pay our respects to their elders, past and present, and commit to reflecting that respect in the ways we carry out our work.**

Senior Kaurna Man, Mickey Kumatpi O'Brien, delivering Welcome to Country at the launch of Hydrogen Park South Australia

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This project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program.

# EXECUTIVE SUMMARY

IN MAY 2021, AUSTRALIAN GAS NETWORKS (AGN) – PART OF AUSTRALIAN GAS INFRASTRUCTURE GROUP (AGIG) – OFFICIALLY OPENED HYDROGEN PARK SOUTH AUSTRALIA (HYP SA).

HyP SA is Australia's largest operating electrolyser site and the first to deliver a volume of up to 5% renewable hydrogen blend with natural gas to homes on the existing gas network in metropolitan Adelaide. In early 2023, its outreach was increased from 700 homes to nearly 4,000 homes and businesses in Mitchell Park, Clovelly Park and parts of Marion.

By blending renewable hydrogen in the southern part of metropolitan Adelaide suburb of Mitchell Park, HyP SA enables the local community to start to reduce the amount of carbon in their existing gas supply without needing to change the way they cook, clean and heat.

HyP SA's delivery is also a key early step to demonstrating how existing gas infrastructure can be used to supply renewable gas to customers to help achieve our climate targets, whilst retaining its reliability and energy security benefits.

This Report is a key deliverable of the Australian Hydrogen Centre (AHC), prepared by AGIG to report on how HyP SA has achieved a technically successful demonstration of hydrogen production and network blending. It also outlines a promising pathway for commercial expansion through recent commencement of industrial supply and imminent network expansion.

## COMMUNITY ENGAGEMENT

Being an Australian-first, HyP SA established a new standard for stakeholder and community engagement by co-designing an approach with the community reaching tens-of-thousands of South Australians and attracted thousands of local and international guests. The approach was designed to ensure high levels of transparency and collaboration with stakeholders and community.

To measure knowledge, awareness, community sentiment and experience, longitudinal research (survey) of the community was undertaken between October 2020 and June 2022, with key trends including:

- **Awareness** more than doubled from 24% to 55% over the first year of operations, and stated usefulness of the information received has grown from 72% to 81%.
- **Appeal** remained strong with 95% of respondents saying the project is either highly appealing, somewhat appealing or neutral in the first year of operations, compared with 93% prior to operations.
- **Experience** has been positive with 94% saying safe delivery of gas to the home has remained (6% better than before, 0% worse than before), and 92% saying they have not experienced any difference in the appliances they use (4% better than before, 4% worse than before).

Averaging more than one tour per week since opening, HyP SA has hosted thousands of stakeholders seeking a real-life experience of a renewable gas future. It has hosted Premiers, Ambassadors and international delegations, industry leaders and multiple levels of students from primary school age to higher learning.


The Hon. Peter Maulinauskas Premier of South Australia announcing the commencement of 100% renewable hydrogen tp industry via tube trailer in August 2022

## PLANT PERFORMANCE

During operational periods since May 2021, HyP SA has safely harnessed South Australia's abundant renewable electricity to produce over 10 tonnes of renewable hydrogen and has delivered enough renewable energy into the networks to cook more than 78,000 pots of pasta or heat more than 12,400 hot showers.[1]

**78,019** pots of pasta

or

**12,483** hot showers

The electrolyser has demonstrated it can flexibly and dynamically respond to prevailing electricity and gas market situations with a start-up time of less than 1 minute, and the ability to ramp up from 0 to 100% at a rate of 10% per second. It has also performed strongly in terms of output, efficiency and hydrogen quality.

HyP SA has demonstrated how its flexible, controllable demand for electricity can contribute to a more secure and reliable energy system by allowing the gas network to be used like a battery to store variable renewable electricity in the form of renewable gas for later cooking, heating and hot water.

In the absence of an established certification scheme for renewable gas, HyP SA requires that the retailer on its behalf purchase and surrender Australian Government-managed GreenPower Large-scale Generation Certificates (LGCs). Recognising that 100% of its electricity used is certified as renewable as contracted via GreenPower, HyP SA's flexible operations targeting periods of surplus renewable electricity has meant that likely over 93% of the electricity it has drawn from the grid in 2022 is renewable on a time-of-use basis. More detail is available at section 3.3.2 of this report.

Since commencing operations, HyP SA's hydrogen production process has consumed an equivalent volume of ultra-pure water to 7.2 average South Australian households. In addition, 140 tonnes of oxygen have been released to the atmosphere, equivalent to the annual oxygen production of approximately 1,189 trees.

## BLENDING AND NETWORK PERFORMANCE

HyP SA's blending equipment is highly responsive to variable intraday and inter-seasonal demand and can comfortably match peak gas network demand in mornings and evenings.

Sampling has found that blended gas remained highly consistent at various points downstream of HyP SA, and that odorant levels were not impacted by 5% hydrogen blending.

Surveys prior, upon blending commencement, and at 12 months of operations have not identified any leaks in the blended gas area.

Appliance inspections were offered to customers at no cost with 90 houses taking up the opportunity and generally found to be in good working order. With advances in testing external to HyP SA, it is now generally accepted existing gas appliances are suitable with gas blends of at least 10% and it is anticipated similar audits would not be required in future blending projects.

1. AGIG worked with the Aurecon Group to provide analysis on the data captured at HyP SA since its operational commencement in May 2021. The data summarises 14 months of operations spanning between May 2021 to mid-November 2022 noting the plant has experienced some periods of paused operations to account for maintenance, installation and commissioning activities, notably between mid-November 2021 and May 2022.

## MARKET ENABLERS AND OPPORTUNITIES

HyP SA paves the way for future renewable gas projects in Australia by removing market barriers in a range of technical, regulatory, commercial, and engagement disciplines. It will continue to inform industry professionals, political decision makers, policy experts and the skills and training sector as part of establishing a renewable gas market.

In addition to technical and community engagement outcomes, wider benefits from HyP SA's development include: upskilling energy sector workers; creating new types of jobs; achieving relevant approvals for an Australian-first; skills and training collaborations; community awareness through positive media coverage; and industry recognition through awards.

Between May 2021 and August 2022, HyP SA's production capacity was limited to plant commissioning and demand from its single demonstration market, represented as around 700 households in Mitchell Park.

While HyP SA has produced over 10 tonnes since May 2021, its maximum capacity is closer to 150 tonnes per year. A promising pathway for commercial expansion includes unlocking further network, industrial and fuel cell supply from site. Recent noteworthy milestones include:

- In August 2022, operations commenced for the supply of renewable hydrogen from site to the Whyalla Steelworks in South Australia, delivered by road by tube trailer as part of a partnership with BOC, a Linde Company.
- In early 2023, HyP SA expanded the delivery of up to 5% renewable blended gas from 700 homes to nearly 4,000 homes and businesses in Mitchell Park, Clovelly Park and parts of Marion.

To date, the emissions reductions achieved by HyP SA's introduction of renewable gas of networks are not recognised or incentivised under any scheme. Policy and regulatory reforms that incentivise the production and supply of renewable gas are key to develop a competitive market environment to achieve least-cost decarbonisation.

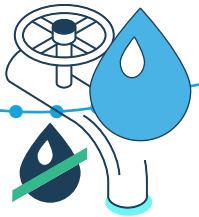
# KEY OUTCOMES: MAY 2021 - NOV 2022

**Key performance results from HyP SA including plant performance, network performance and community experience include:**

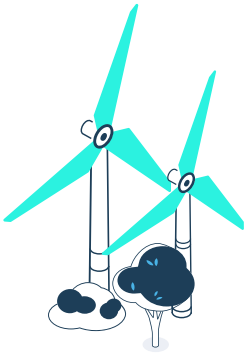
**Positive customer appeal** (94% positive or neutral)

**6 key international and Australian awards for innovation**

**Strong satisfaction with communication** (76% positive or neutral)

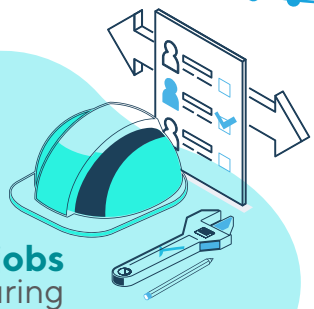


Annual ultra-pure water use by electrolyser equivalent to **7.2 South Australian homes***



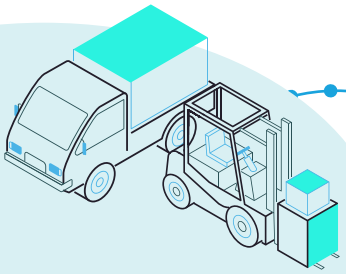
**548MWh** of renewable electricity via the grid** powered HyP SA to date

Enough hydrogen blended to cook **78,019 pots of pasta**



**16 new jobs** initally created during construction and **at least 1 new job type ongoing**

Abatement of **6,432 kg $CO^2$** avoided due to replacing methane with hydrogen since HyP SA's commencement



A **clear pathway to secondary markets,** such as industrial supply, transport and **increased hydrogen blending**

**3,000+ visitors** to HyP SA

* Independently verified calculations based on the Energy Networks Australia's conversion rate of 0.6MJ (or 0.01kg hydrogen) per pot of pasta cooked

** * AGN purchases GreenPower Large Scale Generation Certificates which are surrendered as required to ensure the electricity used to produce hydrogen is renewable

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## ACRONYMS

| | |
|---|---|
| **AEMO** | Australian Energy Market Operator |
| **AGIG** | Australian Gas Infrastructure Group |
| **AGN** | Australian Gas Networks |
| **AHC** | Australian Hydrogen Centre |
| **ARENA** | Australian Renewable Energy Agency |
| **BOC** | BOC a Linde Company |
| **CBD** | Adelaide Central Business District |
| **FFCRC** | Future Fuels Cooperative Research Centre |
| **FSA** | Formal Safety Assessment |
| **HyP MV** | Hydrogen Park Murray Valley |
| **HyP SA** | Hydrogen Park South Australia |
| **MOU** | Memorandum of Understanding |
| **NATA** | National Association of Testing Authorities |
| **NEM** | National Electricity Market |
| **OTR** | South Australian Office of the Technical Regulator |
| **PEM** | Proton Exchange Membrane |
| **RTF** | Renewable Technology Fund |
| **SRMTMP** | Safety, Reliability, Maintenance and Technical Management Plan |


Hydrogen Park
South Australia
Hydrogen
Purification
Australian
Gas Networks
Part of Australian Gas Infrastructure Group

# 01. PROJECT OVERVIEW

## 1.1: BACKGROUND

The Australian Hydrogen Centre (AHC) is a joint project between its members to investigate the technical, commercial, and practical feasibility of hydrogen blending in existing gas distribution networks.

The AHC's overall program of work involves the delivery of key feasibility studies as well as knowledge sharing reports.

**Regional Towns Feasibility Studies**

Detailed feasibility studies that determine how 10% hydrogen might be delivered into the gas distribution networks of selected regional towns in South Australia and Victoria.

**State-Wide 10% Hydrogen Studies**

Feasibility studies that determine how the South Australian and Victorian gas distribution networks might deliver 10% renewable hydrogen.

**State-Wide 100% Hydrogen Studies**

Feasibility studies that determine how the South Australian and Victorian gas distribution networks might deliver 100% renewable hydrogen.

**Hydrogen Park South Australia (HyP SA) Knowledge Sharing Reports**

Presenting key learnings from HyP SA where renewable hydrogen has been blended into the gas networks in the suburb of Mitchell Park, Adelaide between May 2021 and November 2022.

These reports are available here:
**https://arena.gov.au/projects/australian-hydrogen-centre/**

Supported by a range of independent technical studies, these studies outline a possible pathway to decarbonise customers' energy supply while retaining their access to the benefits of gas supply for reliable and affordable energy.

## 1.2: PURPOSE

This Report has been developed by AGIG for the AHC to share key findings from HyP SA's operations since May 2021, covering three key areas of operations: community engagement, facility and plant performance, and network performance. This Report was developed with several independent consultancies.

**HyP SA plant performance analysis**

**HyP SA community engagement**

**HyP SA customer sentiment analysis**

## 1.3: FUNDING AND SUPPORT

HyP SA is supported by a $4.9 million grant from the South Australian Government's (SA Government) Renewable Technology Fund (RTF) made in 2018 to catalyse renewable sector investments in South Australia and fast-track the state's energy transformation.

Funding from Australian Renewable Energy Agency (ARENA) and South Australian Government was committed in late 2019 for the AHC to produce this Knowledge Sharing Report as a deliverable of the AHC. A high-level outline of HyP SA's capital costs is as follows:

| Hydrogen Park South Australia | | |
|---|---|---|
| **Category** | **Description** | **$(m)** |
| **Pre-Financial Investment Decision Activities** | Includes but is not limited to project concept, scoping and Front-End Engineering and Design studies. | **0.39** |
| **Site Acquisition, Engagement and Approvals** | Includes but is not limited to site acquisition, customer and stakeholder engagement, and obtaining relevant approvals. | **0.92** |
| **Hydrogen Equipment Capital Costs*** | Includes but is not limited to supply, installation and commissioning of electrolyser, transformers, rectifiers, harmonic filter, cooling, and water purification equipment | **4.26** |
| **Engineering, Design and Construction*** | Includes but is not limited to connections, design, construction, and third-party engineering assurance. | **8.94** |
| | **Total cost** | **14.50** |

** The total expenditure increased $2.8 million from $11.7m to $14.5m as a result of COVID-19 deferring planned operations from July 2020 to May 2021, and expanded scope through delivery of tube trailer facility.*

## 1.4: TIMEFRAME

With its customers' interests in a lower carbon future in mind, AGIG developed a bid for HyP SA and was awarded funding by the SA Government in February 2018. Construction on HyP SA began in December 2019, and first supply of 5% renewable hydrogen blended gas began on 19 May 2021 after a period interrupted by COVID-19.

**Feb 2019**
Funding announced

**Jul 2019**
Community introduced to the project

**Sep 2019**
Development Approval received

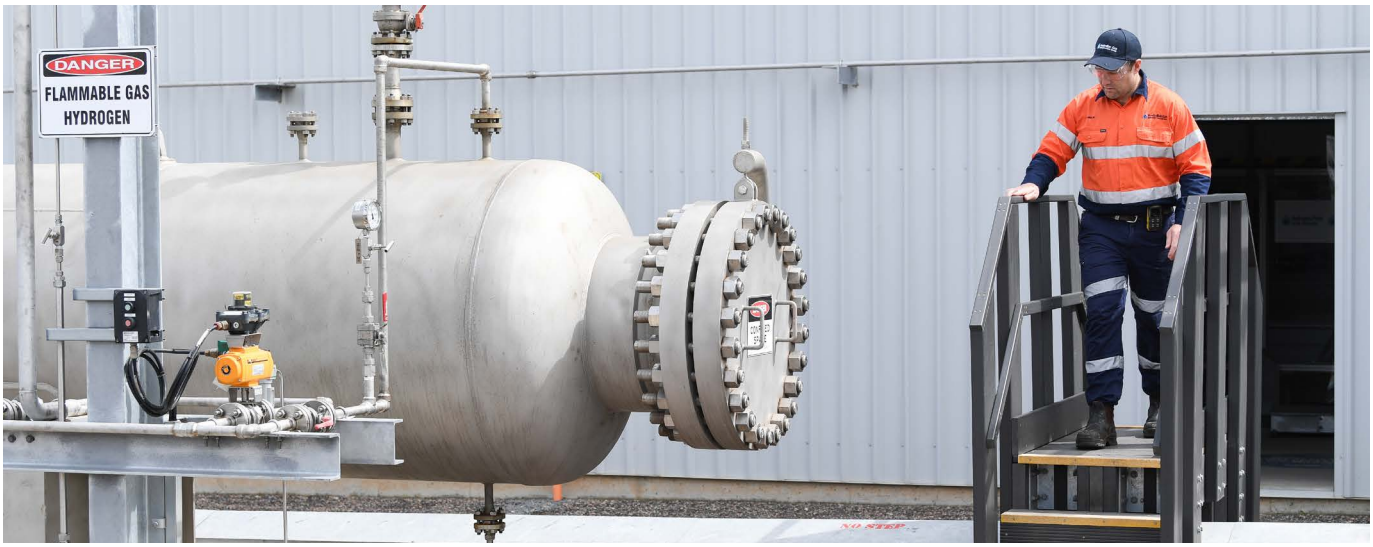
**Dec 2019**
Construction commenced

**Sep 2020**
Electrolyser installation

**May 2021**
Operations commence supplying ~700 homes with volumes of up to 5% renewable gas

**Aug 2022**
Expanded operations for industrial supply commences

**Mar 2023**
Expanded operations to nearly 4,000 homes, schools and businesses



# 02. COMMUNITY ENGAGEMENT

## 2.1: SUMMARY

As Australia's first renewable hydrogen public blending project, securing community acceptance was key to pave the way for future decarbonisation of gas networks and developing a renewable gas source for industry and transport.

With engagement principles embedded in AGIG's operations and a commitment to tailoring engagement to the specific needs of projects and communities, community engagement was central to HyP SA's project planning from the outset.

Initial demographic research identified that the type and volume of information received had the potential to convert a reasonable level of resident apathy into acceptance, provided it addressed residents' primary interests in safety and sustainability.

### Key outcomes:

- A tailored engagement program co-designed with stakeholders and the community helped to secure broad stakeholder and community acceptance for HyP SA and set a new framework for industry engagement.
- Longitudinal research surveys found customers are satisfied with the project's delivery. paving the way for a variety of partnerships and expansion of supply as AGIG builds widespread confidence in the wider industry's development.


AGIG staff cook a hydrogen-fuelled BBQ for conference attendees at the SA H2H event in Adelaide

## 2.3: ABOUT MITCHELL PARK

Mitchell Park was selected for the project due to its location proximal to the Tonsley Innovation District and demographics representing a typical Australian suburb and gas users.

## 2.4: ENGAGEMENT OVERVIEW

AGIG has maintained consistent contact with the community and stakeholders since officially introducing the project in July 2019 and is committed to continuing its engagement program in the years ahead.

To measure knowledge, awareness, community sentiment and experience, longitudinal research, via an online quantitative survey, of the community was undertaken between October 2020 and June 2022.

### 2.4.1: OBJECTIVES

**1. Knowledge and awareness before, during and after the project to ascertain:**

- Awareness, understanding and interest in the HyP SA project;
- Whether engagement was effective;
- Awareness and understanding of the free gas appliance audit;
- Knowledge levels of how renewable hydrogen is produced; and
- Understanding the decarbonisation pathway for gas supply.

**2. Community experience with the switch to blended gas and community sentiment toward the project. Specifically, the research delved into:**

- Community attitudes towards the project;
- Perceptions and knowledge of hydrogen;
- Did opinions change after engagement activity?;
- Potential concerns;
- Is there trust that gas will be delivered safely and affordably;
- Recall of communications;
- Suitability of messaging;
- Perceptions of engagement activity and interactions and whether anything missing;
- Was more information required?

**5,630 Residents**

5,630 residents, 47% male, 53% female
15% aged 20-30 years
20% aged 40-59 years
24% aged 60+ years
One-third of residents born overseas and speaking a language other than English at home

**2,478 households**

38% single-person
31% couples or sole parents with children
16% of families with children aged up to 15 years
47.5% occupied by tenants
52.5% owner occupiers
23% without home internet connection

**Education & Economics**

22% tertiary educated
53% don't hold formal qualifications
31% of households on low incomes

**Top 3 occupations**

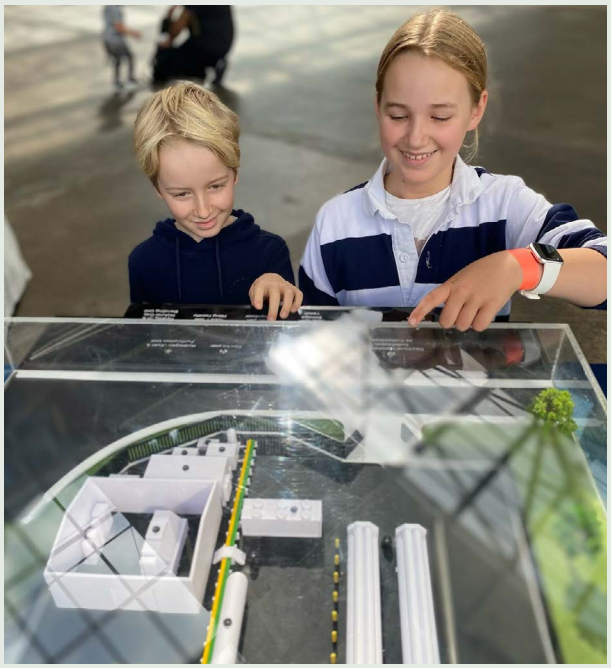
19% Professionals
16% Community personal service workers
13% Administrative/clerical

## 2.5: KEY ENGAGEMENTS

### TONSLEY SCIENCE FAIR

The Tonsley Science Fair is the largest single interactive mobile science exhibition in Australia. The Fair builds community awareness of the scope and significance of science and technology in everyday lives, celebrating South Australia's successes and inspiring future generations of science and technology professionals.

A HyP SA scaled model at the Fair enabled local children and families to learn more about the project and Australia's renewable gas transition.





### SITE TOURS

HyP SA has hosted more than 3,000 stakeholders including students, industry leaders, conference delegates, international dignitaries and political figures averaging more than one tour per week since its launch.

### FIRST COMMERCIAL CONNECTION

Australia's first delivery of up to 5% blended gas to a commercial customer has been connected at the La Loft Hotel Tonsley, located in the Tonsley Innovation District. The hotel features 88 suites, 17 serviced apartments and conference and function facilities. Blended gas powers the hotel's commercial kitchen.

# COMMUNITY ARTWORK CONSULTATION

## MITCHELL PARK RESERVE

AGIG supported a partnership with Marion Council to fund a public artwork to commemorate Mitchell Park being part of this Australian-first project. Residential gas customers were consulted when collaborating with a local artist to develop concepts for the artwork, which was installed in late 2022 as part of an upgrade to the Quick Road Reserve.

Key community sentiments were that the residents were proud to be the first suburb in Australia to receive a renewable gas blend.

The key objectives included:

- Celebrate Mitchell Park as the first suburb in Australia to receive a renewable gas blend;
- Celebrate the pathway to a clean energy future;
- Promote hydrogen as a clean, green energy of the future; and
- Provide further information for residents on the project.

Local artist, Elle Dawson-Scott designed and delivered an extensive ground mural in the Quick Road reserve in Mitchell Park. The artwork depicts 'a pathway to a cleaner energy future', in a bright and bold pathway that seeks to brighten the park space, as well as inspiring us all towards a clean and green future together.

Elle's design was informed by the community following consultation through a barbecue held at the Reserve. The design includes illustrations that touch on the themes of nature and sustainability, renewable energy, hydrogen, cooking, heating and community through the stylised and bold images.

## 2.6: SURVEY PROCESS

| Stage | Timing | Research Activity | Responses |
|---|---|---|---|
| **Pre-blending** | October 2020 | Stakeholder interviews | 3 |
| | | Focus groups (2) | 12 participants |
| | | Online community survey | 80 respondents |
| **Post-blending** (6 months) | October 2021 | Online community survey | 35 respondents |
| **Post-blending** (12 months) | June 2022 | Focus groups (2) | 12 participants |
| | | Online community survey | 111 respondents |

### COMMUNITY FEEDBACK - OCTOBER 2020

> I think it's going to be good for the environment and that's what it's all about

> I like the idea that something progressive is happening with potential benefits for the environment

> Anything which assists with the reduction of emissions is interesting to me

### COMMUNITY FEEDBACK - OCTOBER 2021

> Glad to be involved with this project. [I] am learning more about blended gas and reducing carbon emissions

> Didn't realise it had already changed over, I haven't noticed a difference in the gas to my house - may take a closer look at my gas bill though

> I think it is a great innovation and look forward to it spreading state-wide

> All our appliances have been working well. So if we can help the environment by using hydrogen without compromising efficiency, I'm all for it!

### COMMUNITY FEEDBACK - JULY 2022

> I'm just very conscious that people just do not like change. Prior to coming and living in Mitchell Park I'd never even heard of hydrogen in gas, I thought 'what's this all about, is this another gimmick?' But two, three years down the track, I've got a different opinion because I know a little bit more. The more information I have, the happier I'd be to broadcast it.

> Just being part of making a diference. You now, this is where it all starts

Engaging with community members on HyP SA at the Tonsley Science Fair in 2021

## 2.7: SURVEY RESULTS

### 2.7.1: COMMUNITY AWARENESS

Figure 1 demonstrates awareness of 'Hydrogen Park South Australia' more than doubled from 24% at pre-blending, to 55% over the first year of operations. Familiarity with the more general term of 'blended gas project' also rose from a strong 62% prior to blending, to 73% once operational.

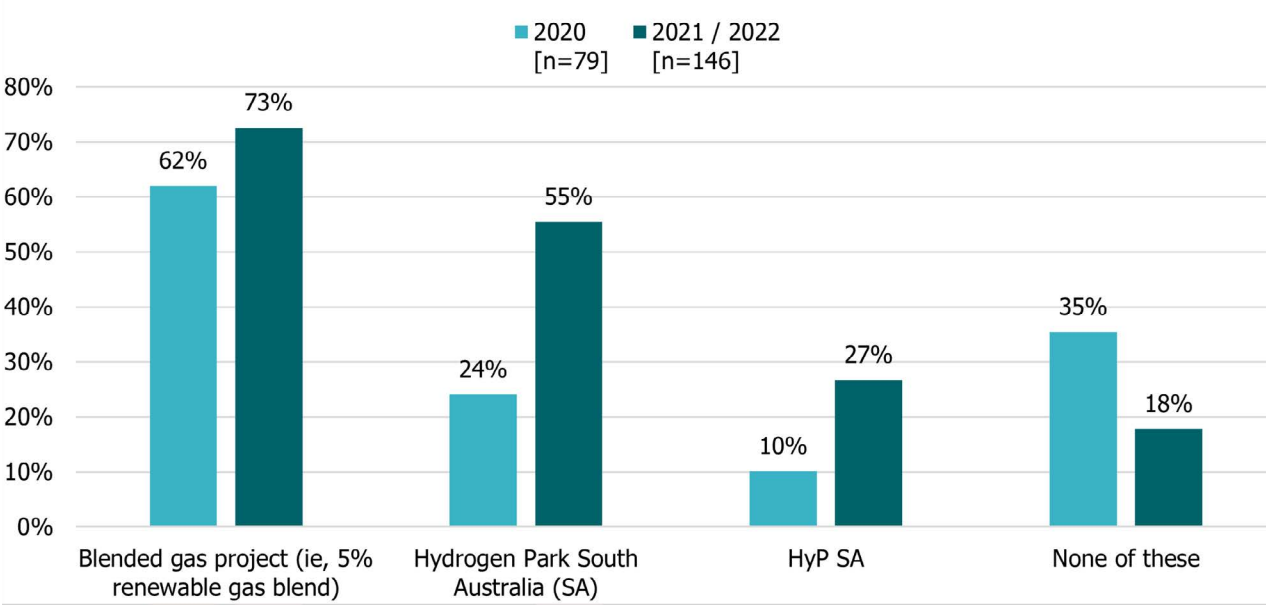



*Figure 1: Community survey results - Awareness of HyP SA*

### 2.7.1: USEFULNESS OF COMMUNICATIONS

Figure 2 shows usefulness of the communications received rose from 72% pre blending to 81% as interest grew once blended gas began to flow. Figure 3 demonstrates the community's likelihood of seeking out more information remained consistent across the survey period at approximately one in two people. These results infer:

- Strong community recall about key project information was achieved through coordinated multi-channel communications activities.
- The information that was provided was considered helpful and relevant at the time of introducing the project and commencing operations.

After 12 months of receiving blended gas, the community is now seeking more technical information on how renewable hydrogen is produced, its environmental benefits, and the potential for expansion of supply.

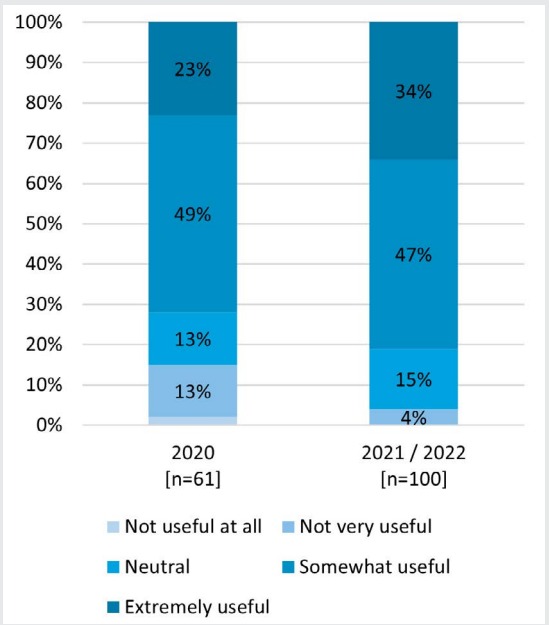



*Figure 2: Survey results - Usefulness of information*

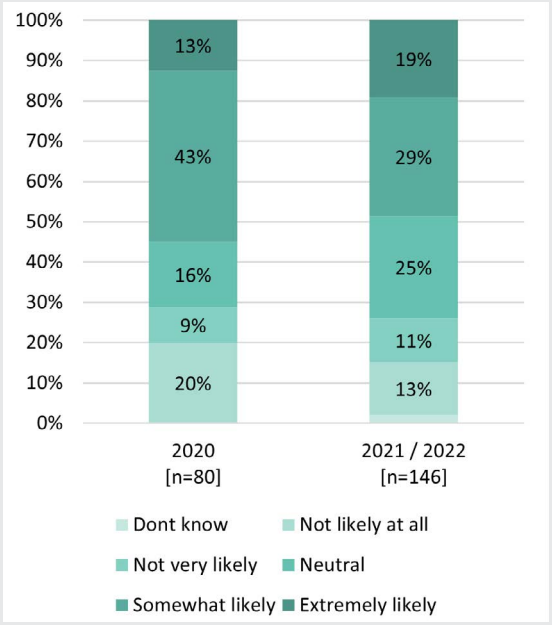



*Figure 3: Survey results - Likelihood to seek further information*

## 2.7.3: PROJECT SENTIMENT

Positive sentiment toward the project continued with 70% remaining positive following the change in their gas supply, shown in Figure 4 and Figure 5. These results demonstrate sentiment has remained positive throughout the 12-months of the project, with the community taking great pride in being part of the gas sector's transformation.

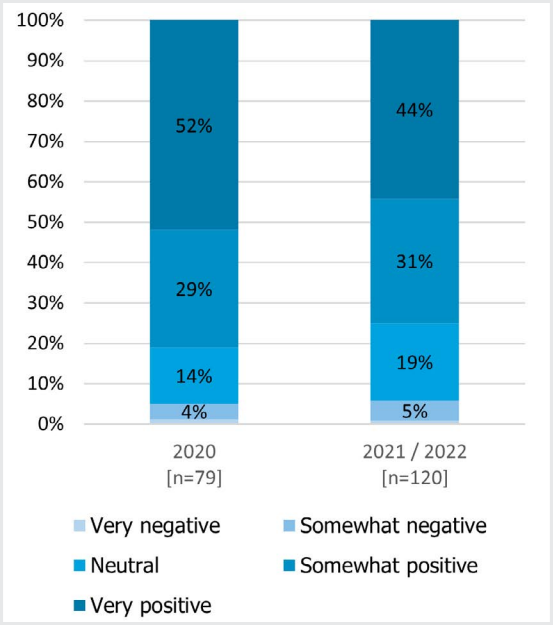



*Figure 4: Survey results - Initial reaction to project*

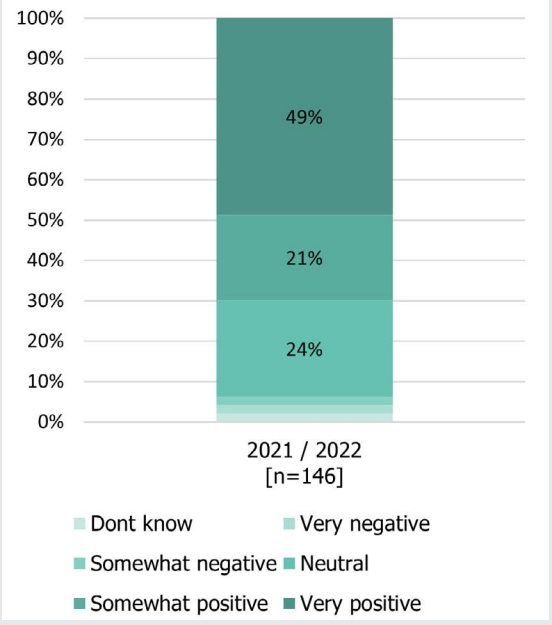



*Figure 5: Reaction now project has been delivered*

## 2.7.4: CUSTOMER EXPERIENCE

Figure 6 shows experience has been positive with 94% saying safe delivery of gas to the home has remained (6% better than before, 0% worse than before), and 90% saying they have not experienced any difference in the appliances they use (4% better than before, 4% worse than before).

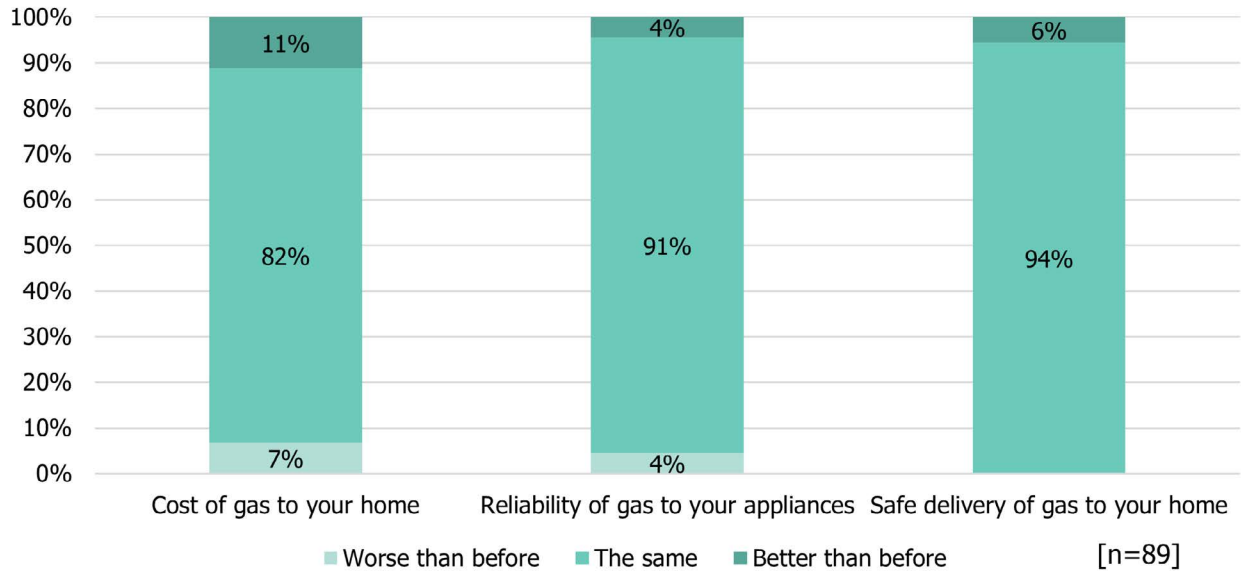


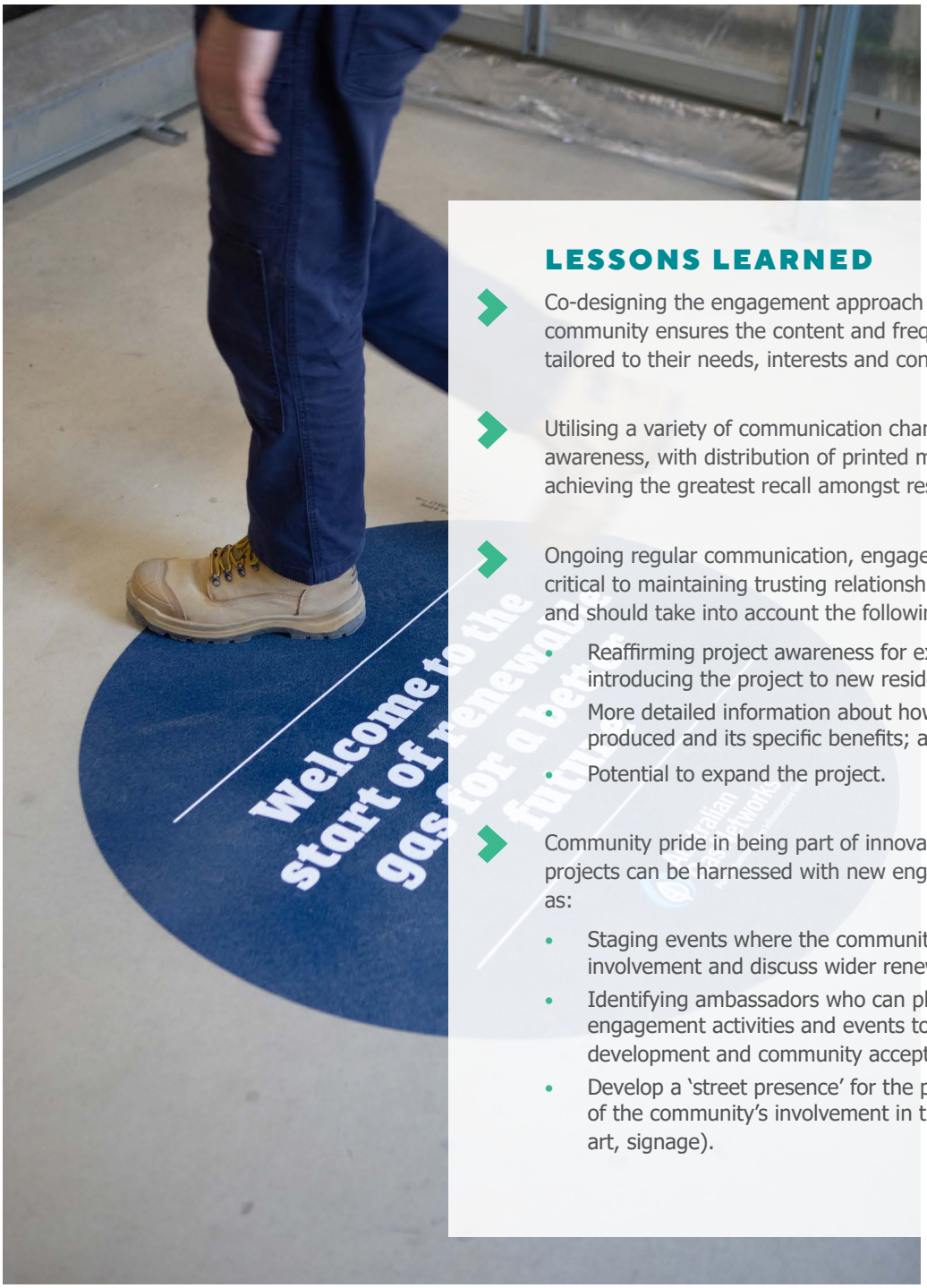

*Figure 6: Community survey results - Community perceptions of blended gas*

## 2.8: SUMMARY OF KEY FINDINGS

Overall AGIG's engagement approach has secured high levels of community acceptance for the project, with no concerns identified nor complaints received.

Longitudinal research found that the community is satisfied with the project's delivery, paving the way for a variety of partnerships and expansion of supply as AGN builds widespread confidence in the wider industry's development.

- **Awareness** has more than doubled from 24% to 55% over the first year of operations, and stated usefulness of the information received has grown from 72% to 81%.
- **Appeal** has remained strong with 95% of respondents saying the project is either highly appealing, somewhat appealing or neutral in the first year of operations, compared with 93% prior to operations.
- **Experience** has been positive with 94% saying safe delivery of gas to the home has remained (6% better than before, 0% worse than before), and 92% saying they have not experienced any difference in the appliances they use (4% better than before, 4% worse than before).




### LESSONS LEARNED

- Co-designing the engagement approach with stakeholders and the community ensures the content and frequency of communications is tailored to their needs, interests and concerns.
- Utilising a variety of communication channels is essential to build awareness, with distribution of printed materials into letterboxes achieving the greatest recall amongst residents.
- Ongoing regular communication, engagement and education remains critical to maintaining trusting relationships once a project is operating and should take into account the following information needs:
  - Reaffirming project awareness for existing residents and introducing the project to new residents;
  - More detailed information about how renewable hydrogen is produced and its specific benefits; and
  - Potential to expand the project.
- Community pride in being part of innovative renewable energy projects can be harnessed with new engagement opportunities such as:
  - Staging events where the community can gather, celebrate their involvement and discuss wider renewable energy options;
  - Identifying ambassadors who can play a role in future engagement activities and events to support industry development and community acceptance; and
  - Develop a 'street presence' for the project as a physical reminder of the community's involvement in the project (for example public art, signage).

# 03. PLANT PERFORMANCE

HYP SA IS IN THE TONSLEY INNOVATION DISTRICT, 10 KILOMETRES SOUTH OF THE ADELAIDE CENTRAL BUSINESS DISTRICT. TONSLEY IS A HUB FOR RENEWABLE ENERGY INNOVATION IN SOUTH AUSTRALIA, MAKING IT THE IDEAL PLATFORM TO DEMONSTRATE AND SHARE THIS EMERGING RENEWABLE TECHNOLOGY.

From Tonsley, HyP SA delivers a renewable gas blend to the adjacent suburb of Mitchell Park, representing a typical Australian suburb of household energy users with a highly diverse mix of residents.

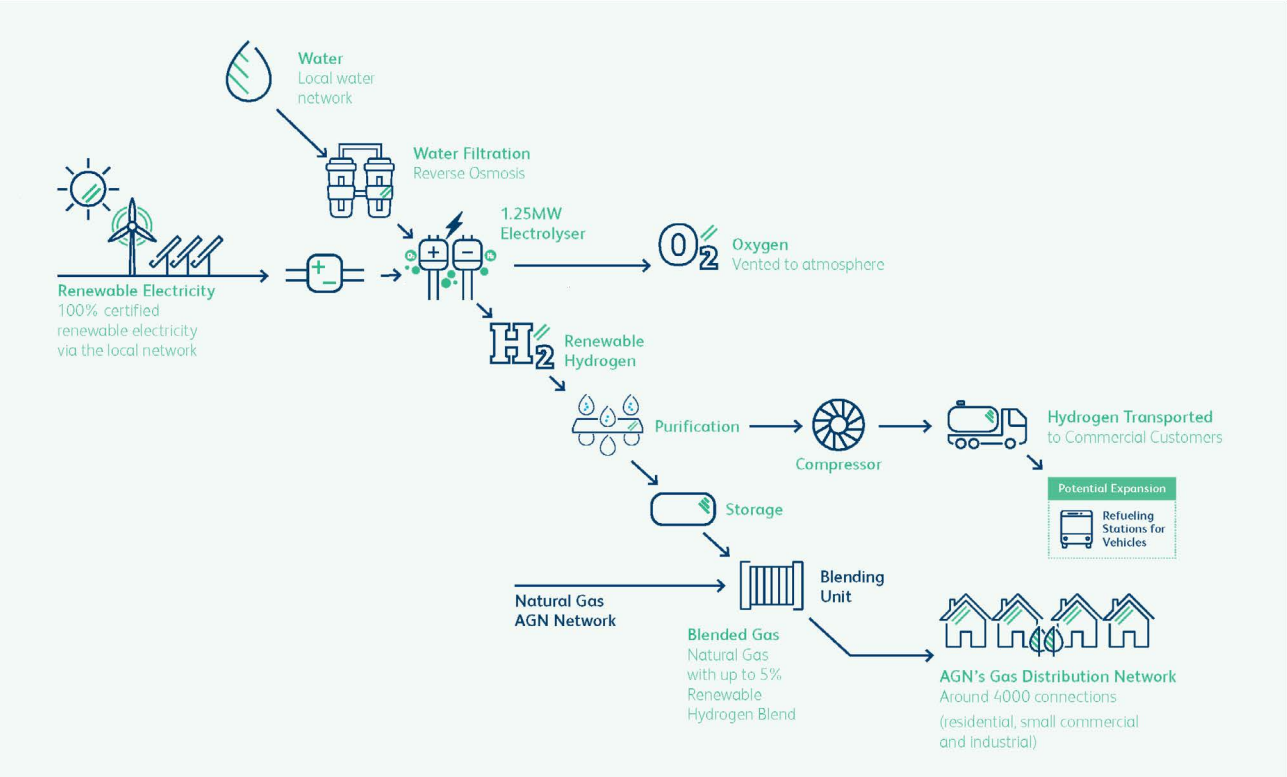
## 3.1: OPERATING REGIME

Hydrogen is made at HyP SA using an electrolyser, which splits water into hydrogen and oxygen using renewable electricity.

The process by which this occurs is known as electrolysis. Electrolysis has been around for a long time, first appearing in the 1800s and is in use around the world today.

HyP SA uses a 1.25 MW Siemens Proton Exchange Membrane (PEM) electrolyser, which can produce up to 20 kilograms per hour of hydrogen.

A key benefit of this technology is that it can rapidly respond to fluctuations in the electricity market, ramping up when renewable electricity is abundant and switching off in times of low renewable supply or high electricity demand. HyP SA targets its window of production from its 24-hour control room, supported by an algorithm that automatically tracks electricity market opportunities.




AGIG worked with the Aurecon Group to provide analysis on the data captured at HyP SA since its operational commencement in May 2021. The data summarises 14 months of operations spanning between May 2021 to mid-November 2022 noting the plant has experienced some periods of paused operations to account for maintenance, installation and commissioning activities, notably between mid-November 2021 and May 2022.


**1 Electrical Input**

Electricity enters the site directly from the local electricity network. A contractual arrangement with GreenPower ensures this is renewable electricity.

**2 Water Input and Purification**

Water enters the site through the local mains connection and is purified and demineralised, then pumped into the electrolyser.

**3 Electrolyser**

Water and electricity then supply a 1.25 MW PEM electrolyser to produce hydrogen and oxygen.

**4 Hydrogen Purification**

Oxygen and hydrogen exit the electrolyser. The oxygen is vented, and hydrogen purified to 99.999% pure (i.e. 'fuel cell grade').

**5 Hydrogen Storage Tank**

Once purified, the hydrogen can be stored in the 40kg storage vessel for later use, to be sent directly to the networks, or be sent to the tube trailer bay.

**6 Gas Analyser Hut**

The gas analyser measures purity of the hydrogen and verfies the correct amount of hydrogen for no more than a 5% by volume blend.

**7 Gas Network Blending**

Renewable hydrogen is blended with natural gas using the gas blending equipment before the 5% renewable gas blend is supplied via the existing gas network.

**8 Tube Trailer Bay**

Renewable hydrogen is supplied to industry via tube trailer facilities.

Tube trailers are semi-trailers with gas storage tanks that vary in length from small tubes to large size tanks, enabling gases like hydrogen to be compressed and transported by road from a supply site to any destination.

## 3.2: HYDROGEN PRODUCTION

Between May 2021 and November 2022, HyP SA produced 11,006 kg of renewable hydrogen.

Its highest production was in the first month of reporting due to facility commissioning. Production at site has been steadily increasing since August 2022 with the commencement of supply to industry via tube trailers representing an additional source of demand (note data from November 2022 does not constitute a full month of production).

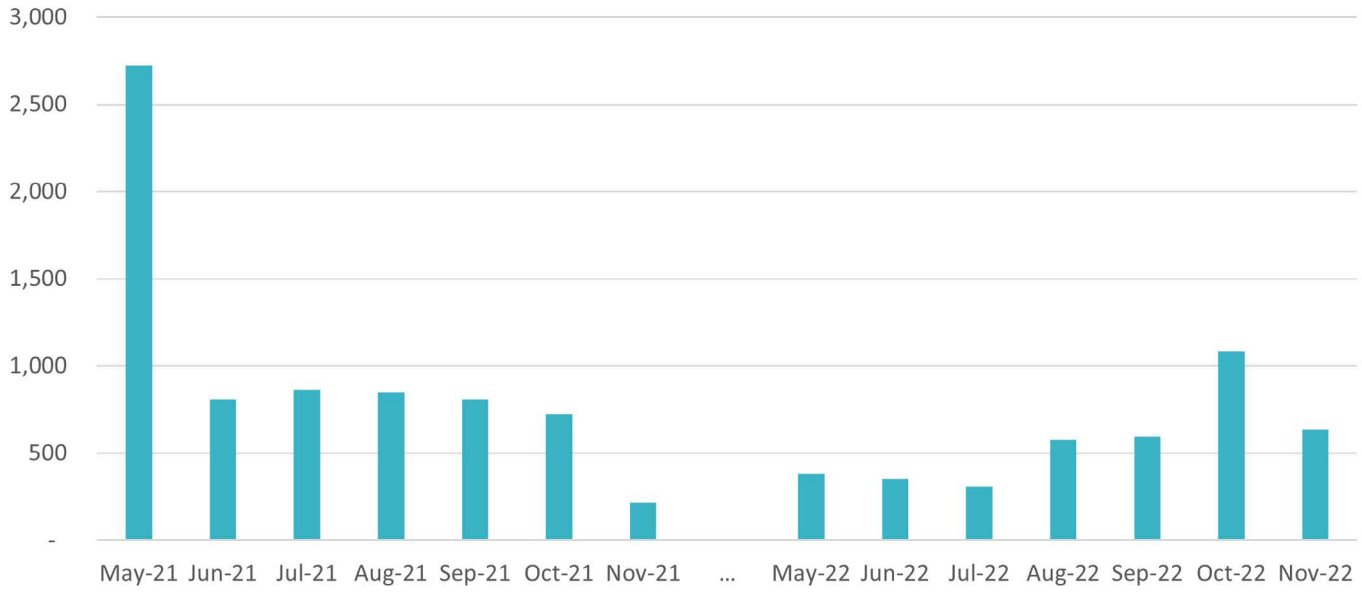



*Figure 7: HyP SA Production (kg)*

### 3.1.1: HYDROGEN PRODUCTION RATE

While producing, the electrolyser has been operated close to its maximum output level of around 20kg, and the average production rate (for operating hours only) is only 2% below the maximum output.

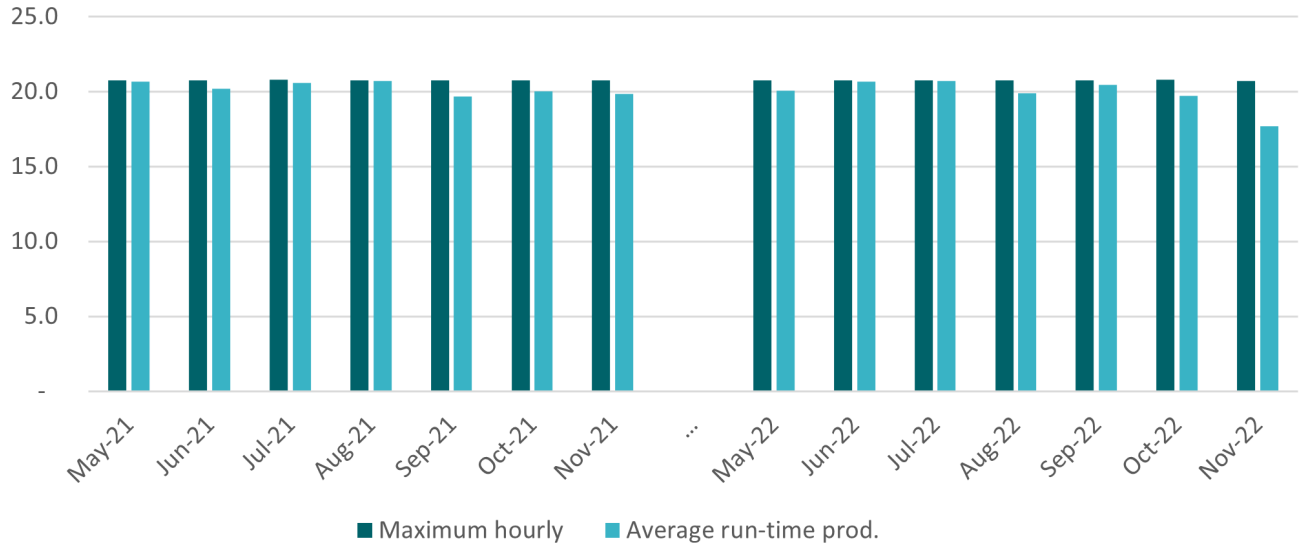



*Figure 8: HyP SA Output (hourly kg)*

### 3.1.2: ELECTROLYSER PERFORMANCE

The electrolyser is highly stable in terms of its output, with a linear relationship demonstrated between minimum and maximum load. Its average calculated efficiency (using High Heating Value) is reflective of the current generation of electrolyser technology ranging between 64.5-74.1%, and over 65% as a weighted average.

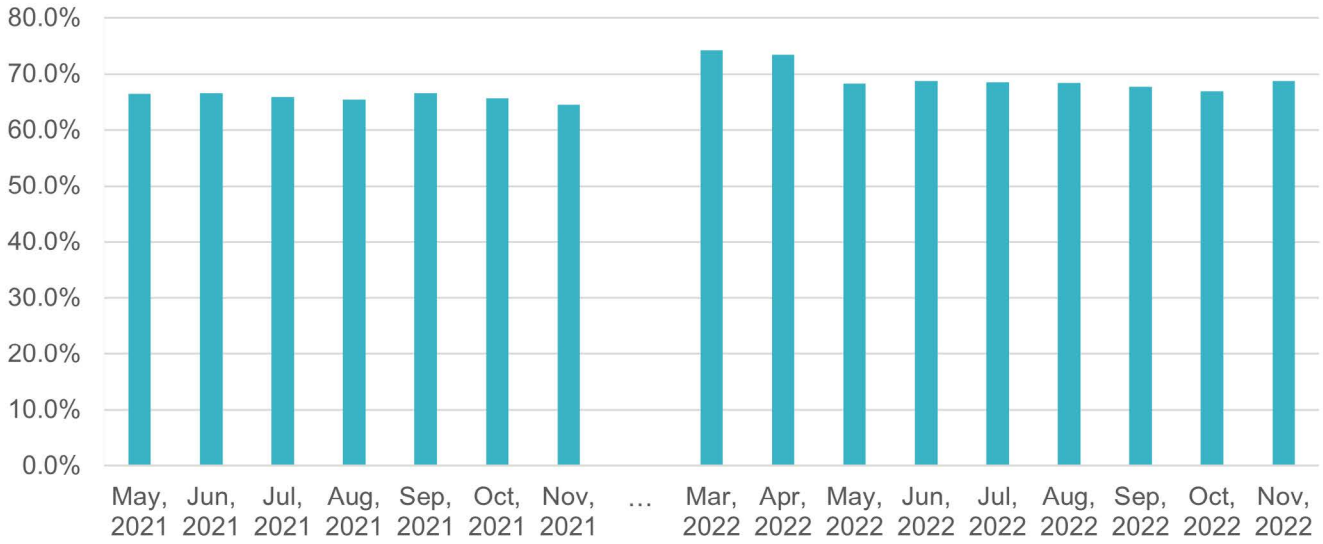



*Figure 9: HyP SA Efficiency*

The hydrogen produced by the electrolyser is ultra-pure at above 99%. Approximately 85% of the time, the hydrogen has less than 6 parts per million of water and 1.2 parts per million of oxygen. After it exits the electrolyser, the hydrogen is then made 99.999% pure by the hydrogen purification unit.

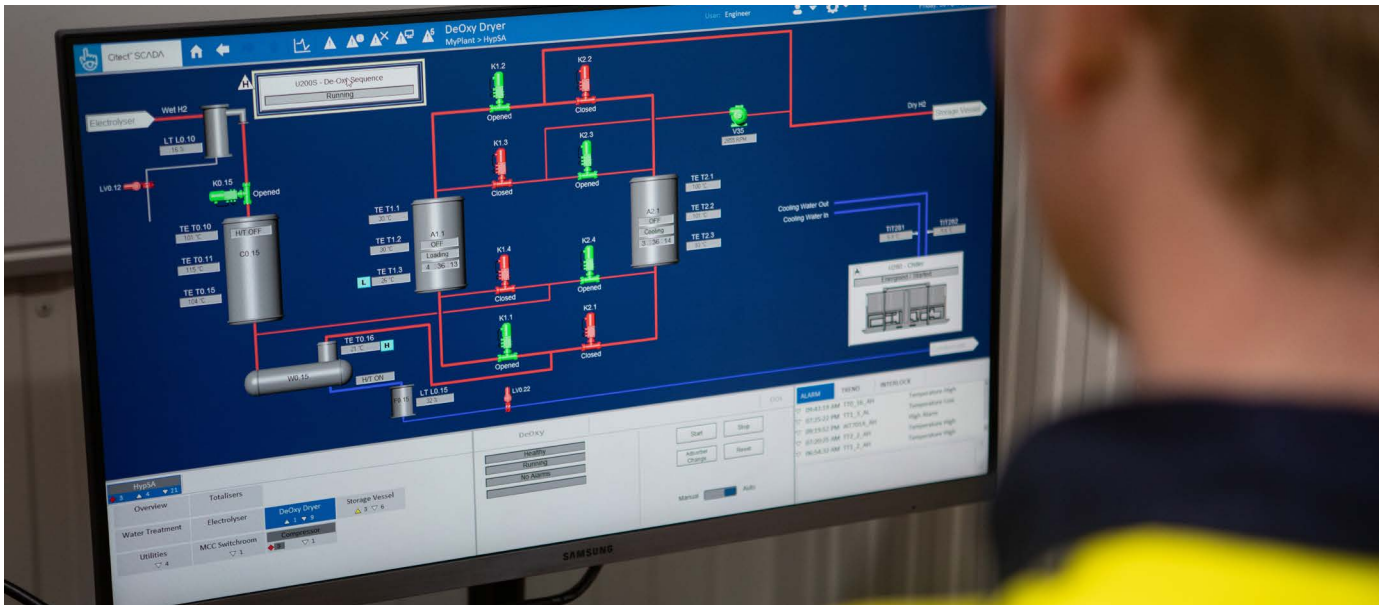
To date, the electrolyser demonstrated it can flexibly and dynamically respond to prevailing electricity and gas market demand levels with a start-up time of less than 1 minute, and the ability to ramp up from 0 to 100% at a rate of 10% per second. Electricity and gas market integration is further considered in section 5.2.

Overall, the technology has achieved a technically successful demonstration of hydrogen production and network blending. Further utilisation and expansion opportunities are considered in section 5.2.3.

## 3.3: ELECTRICITY AND GAS SECTOR COUPLING

South Australia's electricity system is rapidly transitioning from one built around synchronous, large-scale centralised generation to one that is ever more dispersed, weather-dependent, and increasingly led by consumers. This is changing the range and shape of demand and supply on the South Australian electricity grid, with the frequency of negative spot prices reaching record levels in 2020-2021 despite trends demonstrating power prices are rising overall.

HyP SA has sought to demonstrate how flexible, controllable demand loads such as electrolysis can contribute to a more secure and reliable energy system by allowing the gas network to be used like a battery to store intermittent renewable electricity in the form of renewable gas for later cooking, heating and hot water.



## 3.3.1: ELECTRICITY GRID DEMAND VS HYDROGEN PRODUCTION

In the context of demonstrating grid integration and harmonisation, HyP SA is purposefully connected to the local grid rather than directly supplied by dedicated renewable electricity generation. This also demonstrates the replicability of the project throughout Australia, where gas and electricity systems commonly coincide to provide customer choice and security of energy supply.

The increasing occurrence of minimum electricity demand occasions in South Australia is strongly driven by more than 40% of South Australian households uptaking rooftop solar systems. There have been several occasions where distributed solar systems supply the vast majority of South Australia's underlying demand, with spot prices negative 32% of the time between midday and 3pm in 2020/21.

HyP SA's production profile demonstrates 65% of its operational hours occured in daylight hours between 10am and 3pm with 11am to midday hours being the most utilised, highlighted by the blue circle in Figure 10.

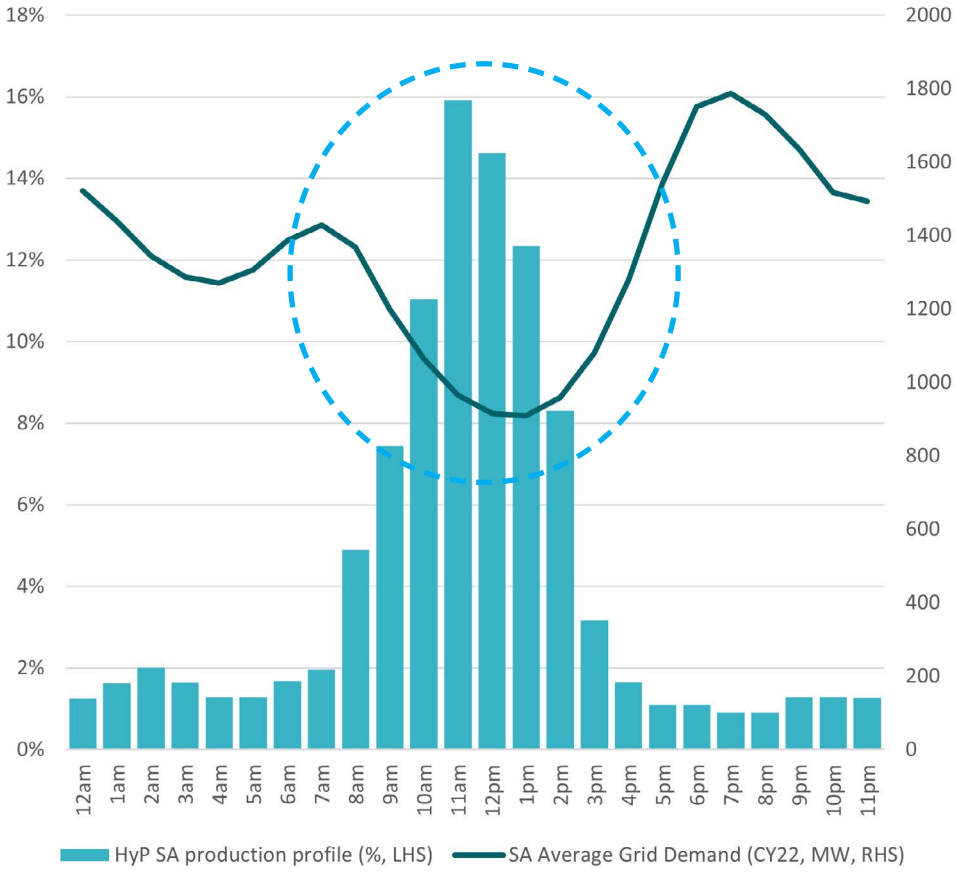



*Figure 10: South Australia National Electricity Market Average Grid Demand (MW) versus HyP SA production profile (% by time of day)*

Figure 10 demonstrates how the scaled and efficient application of rapid demand-response hydrogen technologies could be well suited to balancing supply and demand in the electricity grid, that relies on increasing variable renewable sources such as solar and wind. The National Hydrogen strategy points out that if managed well, this could lower electricity costs for consumers.[2]

## 3.3.2: RENEWABLE ELECTRICITY CONSUMPTION

In the absence of an established certification scheme for renewable gas, HyP SA requires that the retailer on its behalf purchase and surrender Australian Government-managed GreenPower Large-scale Generation Certificates (LGCs). Purchasing GreenPower LGCs means that the retailer must secure an equivalent volume of renewable electricity to meet 100% of HyP SA's needs.

Because GreenPower goes above and beyond mandated Government Renewable Electricity Targets, HyP SA and similar projects promote further investment in renewable energy by creating an additional market for projects. Since May 2021, HyP SA has used 649 MWh, which is equivalent to the average annual rooftop solar production of more than 80 homes.

GreenPower™

2 Please refer to page 17 of the National Hydrogen Strategy: https://www.dcceew.gov.au/sites/default/files/documents/australias-national-hydrogen-strategy.pdf

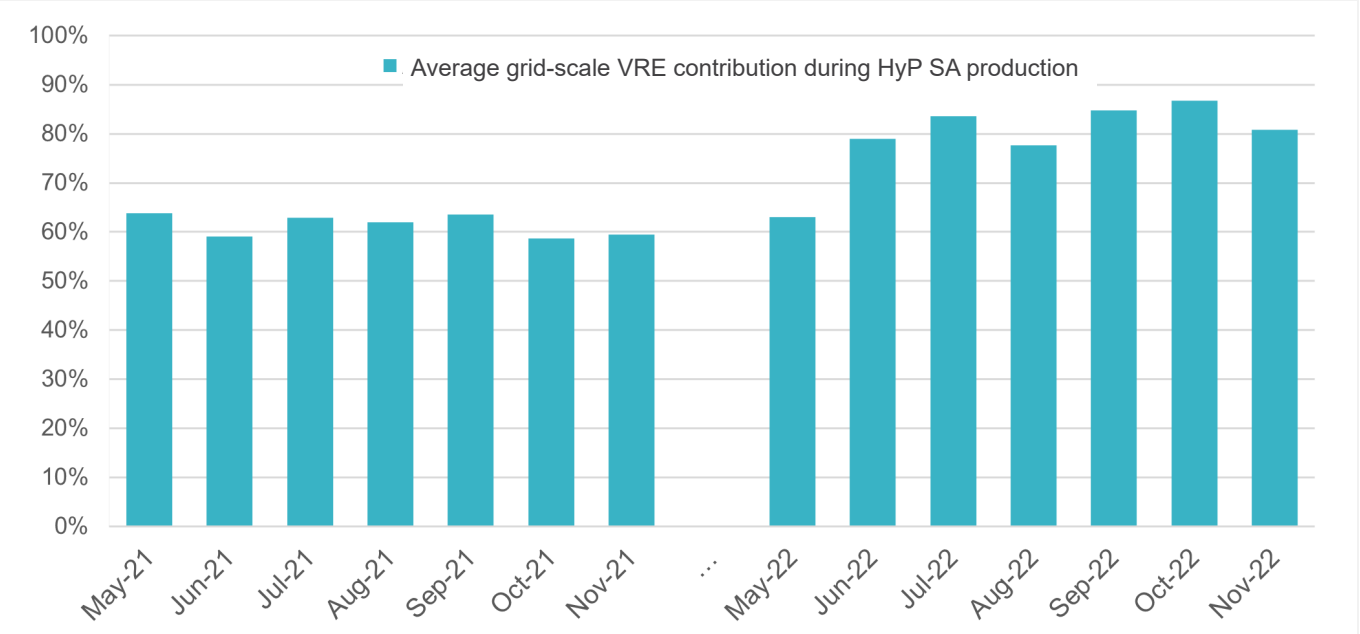



*Figure 11: Average grid-scale Variable Renewable Energy (VRE) contribution*

Figure 11 demonstrates the proportion of grid-scale variable renewable electricity (excluding rooftop solar) HyP SA has utilised on a time-of-use basis, averaging 69% over its lifetime, and 77% from May to November 2022.

Noting small-scale rooftop solar accounted for 16.9% of South Australian energy supply in 2022, and HyP SA operated 65% of the time between 10am and 3pm to target surplus electricity supply driven by roof-top solar, it could be inferred HyP SA's time-of-use renewable electricity consumption for 2022 was likely to be over 93% (i.e. 77% grid scale renewable electricity combined with 16.9% small-scale rooftop solar generation).

Increases in VRE contribution between 2021 and 2022 operations are attributed to improvements in HyP SA's operations from its 24-hour control room, supported by an algorithm that automatically tracks electricity market opportunities.

This optimises the flexible and dynamic electrolyser operations by placing the electrolyser in standby mode to prepare to ramp up in seconds where opportunities to capture low and negative prices prevail (refer Case Study 1). It further avoids exposure to very high electricity pricing.

Figure 12 demonstrates HyP SA's dynamic operations have meant it has captured electricity market pricing at 13% of the cost of the wholesale pricing during its operational period of May to November, and around 10x cheaper for the 2022 calendar year.

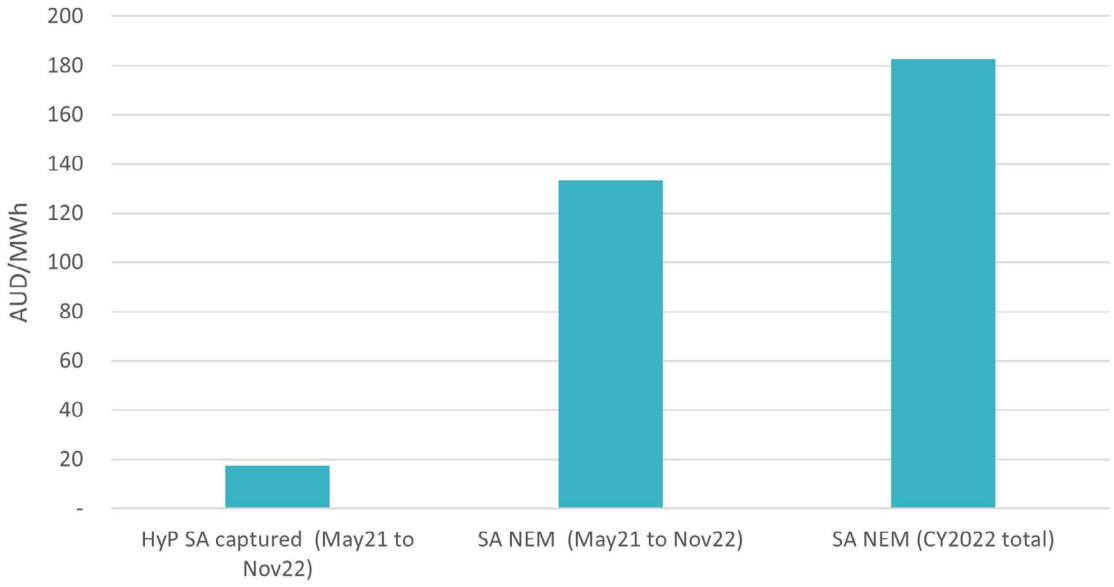



*Figure 12: NEM Pricing comparison*

# CASE STUDY 01

## ESTABLISHING A RENEWABLE GAS MARKET

TO DATE, THE EMISSIONS REDUCTIONS ACHIEVED BY HYP SA'S INTRODUCTION TO RENEWABLE GAS TO NETWORKS ARE NOT RECOGNISED OR INCENTIVISED UNDER ANY SCHEME.

POLICY AND REGULATORY REFORMS THAT INCENTIVISE THE PRODUCTION AND SUPPLY OF RENEWABLE GAS ARE KEY TO DEVELOP A COMPETITIVE MARKET ENVIRONMENT TO ENABLE LEAST COST DECARBONISATION ACROSS THE WIDER ENERGY SECTOR, WHILE PLAYING A KEY ROLE TO SUPPORT RENEWABLE GAS PROJECTS TO MOVE FROM DEMONSTRATION TO COMMERCIAL PHASE.

GREENPOWER IS HELPING TO ESTABLISH A VOLUNTARY MARKET FOR RENEWABLE GAS THROUGH A RENEWABLE GAS CERTIFICATION PILOT TO ENABLE GAS CUSTOMERS TO GREEN THEIR GAS USE IN A SIMILAR WAY TO EXISTING COMMON PRACTICE FOR ELECTRICITY CONSUMPTION OF HOUSEHOLDS AND BUSINESSES.

HYP SA IS ALSO A PILOT PLANT FOR THE AUSTRALIAN GOVERNMENT'S HYDROGEN GUARANTEE OF ORIGIN (GO) CERTIFICATION SCHEME AIMING TO PROVIDE TRANSPARENCY ABOUT CARBON EMISSIONS ASSOCIATED WITH HYDROGEN PRODUCTION.

# CASE STUDY 02

## RENEWABLE ELECTRICITY SOAKING ON A MILD SPRING DAY – 18 OCTOBER 2022

**DAILY TEMPERATURE:** LOW 14.4*C
HIGH 22.4*C

South Australian household energy demand (electricity and gas) is lower on mild, sunny days. This can result in lower and often negative electricity prices, such as on 18 October 2022 when the daily average was $49.23 AUD/MWh (weighted by operational demand).

Figure 13 demonstrates how HyP SA harnessed low and negative pricing occasions driven by excess solar during the day and wind electricity overnight to produce 218.8kg at a weighted average price of -$195.31.

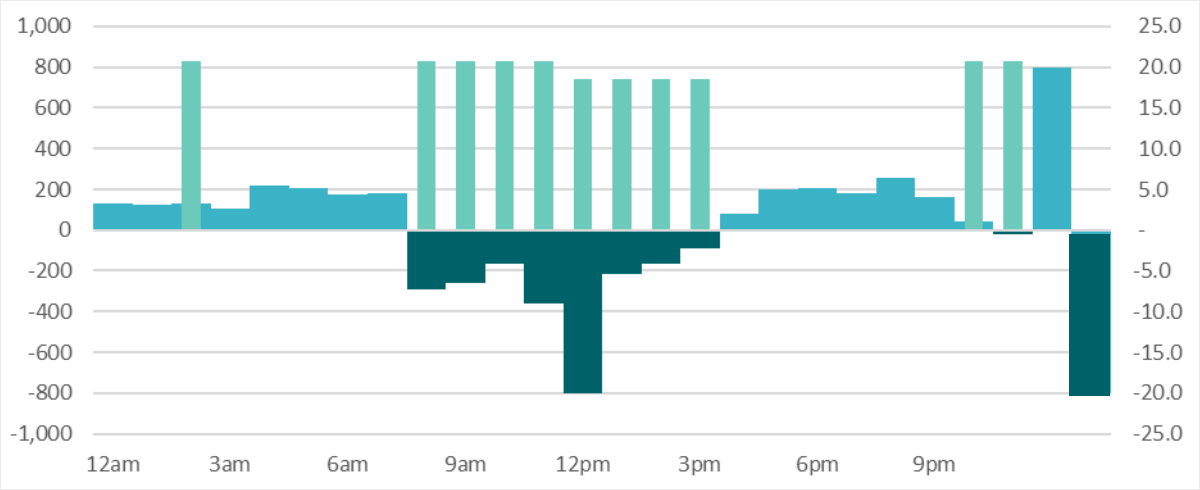



*Figure 13: NEM Pricing and HyP SA Production*

Figure 14 demonstrates that by design, HyP SA's blending operations automatically shut off between 10 and 12pm when very low demand to our 700 homes was experienced.

The majority of hydrogen produced was therefore directed to on-site storage and to tube trailers for industrial supply. It is expected that expansion to more than 3000 additional connections will reduce the occasions low demand causes network blending to shut off.

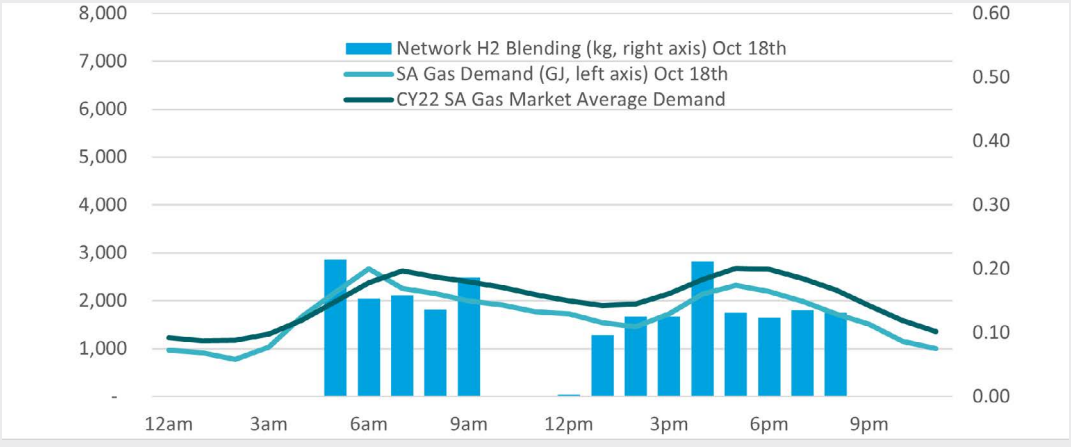



*Figure 14: Hourly blending volumes and Adelaide distributed gas*

# CASE STUDY 03

## GAS PEAK BLENDING ON A COLD WINTER DAY – 21 JULY 2022

**DAILY TEMPERATURE:** LOW 6.4*C
HIGH 16.8*C

South Australian household energy demand (both electricity and gas) is higher on cold winter days. This can result in high electricity prices, such as on on 21 July 2022, the electricity spot market averaged $310.20 AUD/MWh (weighted by operational demand), with a morning peak price of $473.52 (6am to 9am) and evening peak price of $334.17 (6pm to 9pm).

Figure 15 demonstrates how HyP SA did not further constrain the electricity grid during peak times on this day, instead harnessing a short window of low to negative pricing during the middle of the day at a weighted average price of $11 AUD/MWh to produce 41.4 kg of hydrogen to replenish on-site storage and ensure continued blending.

As HyP SA's utilisation increases with additional markets, AGIG may consider the trade-off between investment in additional on-site storage and production during higher electricity price occasions.

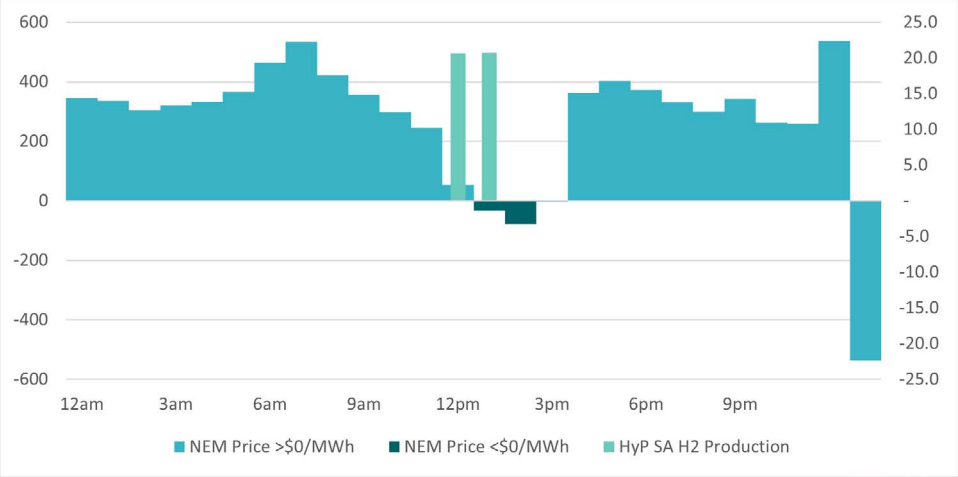



*Figure 15: NEM Pricing and HyP SA Production (21/7/22)*

Figure 16 demonstrates HyP SA's blending equipment responds in real time to higher seasonal network demand, as well as intra-day peaks during mornings and evenings.

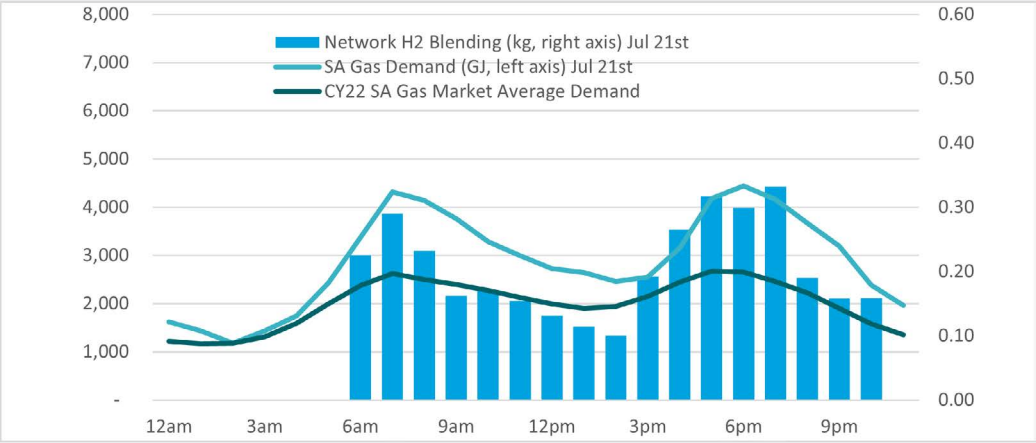



*Figure 16: Hourly blending volumes and Adelaide distributed gas (21/7/22)*

## 3.4: WATER CONSUMPTION

HyP SA's water is supplied from the local network via a typical potable water connection. Analysis in this section is based on billing data with electrolysis representing a portion of total water used at site, with the remainder being utilised by balance of plant and general purposes.

Current technology electrolysis requires that potable water is purified at site to what commonly referred to as ultra-pure water. The HyP SA electrolyser's total use of ultra-pure water (including electrolysis, start-up, faults and purging process) is estimated to represent the same annual amount as 7.2 South Australian households.

Electrolyser water use efficiency at site increases with use, with recent high hydrogen production periods consuming 15 litres of ultra-pure water per kilogram of hydrogen produced, compared with an average of 21.7 litres per kilogram in the initial phase of production. It is expected that increased use through gas network expansion will bring ultra-pure water consumption to around 14.7 litres per kilogram.

A significant portion of the potable water used to produce ultra-pure water at site is re-circulated and re-used through the purification process with total efficiency presently unknown. A learning has been to refine our understanding of water use for the full purification process through the installation of additional water meters. We will continue to report to key stakeholders on water use at site through existing channels.

### FUN FACT

Since commencing operations, HyP SA's hydrogen production process has consumed the equivalent volume of ultra-prue water to 7.2 average South Australian households.


The AHC's South Australian 100% Statewide Study anticipates that large-scale renewable hydrogen production will require around 20 litres of raw water per kilogram of hydrogen produced, finding 0.3% of total annual physical water consumption in South Australia in 2019-20 would be required to deliver 100% hydrogen in networks throughout South Australia[3].

Hydrogen production does not necessarily require high quality water supply and can avoid competition with existing demands for these sources by drawing on lower quality options, including surface water, groundwater, seawater, and recycled wastewater.

## 3.5: OXYGEN PRODUCTION

Oxygen is a by-product of electrolysis with potential offtakes and revenue opportunities through several industrial uses. HyP SA has averaged 8 kilograms of oxygen per kilogram of hydrogen produced.

There is a desire to commercialise the oxygen value stream at HyP SA, particularly as production increases result in higher oxygen yelds.

### FUN FACT

Since commencing operations, HyP SA has released 140 tonnes of oxygen to atmosphere, equivalent to the annual oxygen production of approximately 1,189 trees.

There is growing recognition exploring the symbiotic relationship between oxygen and other renewable gases as part of a potential path to accelerate the commercialisation of Australia hydrogen industry. Pure oxygen is a valuable resource to wastewater treatment plants, increasing the efficiency of the energy-intensive aerobic treatment processes most commonly adopted by the industry.

Multiple leading studies have suggested co-locating waste-water treatment plants and hydrogen production facilities, alongside other demand could springboard hydrogen infrastructure development. AGIG's proposed 10 megawatt Hydrogen Park Murray Valley (HyP MV) project has purposefully co-located with a waste water treatment plant as a potential off taker of oxygen.

3 Australian Hydrogen Centre, 2022. Hydrogen Production, Storage, and Transmission. In 100% State-Wide Distribution Networks Study – South Australia.

# 04. NETWORK PERFORMANCE

THE RENEWABLE HYDROGEN PRODUCED AT HYP SA IS BLENDED WITH NATURAL GAS TO SUPPLY MORE THAN 700 HOMES IN THE SOUTHERN PART OF MITCHELL PARK. THESE CUSTOMERS RECEIVE AUSTRALIA'S LOWEST CARBON GAS THROUGH THE EXISTING NETWORK AND PAY NO MORE THAN IF THEY WERE RECEIVING 100% NATURAL GAS.

## 4.1: SUMMARY

HyP SA has driven significant findings about gas quality and network monitoring when using hydrogen in gas distribution networks. These regard how gas performs when exchanging from natural gas to blended hydrogen gas, and its impact on network maintenance and operation, including:

- Network piping and component materials;
- Network capacity;
- Regulatory and safety considerations; and
- Downstream considerations and appliance compatibility.

Up until the 1960s and 1970s, around 50% of the 'town gas' delivered to customers by South Australia's gas distribution networks was hydrogen.

## 4.2: OVERVIEW OF DISTRIBUTION NETWORK

The gas distribution network is in Mitchell Park, next to the Tonsley Innovation District. This area was selected because it is a representative sample of Australian residential suburbs and has typical network characteristics; making it highly replicable as a utility installation of the future.

It was originally built in the 1950's and upgraded in 2010 with modern polyethylene (plastic) piping, providing a high degree of confidence in its capacity to safely and reliably transport high volumes of hydrogen.

As discussed in Section 2, Mitchell Park is a highly diverse suburb with a mix of residents in terms of income levels, age groups, and cultural and ethnic backgrounds. There is an equal mix of homeowners and renters, with renters split evenly between private rentals and public or social housing.

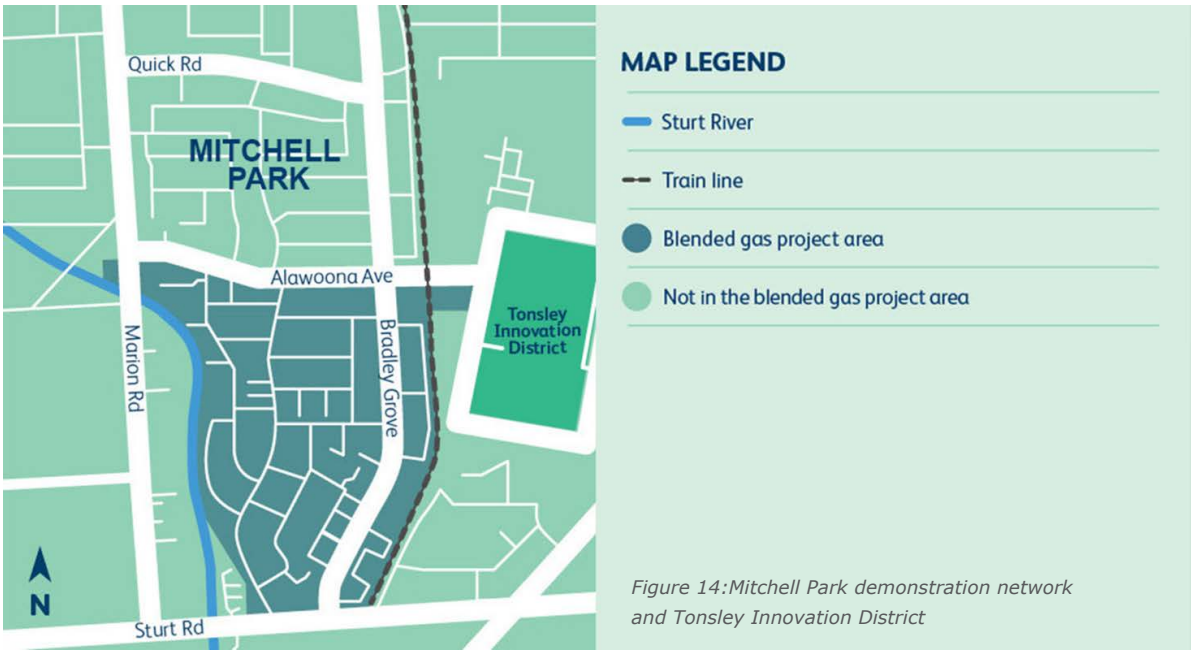



*Figure 14:Mitchell Park demonstration network and Tonsley Innovation District*

## 4.3: PREPARATION FOR BLENDING

While it is recognised that 5% hydrogen has characteristics in line with the Australian Standard AS/NZS 5601.1:2022 for gas, a number of measures ensured best practice process safety was implemented.

### 4.3.1: NETWORK SECTIONALISATION

Standard network isolation valves were installed to sectionalise the blended gas project area from the remainder of the South Australian gas distribution network. This work ensured only those customers in the target area would receive blended gas and could be easily reversed to facilitate future expansion of the blended area (refer Section 4.6). Customers were advised that they might notice these minors works taking place, however no disruption to network supply was caused by these minor works.

### 4.3.2: MATERIAL AND COMPONENT CAPABILITY

As part of South Australia's ongoing network maintenance program, common components in gas distribution networks such as meters and regulators are frequently inspected, with older-generation components replaced as they reach the end of their useful life. The Mitchell Park blended gas area was inspected prior to first blending to ensure all components were compliant with relevant standards.

### 4.3.3: APPLIANCE AUDITS

Gas appliances sold in Australia are designed to operate efficiently and effectively with varying gas compositions to account for the varying sources of gas supplied around Australia. One "limit" gas  appliances are tested against contains 13% hydrogen, and therefore certified household gas appliances sold in Australia have undergone a range of safety tests with this level of hydrogen.

Further rigorous appliance testing led by the Future Fuels Cooperative Research Centre have proven that the majority of existing home appliances will work safely, reliably, and effectively with up to 10% hydrogen blends with research underway to determine the maximum acceptable upper limit[5]. These findings are in line with international projects that are supplying a 20% blend. For more on these international projects, please refer to the Hy4heat[6] and the H21[7] projects.

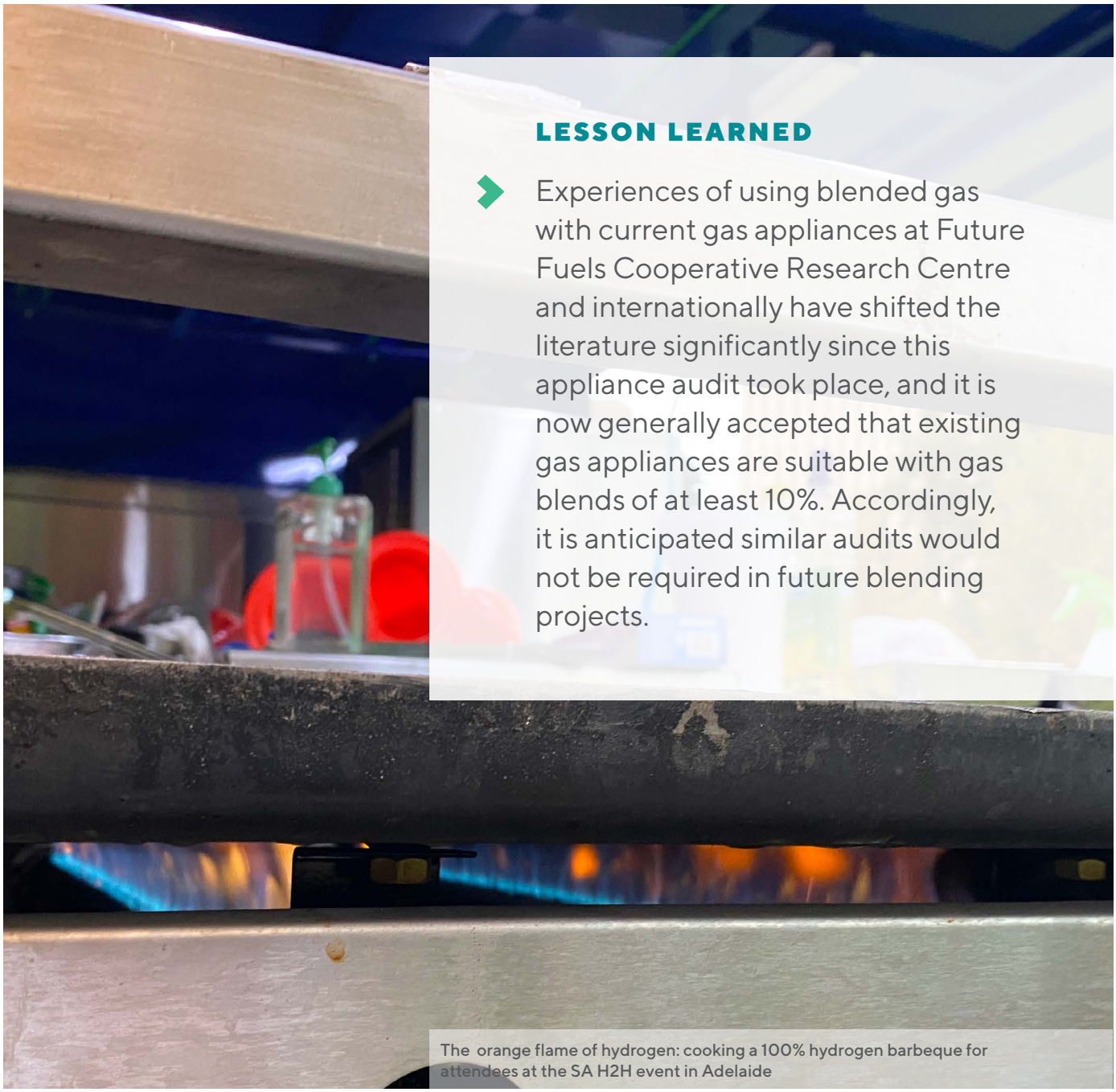
5 Future Fuels CRC, Compatibility of end user equipment with future fuels (RP1.4). Report can be found at: <https://www.futurefuelscrc.com/program_area/compatibility-of-end-user-equipment-with-future-fuels-rp1-4/>
6 For more information on the Hy4Heat project, please visit: https://www.hy4heat.info/
7 For more information on the H21 project, please visit: https://h21.green/

The South Australian Office of the Technical Regulator (OTR) recommends testing and maintenance of appliances by a qualified technician every two years.

In line with the OTR's recommended maintenance schedule and to provide further assurance as to the general condition and operability of typical gas appliances installed in the blended gas area, appliance inspections were offered to customers at no cost.

These inspections enabled AGN to gather information about the number, type, and condition of appliances being used in a typical South Australian household and to ensure appliances were installed correctly in line with relevant Australian Standards. There were 90 participating households, representing a statistically relevant sample of over 10% of the total customer base.

Of the 90 participants, the general condition of appliance was good, with only one appliance identified as being unfit to operate safely on 100% natural gas. This was replaced for the customer with a new appliance.



### LESSON LEARNED

Experiences of using blended gas with current gas appliances at Future Fuels Cooperative Research Centre and internationally have shifted the literature significantly since this appliance audit took place, and it is now generally accepted that existing gas appliances are suitable with gas blends of at least 10%. Accordingly, it is anticipated similar audits would not be required in future blending projects.

The orange flame of hydrogen: cooking a 100% hydrogen barbeque for attendees at the SA H2H event in Adelaide

## 4.3.4: NETWORK TESTING

Stakeholder engagement activities revealed a common concern that hydrogen may leak more readily from gas distribution networks due to its smaller molecule size[8]. A series of leak surveys of the demonstration network were undertaken to quantify this concern.

Leak surveys were conducted prior to blending to establish a baseline, not long after blending commenced to determine any immediate impacts, and at 12 months of operations to assess any long-term impacts. No evidence of leaks was found in the Mitchell Park project area during any of the surveys. This is as expected for a well-maintained polyethylene network and is a useful datapoint for future blending projects.

These results validate the hypothesis that polyethylene mains and polymer-based joints and sealants used in Mitchell Park demonstration network would perform as normal with blended gas.

8 ARENA and UQ, The Australian public's perception of hydrogen energy, December 2018. Report can be found at: <https://arena.gov.au/assets/2018/12/the-australian-publics-perception-of-hydrogen-for-energy.pdf>

## 4.3.5: SAFETY, RELIABILITY, MAINTENANCE AND TECHNICAL MANAGEMENT PLAN (SRMTMP)

The SRMTMP is the operating plan for the network which outlines the controls, process and procedures in place to minimise risks identified through the Formal Safety Assessment (FSA).

A FSA was conducted prior to blending to assess the effectiveness of existing operational controls on a blended gas network. The SRMTMP was subsequently updated to include specific learnings from the FSA and to add a third type of covered network (blended hydrogen) to the existing natural gas and liquified petroleum gas (LPG) types.

This review and update was conducted as part of the normal annual review process which ultimately leads to consideration and endorsement by the South Australian Office of the Technical Regulator (OTR).

## 4.3.6: OFFICE OF THE TECHNICAL REGULATOR ENDORSEMENT

The role of the OTR is to monitor and regulate the safety and technical standards for electrical, gas and plumbing installations in South Australia. The OTR conducts a range of activities and oversees the administration, compliance and performance of organisations that operate in these industries.

AGN engaged early with the OTR and maintained an ongoing, open, dialogue on concerns and learnings as this project progressed. Regular project updates, involvement in risk identification processes and an interest in resolving all queries and concerns ensured all parties remained comfortable that public safety was the number one priority.

Through this engagement it became clear that a detailed and conservative commissioning plan was an important final piece of the blending preparatory work. This commissioning plan included specific hold points which allowed assumptions and progress to be tested before the full rate of hydrogen blending was implemented.


HyP SA's 1.25MW Siemens Electrolyser

## 4.4: BLENDING PERFORMANCE

South Australian gas demand is 2.8 times higher in winter than summer. In a similar profile to electricity, gas demand experiences intra-day peaks in the morning and evening when users cook, clean and heat. This demand variability necessitates a reliable real-time response to supplying renewable gas for blending with natural gas on a daily and seasonal basis.

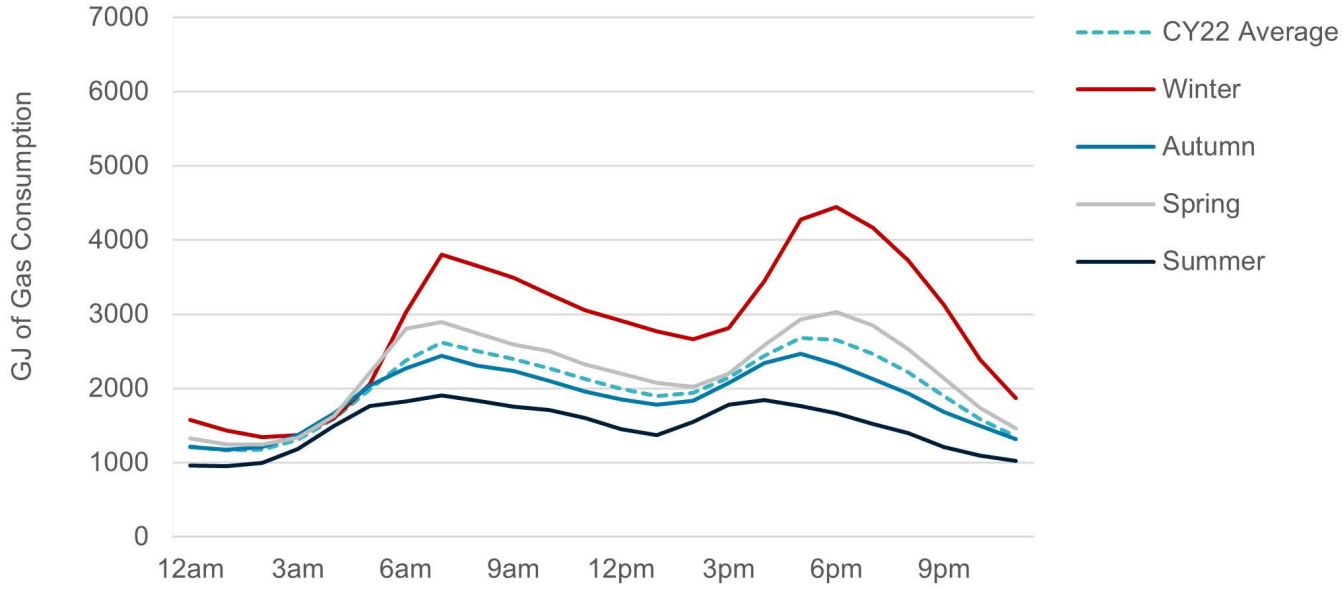



*Figure 18: Average daily gas consumption profile in different seasons*

Figure 18 demonstrates the ability of HyP SA's blending equipment to apply up to 5% renewable hydrogen in line with trends of Adelaide's intra-day gas use demand.

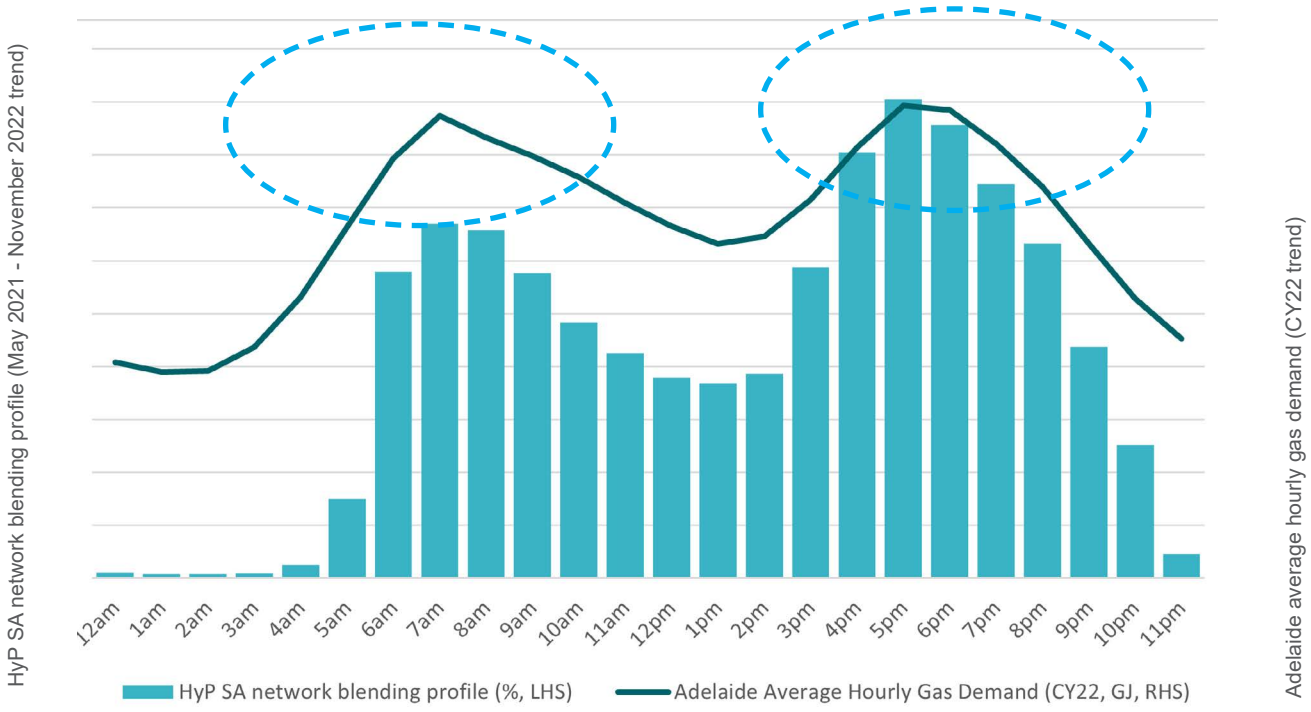
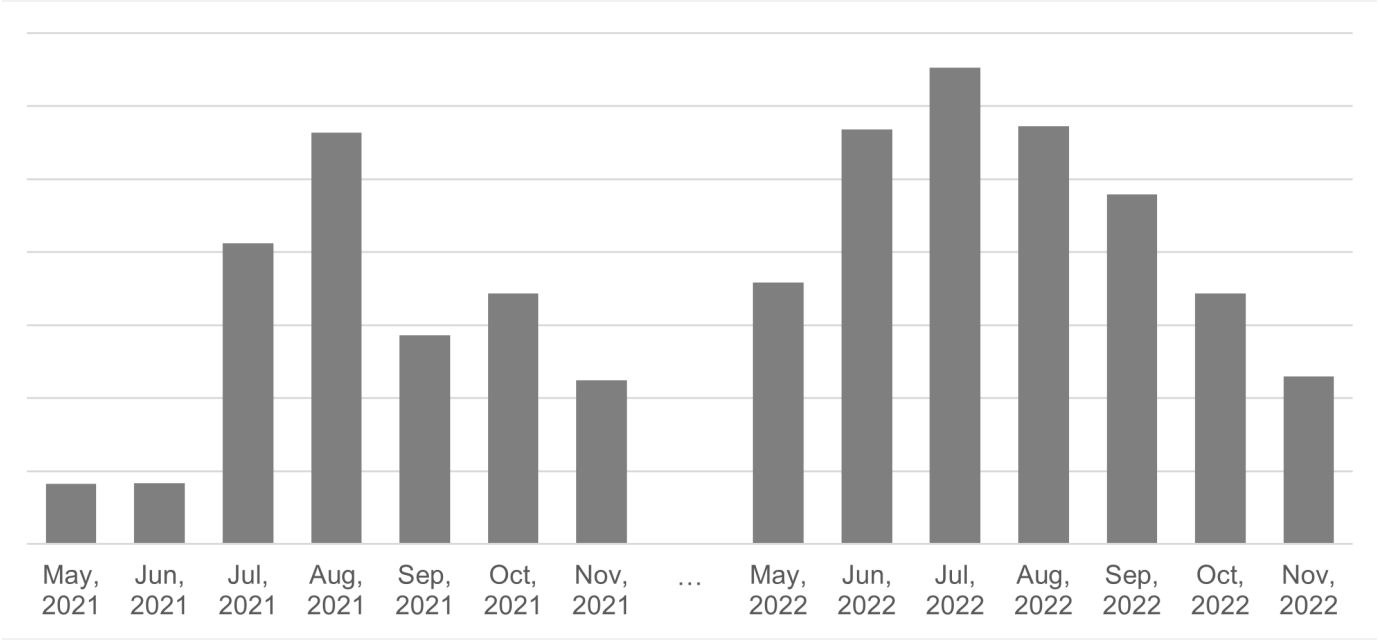



*Figure 19: Hourly blending volumes versus distributed gas demand in Adelaide (CY22)*

Figure 19 demonstrates that higher winter gas consumption provides more demand and opportunities for hydrogen blending.




(May 2021 - November 2022 trend)

*Figure 20: Monthly blending volumes, kg of hydrogen*

Figure 20 demonstrates variable injection volumes, suggesting an ability to respond to swings in demand driven by weather.

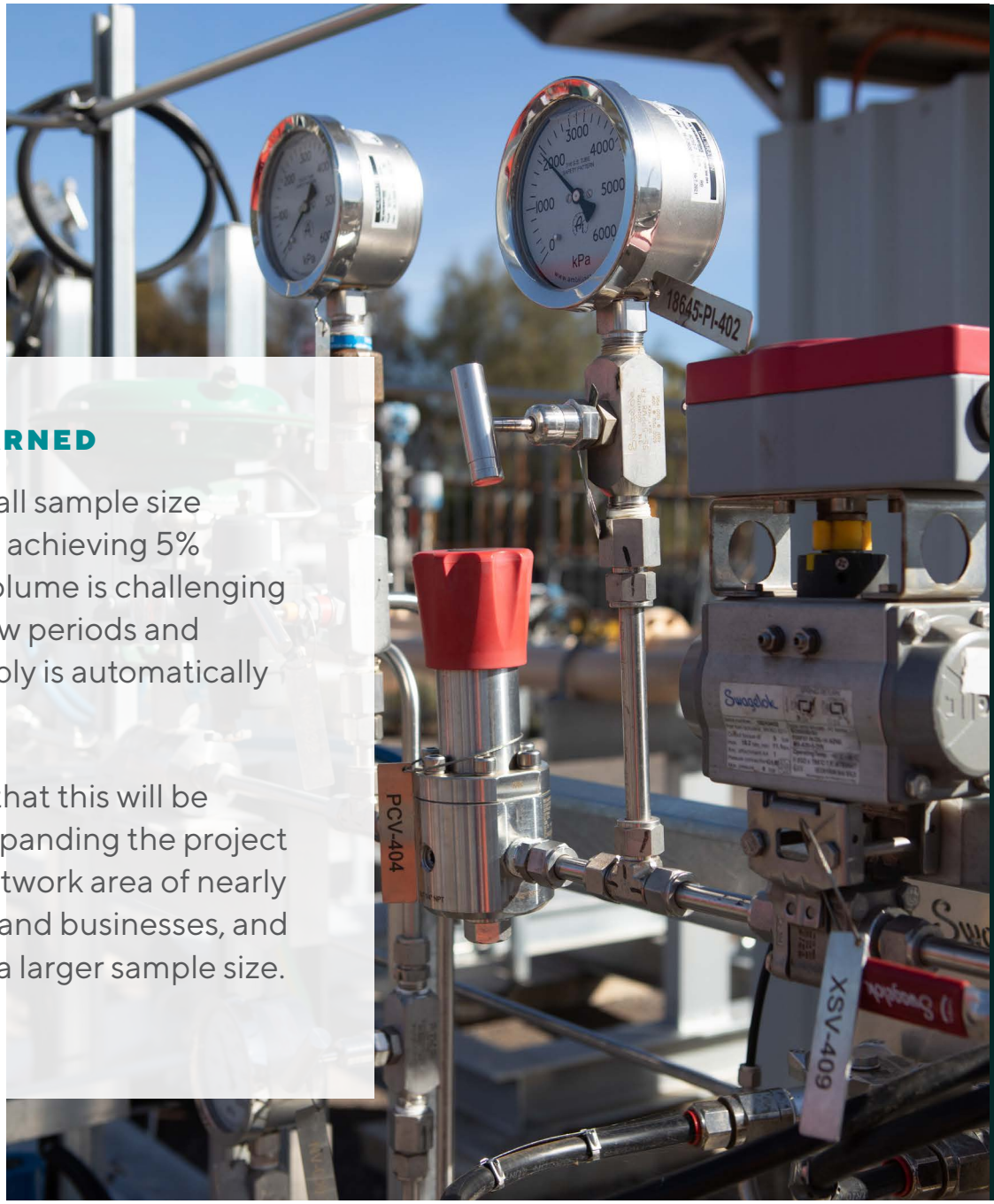
## 4.4.1: CONTROL OF BLEND RATIOS

The hydrogen blending control system is a critical control to ensure the gas blend remains within allowable limit. A hydrogen analyser was installed downstream of the blending unit to analyse the thermal conductivity of the blend delivered in the blended gas area.

This control system was validated by downstream measurement with results showing that the blending unit provides a very good level of control.

A learning has been the blended gas area can experience low network flow at periods of low network demand (such as overnight in summer) due to its relatively small number of customers. Low flow challenges the current blending control system as the amount of hydrogen that can be blended and still meet the 5% limit is too small to be accurately measured. In these situations, blending is automatically halted until flows increase to flow against which a 5% renewable gas match can be applied.

During operational periods in 2022, HyP SA's blending operations have averaged 60% utilisation, with most of the remainder reflecting low flow occasions. It is anticipated that expanding the network to an additional 3000 homes will significantly decrease this occurrence.




## LESSON LEARNED

Due to the small sample size of 700 homes, achieving 5% blending by volume is challenging during low-flow periods and hydrogen supply is automatically halted.

It is expected that this will be resolved by expanding the project to a greater network area of nearly 4,000 homes and businesses, and subsequently a larger sample size.

Australian Hydrogen Centre

HyP SA's demonstration complements detailed work by the Australian Hydrogen Centre that finds existing gas distribution networks are suitable for transporting 10% blended gas today and will be 100% hydrogen ready with minimal works undertaken as part of existing network maintenance programs.

**For more information, please refer to ARENA's Knowledge Bank.**

## 4.5: NETWORK PERFORMANCE

### 4.5.1: NETWORK CAPACITY

Theoretically, it was considered that the project area network capacity would reduce because of the lower heating value of hydrogen compared to natural gas. Network modelling using standard processes adapted for hydrogen blending validated that network capacity reduction was immaterial at around 0.5-0.75%.

Considering the differences in physical properties between natural gas and hydrogen including energy density and flow, the AHC's State-Wide 100% Hydrogen Studies found 100% hydrogen could slightly reduce the networks' overall capacity by around 13%. The network can absorb this minor reduction with enough available capacity to maintain current supply levels.

### 4.5.2: NETWORK GAS QUALITY AND ODORANT LEVELS

Post operational testing confirmed that the blended gas quality remained within AS 4564:2020 General-purpose Natural Gas quality limits. Testing was conducted by a National Association of Testing Authorities (NATA) accredited laboratory using samples gather from various point in the network as detailed below.

Gas quality testing was undertaken for three reasons:

- to validate consistency of blend achieved by the injection equipment;
- to validate the degree of dilution/interaction of hydrogen with gas odorant; and
- to validate if blended gas stayed mixed in the distribution network.

Testing took place on two occasions:

- June 2021 (at the commencement of HyP SA operations);

  This round of testing focused on injection skid and initial network blending. Samples were taken from all testing sites (red and blue pins) in Figure 19 across several days.

- May 2022 (around 12 months post-operations)

  This round of testing focused on network blending consistency. Samples were taken from 4 testing sites (red pins) in Figure 19.


*Figure 22: Mitchell Park gas quality and odorant testing locations*

### 4.5.3: NETWORK EQUIPMENT PERFORMANCE

To assess the impact of hydrogen on the condition and operation of network equipment a sample of domestic meters and service regulators were removed from the network after 12 months of hydrogen blending. These were independently tested and internally inspected by a NATA accredited laboratory to check the performance of metallic and 'soft' components (elastomers) within the equipment. This testing showed no indication of leaks or degradation in performance or damage to components in this equipment.

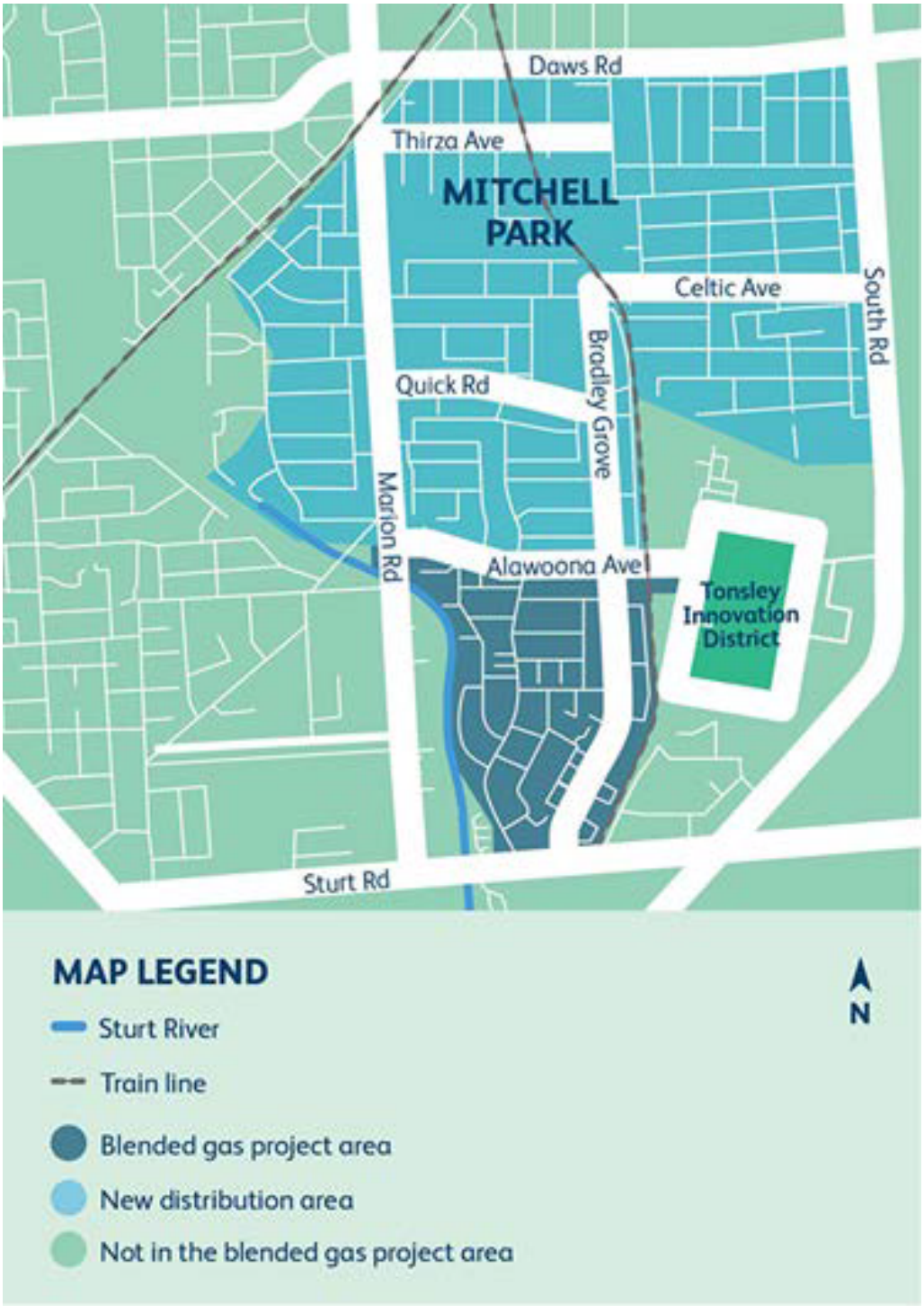
As described in section 4.3.5 leak surveys were also conducted on the entire blended network immediately after blending commenced, and 12 months later. Consistent with expectations, no leaks were detected at either of the surveys which is common for a modern polyethlene network such as in the blended gas project area.

## 4.5: NETWORK EXPANSION

In June 2023, AGN announced that it has expanded the supply of blended renewable hydrogen in South Australia, increasing from 700 homes to nearly 4,000 homes and businesses in Mitchell Park, Clovelly Park and parts of Marion.

HyP SA is also now delivering blended renewable hydrogen gas to the brand new, 4.5 star La Loft Hotel, making it Australia's first commercial property to use a renewable hydrogen blend.

The expansion also includes a range of other small businesses and schools, as well as thousands of households who have been actively engaged throughout development of HyP SA.



# 05. MARKET ENABLERS AND OPPORTUNITIES

## 5.1: INNOVATION IMPACTS

In addition to technical and community engagement outcomes summarised in this report, wider benefits from HyP SA's development include:

- **Upskilling energy sector workers**

Upskilling professionals, technicians, tradespeople, engineers, and first responders throughout the energy industry as well as the public sector. Its construction phase alone required over 100 personnel providing equivalent 16 full time equivalent roles and over 30,000 hours of employment.

- **Creating new types of jobs**

On an ongoing basis, it has created new roles including a dedicated Hydrogen Facilities Manager. Renewable hydrogen production and delivery is now business-as-usual for AGN, as we seek to deliver more projects and achieve our vision of 100% renewable gas networks.

- **Skills and training collaborations**

AGIG has signed a Memorandum of Understanding for the Hydrogen Training Collaboration Framework between government, industry and education and training organisations in South Australia.

As part of the initiative, AGIG has worked with TAFE SA Tonsley Campus Plumbing and Water School to develop a 'Hydrogen Fundamentals' short course utilising a 3D scan of HyP SA, as well as the potential display of 100% hydrogen appliances.

- **Positive Media Coverage**

HyP SA has featured in local and international television, radio and print media, with more than 500 pieces between January 2021 and March 2022 with a cumulative reach of 179 million views at an equivalent advertising value of $2.7 million.

Analysis of all media coverage indicated that the tone was consistent at neutral to positive, with no negative sentiment recorded.

- **Awards**

HyP SA has been widely recognised for its innovation and engagement outcomes with the following commendations:

**2020 Australian Engineering Excellence Award, Engineers Australia;**

**2020 Environment Award, Australian Pipelines and Gas Association;**

**2020 Business and Industry Award, SA Climate Leaders Awards;**

**2022 Hydrogen Project of the Year, MENA Future of Hydrogen Awards; and**

**2022 Energy and Mining Community Engagement Award, South Australian Premiers Awards**

In line with its engagement principles, AGIG is committed to continued engagement and knowledge sharing with government, industry and other key stakeholders to work together to establish a renewable gas market.

## 5.2: MARKET OPPORTUNITIES

This Report illustrates HyP SA has achieved a technically successful demonstration of hydrogen production and network blending. It also outlines a promising pathway for expansion through recent commencement of industrial supply and network expansion.

Between May 2021 and August 2022, HyP SA's production capacity has been constrained by demand from its demonstration market, of around 700 households in Mitchell Park. While HyP SA has produced over 10 tonnes since May 2021, over 150 tonnes of hydrogen could be produced per annum if it was allowed to run unconstrained outside of maintenance periods.

Unlocking HyP SA's future markets requires consideration of capital and operating costs. Operating costs are primarily driven by electricity costs where there is significant opportunity for HyP SA to further capture increasing negative price occasions in the electricity market. For instance, a ~30% utilisation rate modelled on targeting the lowest 30% of electricity market prices in 2022 would have captured an average NEM price of negative $25/MWh.

Increased utilisation at site also improves operational factors including greater water efficiency and more consistent overall production. The following sections outline network blending, industrial supply and fuel cell opportunities to support HyP SA's commercial pathway. Note research and development, skills and training, and oxygen value stream opportunities also form part of HyP SA's wider commercial strategy.

### 5.2.1: NETWORK BLENDING

HyP SA demonstrates there is an established market for renewable hydrogen in which megawatt-scale projects can supply to, which customers support and expect to see more of into the future.

Expanding the delivery of up to 5% renewable blended gas to more than 3,000 households, businesses and schools in Mitchell Park, Clovelly Park and parts of Marion increases HyP SA's production capacity by a factor of approximately 4-5 times.

While this expansion is an important next step, Figure 23 demonstrates the near-term potential for large-scale renewable gas blending across South Australia. Depending on the operating model including electrolyser capacity factor, a 5% volume blend for all of South Australia's distributed gas use could be achieved by a facility 25 times HyP SA's production capacity, and 50 times for 10% blending.

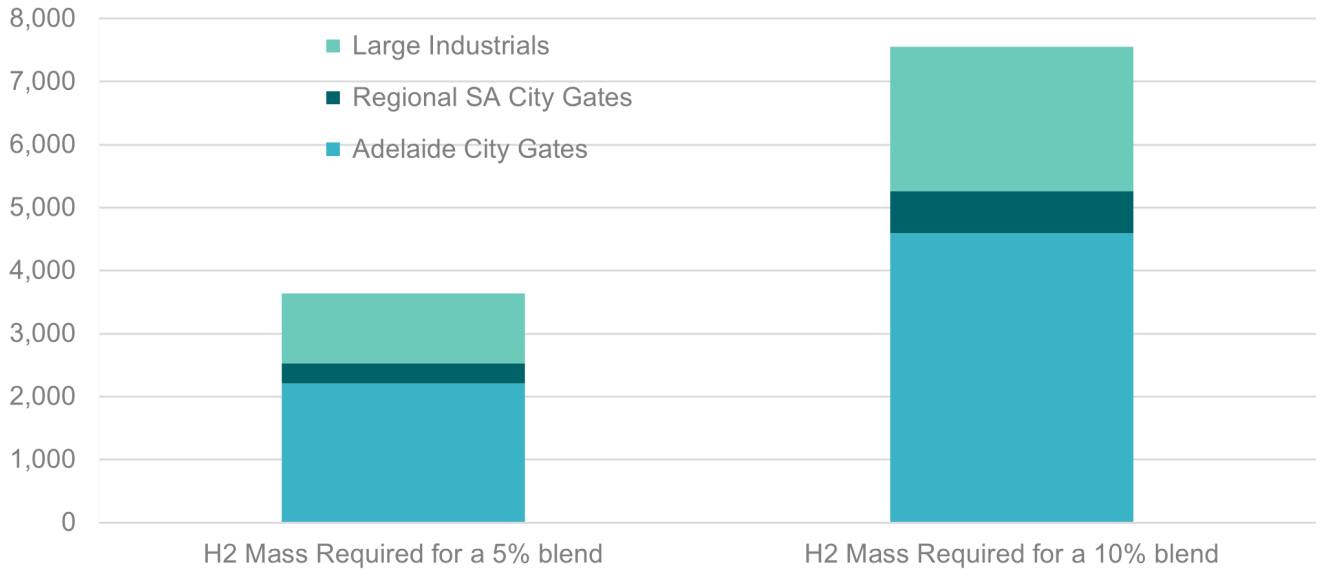



*Figure 23: Hydrogen tonnes required for distributed gas blending across South Australia*

To date, the emissions reductions achieved by HyP SA's introduction to renewable gas of networks are not recognised or incentivised under any scheme. Policy and regulatory reforms that incentivise the production and supply of renewable gas are key to develop a competitive market environment to achieve least-cost decarbonisation.

Incentive scheme development could benefit from the success of Australia's renewable electricity sector, which is now considered mature having achieved significant cost reductions over time through a range of mechanisms such as the Renewable Energy Target.

9 This calculates the hydrogen required to achieve 5% and 10% volume while ensuring the same throughput of energy content.

## 5.2.2: INDUSTRIAL SUPPLY

In October 2020 AGIG and BOC, a Linde company, announced a planned partnership for HyP SA to produce renewable hydrogen for transport to BOC's Whyalla processing plant, replacing previous deliveries from Victoria.

Operations commenced in August 2022 as part of another Australian-first. The partnership eliminates the need for local industry to source hydrogen from interstate, saving 117,000 km of driving and 122,000 kgs of related carbon emissions annually.

The partnership represents a strong uplift in HyP SA's production and its first commercial agreement for hydrogen sale.

There remains significant opportunity for HyP SA to supply further renewable gas to market, whether it be via the direct supply model applied in the current example, or through a certificate trading scheme as is common practice in the electricity market.


Key industry and government stakeholders with AGIG CEO and representatives to commemorate the first tube trailer supply to Whyalla

## 5.2.3: FUEL CELLS

One of the most exciting prospects for hydrogen is the transport sector, with analysis by the International Energy Agency already showing hydrogen to be cost-competitive in selected uses.

Based on a standard assumption of 27 kg/day per heavy vehicle, HyP SA has capacity to fill 15 hydrogen fuel cell electric buses or trucks per day, or sustain a fleet of hundreds of passenger vehicles or forklifts.

AGIG is committed to working with partners across the supply chain to "seed" the establishment of hydrogen transport in South Australia. Options to co-locate refuelling infrastructure at HyP SA or transport the hydrogen to an off-site hydrogen refuelling station(s) exist.

AGIG is a member of South Australian Hydrogen Hubs Incorporated (SA-H2H), which in December 2022 called for expressions of interest to supply hydrogen refuelling stations based in strategic locations across the state[10].



Toyota Mirai hydrogen-fuelled vehicle on site at HyP SA

10 https://gateway.icn.org.au/project/4770/south-australian-hydrogen-hubs-inc-hydrogen-technology-cluster

# CONCLUSION

THIS REPORT DEMONSTRATES HYP SA HAS ACHIEVED A TECHNICALLY SUCCESSFUL DEMONSTRATION OF HYDROGEN PRODUCTION AND NETWORK BLENDING, AS WELL AS STRONG ACCEPTANCE FROM THE COMMUNITY.

It also outlines a promising pathway for expansion through recent commencement of industrial supply and network expansion, with a number of future opportunities including fuel cells.

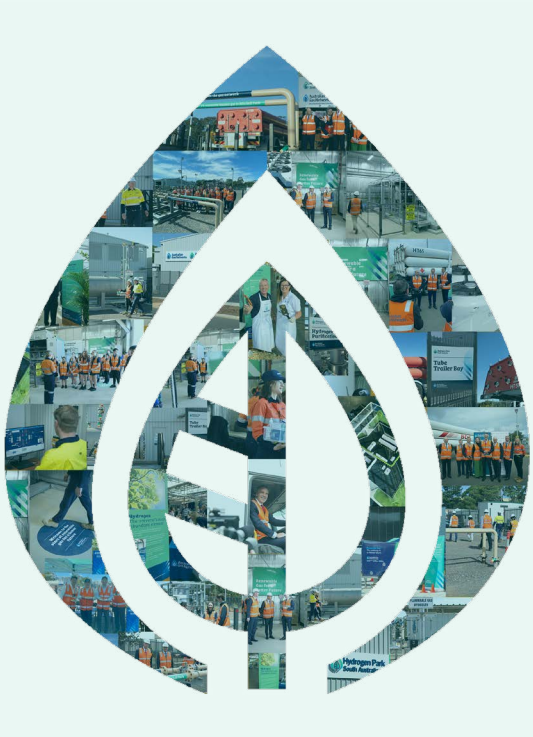
This HyP SA Knowledge Sharing report is part of a series of reports developed by the Australian Hydrogen Centre. These reports inlude:

- **10% Hydrogen Distribution Networks in selected Regional Towns in Victoria and South Australia**
- **10% and 100% Hydrogen Distribution Networks – South Australia Feasibility Study.**
- **10% and 100% Hydrogen Distribution Networks – Victorian Feasibility Study.**

Please refer to ARENA Knowledge Bank for more information: https://arena.gov.au/knowledge-bank/

For more information about HyS SA and AGIG's wider renewable gas development please refer to: https://www.agig.com.au/

HyP SA site exterior at Tonsley



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