PITT STREET RESEARCH

Pure Hydrogen Corporation Limited

Capturing hydrogen value

Share Price: A$0.21

ASX: PH2

Sector: Energy

***10 September* 2021**

Pure Hydrogen Corporation Limited (ASX: PH2) is an emerging energy play that offers investors a unique exposure to both hydrogen and gas. PH2 came to its listing life on the back of a merger between two small oil & gas plays, Real Energy Corporation Ltd and Strata-X Energy Ltd. Following the merger, management decided to transform the business to fit a cleaner energy theme, hydrogen. Given hydrogen is becoming an important clean energy transition pillar, we think the underlying market will likely experience structural growth over the long term. This backdrop is favourable for PH2 as it builds up its hydrogen business.

A unique hydrogen developer

In our view, PH2 has a unique technology proposition driven by its multiple competitive advantages 1) a modular plant model, which ensures production scalability, 2) a methane pyrolysis method to produce turquoise hydrogen at c.1,500kg/day, which offers a cost advantage versus competitors trying to rely on the water electrolysis green hydrogen model, 3) high-value solid carbon by-products such as graphite that can be sold to earn an extra revenue stream, and 4) an early mover with a developed technology. We expect PH2's strong competitive position to help it gain shares in both the domestic and export markets, when and if its projects reach commercialisation.

Currently, PH2 is working on five hydrogen projects. Its near-term focus is to achieve commercial production at its initial hydrogen hub located at Miles, Queensland. Various parts of the supply chain have been rapidly assembled, with first production expected in 2H 2022.

An underappreciated gas business

PH2 also operates a diversified portfolio of gas assets that aims to develop unconventional gas resources in Australia and Botswana. It has a 2C Contingent Resources of c.460PJ, with a portion of this expected to convert to 2P Reserves in the near term. Further, the Australian East Coast gas market is widely anticipated to experience a supply gap by c.2023, which we think will be a positive for PH2.

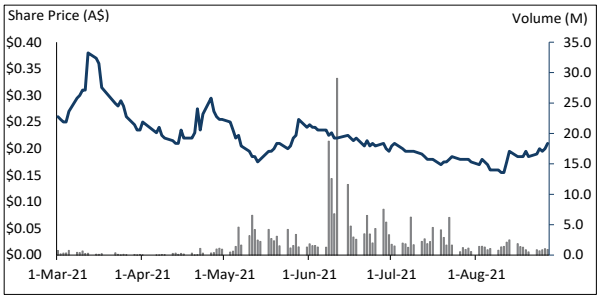
Valuation of A$0.60 per share

We value PH2 at A$0.60ps base case and A$0.83ps bull case using a sum-of-the-parts approach. We estimate either the hydrogen or water business alone should sufficiently justify the current share price of A$0.21ps. Refer to our valuation and risk chapters for more detail.

Market Cap. (A$ m)	67.5
# shares outstanding (m)	321.2
# shares fully diluted	351.5
Market Cap Ful. Dil. (A$ m)	73.8
Free Float	84.9%
52-week high/low (A$)	$0.44 - $0.15
Avg. 12M daily volume (m)	2.2
Website	purehydrogen.com.au

Source: Company, Pitt Street Research

Share price (A$) and avg. daily volume (m, r.h.s.)



Source: CommSec, Pitt Street Research

Valuation	
Sum-of-the-Parts Valuation (A$ per share)	0.60 – 0.83

Source: Pitt Street Research

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Investment thesis

Introducing Pure Hydrogen (ASX: PH2) – New name, new story

We initiated coverage on Real Energy, precursor to Pure Hydrogen (ASX: PH2), back in late 2019. A copy of the report can be found here. Since then, management had made solid progress with its gas business. Importantly, they transformed the business to fit a new structural growth theme, hydrogen.

Following its merger with Strata-X Energy, management renamed its merged entity Pure Hydrogen Corporation Limited (ASX: PH2). As reflected by its new name, PH2 aims to supply hydrogen as a clean energy solution to the global market. The merger with Strata-X not only diversified PH2's gas portfolio, but also injected a fresh hydrogen initiative. Hence, PH2 currently operates two energy businesses – hydrogen and natural gas. While these businesses can operate on a standalone basis, they can also help each other to create synergies and achieve internal production optimisation.

Strong competitive position in producing hydrogen

As hydrogen becomes an increasingly important clean energy source in our transition to a decarbonised economy, businesses that are tapping into this lucrative and structurally growing market are likely to reap large long-term profits, in our view. Locally, we already seeing a number of small hydrogen players emerging across the country, with most of them trying to produce different types of hydrogen via unique production processes. We believe PH2's technology is differentiated and has multiple competitive advantages 1) a unique modular plant model, which allows for production scalability and flexibility to relocate, 2) a production method called methane pyrolysis to yield turquoise hydrogen, which offers a cost advantage versus competitors trying to work off the water electrolysis green hydrogen model, 3) a commercially valuable solid carbon by-product that can be sold to earn an extra revenue stream, and 4) an early mover with a developed technology. We expect PH2's strong competitive position to drive significant market share gains in both the domestic and export hydrogen market.

A diversified gas portfolio that's being underappreciated by investors

Apart from building its hydrogen business, PH2 is also working on and making progress on its gas business, which constitutes three multi-national projects, all of which focus on developing unconventional gas resources. At this time, PH2 has recorded 2C Contingent Resources of 460PJ, with a portion of this ready to be converted to 2P Reserves when and if commercial gas flows can be proved from the ongoing testing of its Project Venus pilot well. Earlier test results have been very positive. If PH2 can convert its 2C to 2P, the potential upside can be material because it would increase the company's chance of commerciality and therefore, help it to secure future gas sales contracts. Also, we note that PH2 retains the option to use its gas for hydrogen production, which we believe should de-risk the gas projects. Moreover, the East Coast gas market is widely anticipated to be in supply shortage by c.2023 driven by the structural decline in gas output from fields in the south-east such as Bass Strait. We think this market dynamic plays favourably for PH2 and expect it to expedite the development of its Australian gas assets.

We initiate coverage of PH2 with a fair valuation range of A$0.60-0.83ps

Our fair valuation range is derived using a sum-of-the-parts approach, which involves separating PH2's hydrogen and gas businesses and then valuing them on a standalone basis. While we acknowledge PH2 is a highly speculative play given its early stage position and pre-revenue status, we estimate either its hydrogen or water business alone should sufficiently justify the current share price of A$0.21ps, implying plenty of upside potential exists, in our view.

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Hydrogen – underappreciated investment theme

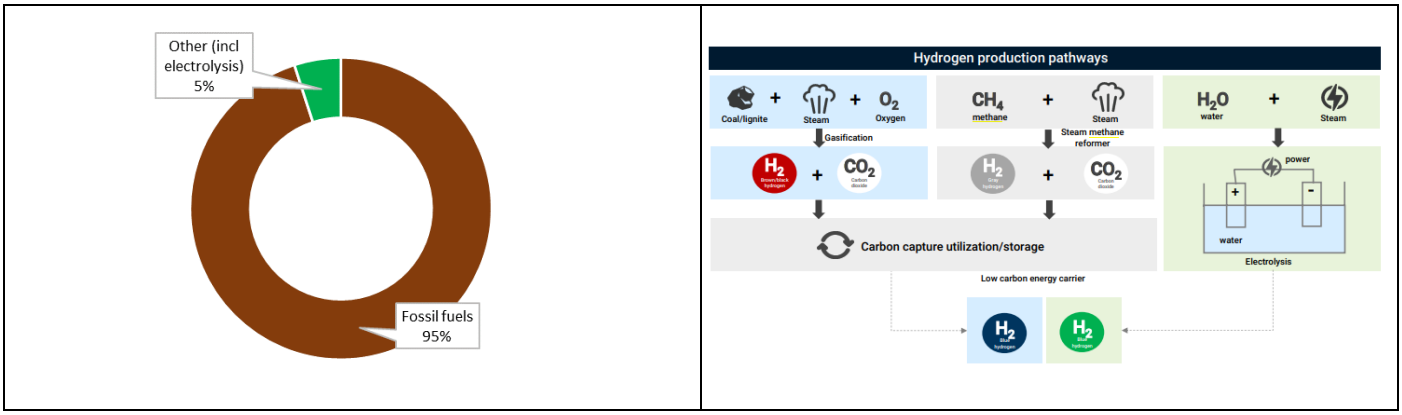
In our view, hydrogen is an underappreciated investment theme exposed to a structural tailwind over the coming decades

So far in 2021, the world has suffered multiple climate disasters, evident in the Australian flooding, Cyclone Seroja and the recent Western European and Chinese flooding. These disastrous events are likely to increase as we approach global warming of 1.5C by c.2030, as per the recent Intergovernmental Panel on Climate Change (IPCC) report released in August 2021. This stark warning has effectively accelerated the urgency for regulators, investors and financial institutions to push for decarbonisation across the globe. The question is what role will hydrogen play in this transition. We believe it will be a significant one. Below are three factors that we think will continue to drive the investment case for hydrogen over the next several decades:

Making emission-free hydrogen…

- **Multiple zero-emission hydrogen production techniques** – Up until now, the majority of global hydrogen is produced from fossil fuels (Figure 1), resulting in large CO_2 emission pa. According to the International Energy Agency, global hydrogen production contributes c.830Mt of CO_2 pa, representing c.3% of global CO_2 emissions. Industry has labelled these types of hydrogen as brown/black/gray depending on the fossil fuel source used. However, several cleaner production methods have gained increasing prominence over the recent years. These include 1) green hydrogen, using renewable electricity to split water molecules, 2) blue hydrogen, which relies on the existing manufacturing method but with an added carbon capture and storage functionality, and 3) turquoise hydrogen, which works off a technology called methane pyrolysis, using natural gas and renewable energy as inputs to yield hydrogen along with solid high-value carbon byproducts such as graphite. We view the zero-emission feature of these technologies as an attractive value proposition.

Figure 1: Global H2 production sources, 2020 (LHS); Blue/Gray/Brown & Green hydrogen production pathways (RHS)



Source: Wikipedia, Pitt Street Research

Source: Goldman Sachs, Green Hydrogen report, September 2020

- **Continued technological advancement is expected to drive better economics in green hydrogen production, but nonetheless, we view turquoise hydrogen as a better alternative** – Production cost for green hydrogen is noted as the top barrier for its wide adoption, owing to the sheer amount of energy required to make electrolysis work. According to the estimates provided Goldman Sachs[1], producing green hydrogen based on solar-powered electrolysis currently costs c.€2.3/kg, more than

[1] Source: Goldman Sachs, Green Hydrogen report, September 2020.

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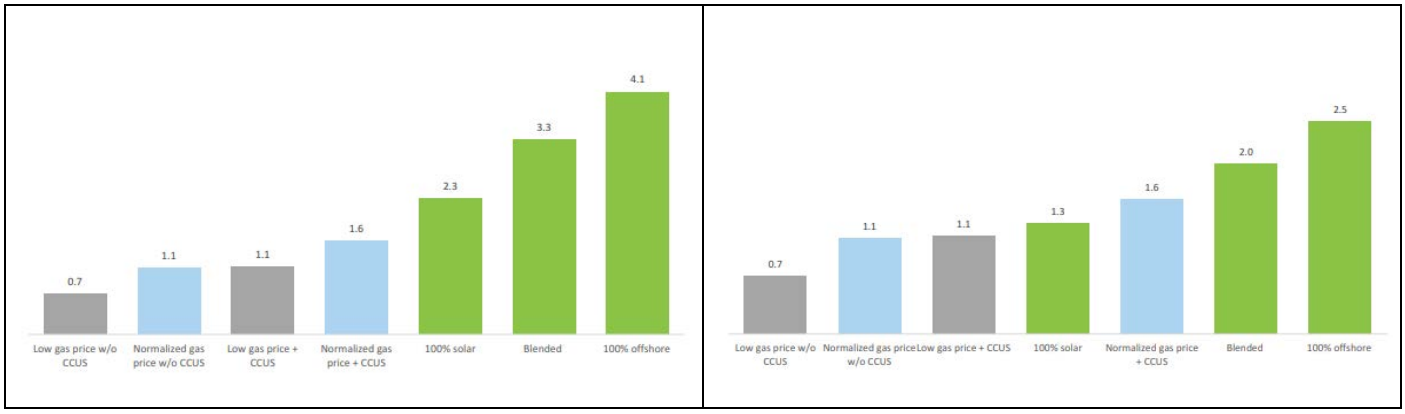
Pyrolysis requires 4-7.5x less electricity versus electrolysis

doubling the cost for fossil fuel-sourced blue hydrogen at c.€1.1/kg (Figure 2). Thus, in order for green hydrogen to be competitive, its production cost would need to fall heavily. Figure 2 (RHS) shows this may be possible by 2050, driven by expected continued falls in renewable pricing and the lower cost of electrolysers, the latter helped by increases in scale as well as fruition of better technologies. It appears that this view is supported by the Hydrogen Council, which in its recent report[2], has predicted a fall in production cost for green hydrogen by c.62% by 2030. While the future economics for green hydrogen look rosy, the time and journey to get there seem to be long. In our view, turquoise hydrogen is arguably a better, zero-emission alternative. According to the Polytechnic Institute of Paris, the amount of electricity required for pyrolysis to work is 4-7.5x less versus electrolysis. This demonstrates its cost advantage over green hydrogen. Thus, in our view, turquoise hydrogen could take shorter time for its economics to catch up to blue hydrogen, potentially making it a better and cheaper technology to produce hydrogen.

Figure 2: Levelised cost of H2 production in 2020E (LHS) vs 2050E (RHS), €/kg



Source: Goldman Sachs, Green Hydrogen report, September 2020

**Green bars = green hydrogen; blue & gray = blue hydrogen scenarios*

**CCUS = Carbon Capture, Utilisation and Storage*

Solving the hard-to-decarbonise part of the equation…

- **Fixing the difficult-to-decarbonise sectors** – While renewables can help resolve the electrification component of the decarbonisation equation, emission-contributing sectors like steel and cement-making as well as heavy transportation such as shipping, aviation and long-haul trucking are difficult, if not impossible, to electrify. That's where hydrogen comes in. Due to its unique chemistry, hydrogen can potentially bridge this gap to help us reach zero emissions. For instance, hydrogen can be cleanly burnt to produce heat, which in turn could be used for steel-making, effectively replacing coal as a potential energy source. Another instance would be its application in heavy-duty vehicles such as trucks, where a hydrogen-based vehicle allows longer driving distance, faster refueling and higher payload versus a typical battery vehicle. We will expand on this point later in this report.

To sum up, these abovementioned factors point to a compelling investment case for hydrogen as we transition to a decarbonised economy. We think it's important to set out this background information before we dive into PH2's technologies as they provide investors with an understanding of hydrogen as an important clean energy transition pillar.

[2] Source: Hydrogen Council, McKinsey & Company, Hydrogen Insights Report, February 2021.

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A closer look at PH2's hydrogen technology

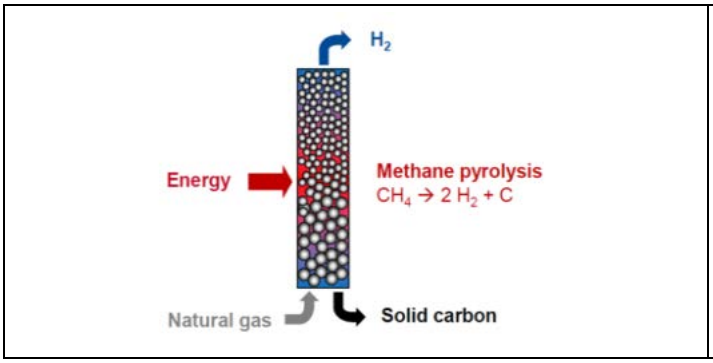
PH2's modular plant technology – plasma pyrolysis

In 4Q FY21, PH2 entered into a 50/50 JV with Sygnergen Met Pty Ltd, a private Australian technology company, to pursue the production of clean hydrogen. Their proven modular plant technology is based off the principle of plasma pyrolysis, which is one of the three variants of methane pyrolysis. In short, it is a process that involves:

- Obtaining natural gas, a key required input;
- Using high temperature to break up the chemical molecules of methane (CH_4) contained in natural gas into hydrogen gas and carbon; and
- Capturing all carbon content in solid form to avoid being emitted as CO_2.

See Figure 3 for the chemical reaction behind the methane pyrolysis process. Depending on the energy source used, the process can be either low-carbon or carbon-free. As per management indication, PH2 has solar panels set up in its initial production locations and therefore aims to rely on renewables to produce the electric heat input, effectively rendering the process emission-free. The resultant clean hydrogen is also known as 'turquoise' hydrogen.

Figure 3: Methane pyrolysis process



Source: BASF Research presentation, Dr. William Daloz, December 2019

Figure 4: PH2's modular portable hydrogen generator

Source: Company

A 2-stage plan devised for hydrogen and solid carbon production

Expected daily production capacity of c.1,500kg of hydrogen

Stage 1 will involve building a 12m shipping container sized generator with an expected daily production capacity of c.1,500kg of hydrogen and c.4,500kg of carbon products (Figure 4). PH2 plans to install its first module nearby its existing Venus CSG field in Miles, Queensland, hoping to leverage its potential methane resource in the area. Management expects first production to occur in 2H 2022.

Stage 2 will focus on turning the carbon by-products into high-value products such as graphite and carbon nanotubes, which are currently experiencing high demand due to their chemistry and applications in rapidly growing markets such as those for Electric Vehicle batteries. PH2 will have the option to sell into these attractive end-markets and thereby, potentially, gain significant revenue streams additional to the core hydrogen sales. This reflects the deep optionality of PH2's new technology.

More than a decade of R&D invested in proving up the technology

Around 2006, Sygnergen and the University of Queensland collaborated on development of a modular, stand-alone sodium cyanide plant for use in the mineral processing industry. Sygnergen further adapted the knowledge gained so that other products can be made with the technology, such as hydrogen, acetylene and carbon black. Through years of rigorous trialling and testing, Sygnergen eventually succeeded in developing a production plant

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that can manufacture up to c1,350kg of hydrogen per day. Patents have been granted in various geographies including Australia, the US and Europe.

PH2's modular approach to technology can be applied to both a distributed production model as well as a permanent model

We note PH2's modular approach has two important benefits: 1) the ability to scale up production, as additional modules can quickly be built, installed and commissioned, 2) portability, allowing a rapid relocation of plant to a new production site, if necessary (e.g., when underlying resource is exhausted).

In our view, PH2's JV with Sygnergen is sensible and synergistic

A win-win JV between PH2 and Sygnergen

Since methane pyrolysis requires natural gas as a key input, countries with an abundant supply of natural gas like Australia should gain an operational and cost advantage in utilising this type of technology versus countries needing to import gas. Given PH2 also has a diversified gas portfolio comprising c.11 TCF of methane resources, we think it makes a lot of sense strategically to enter into a JV with Sygnergen, because PH2 can leverage on its internal gas resource capability to potentiate Sygnergen's plasma pyrolysis technology. This would mitigate supply chain risk and also provide control over margins. It's a win-win scenario, in our view.

Methane pyrolysis possesses competitive advantages versus other methods of manufacturing hydrogen

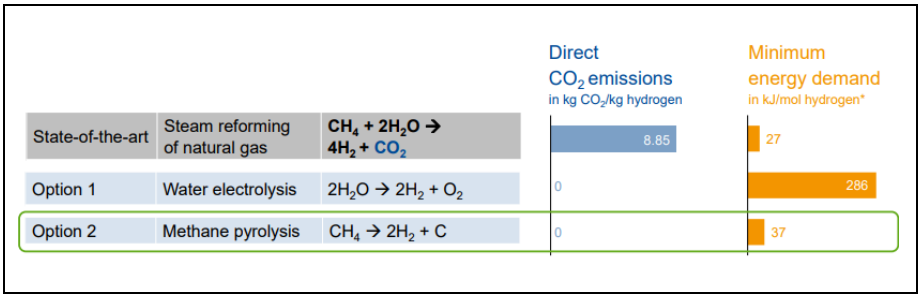
Figure 5 summarises the benefits of methane pyrolysis.

- **Emission-free** compared to gray hydrogen, with the caveat being that the electric heating used for the methane decomposition process need to be sourced from renewables such as solar and wind.

PH2 could potentially undercut its green hydrogen competitors on commodity pricing

- **Better commodity pricing** compared to green hydrogen, as the increase in energy demand for methane pyrolysis is marginal compared to water electrolysis used for green hydrogen production. This is important as it translates to lower cost of production, meaning lower/more competitive hydrogen pricing for PH2 versus green hydrogen producers.
- **Cost-saving** as PH2 can use the profits from the realised sale of value-add carbon products to offset its hydrogen production cost. In our view, this element should not be overlooked by equity investors when assessing companies developing methane pyrolysis platform technologies.

Figure 5: Comparison between various hydrogen production methods



Source: BASF Research Press Conference, Dr. Andreas Bode, January 10, 2019

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Dissecting PH2's hydrogen business

Currently PH2 has five hydrogen projects under development (Figure 6):

Figure 6: Overview of PH2's hydrogen projects

	Project Saturn	Project Jupiter	Project Mars	Project Liberty South	Project Liberty North
PH2's ownership	100%	60%	60%	60%	60%
Partnership	NA	Liberty Hydrogen	Liberty Hydrogen	Liberty Hydrogen	Liberty Hydrogen
Location	Miles, Queensland	Gladstone, Queensland	Mackay, Queensland	Port Anthony, Victoria	Port of Newcastle, NSW
Stage of development	Assembling supply chain	Early-stage development	Early-stage development	Early-stage development	Early-stage development
Target markets	Domestic	Domestic & Offshore	Domestic & Offshore	Domestic & Offshore	Domestic & Offshore

Source: Company, Pitt Street Research

Solar and wind power generation are available in the area which could be used to power PH2's plant, thus making the production process emission-free

PH2's near-term focus is on advancing Project Saturn

PH2's near-term priority is to assemble all parts of the value chain with the goal to implement Project Saturn. This project involves PH2 building a small-scale hydrogen plant located in Miles, Queensland, which is c3.5-hour drive from Brisbane. Management strategically chose this location for a number of reasons 1) it sits on the Walloon CSG fairway and next to major gas pipelines, 2) there is the option to use gas supply from its natural gas projects which have >9TCF of 3C contingent and prospective gas resources, 3) existing solar and wind power generation in the area which could be used as a renewable source to power PH2's plant, thus making the production process emission-free, 4) the area's favourable climate is important for solar and wind power generation and 5) prospective customers on the East Coast are not far away.

Business model – hub and spoke approach in Australia

PH2 plans to deploy a hub and spoke model on the East Coast. This distribution approach will likely see PH2 continue to strategically set up various supply hubs across the East Coast of Australia. Project Saturn serves as an example, in which Miles has been selected as a satellite hub where hydrogen is expected to be produced and then distributed to customers located nearby. Given PH2's plant can be readily located and transported, we think this type of distribution model is suitable for PH2 and could also lead to operational efficiency such as accelerated hydrogen delivery.

Recent partnership with Wildfire Energy helped PH2 to scale up and diversify its network of hydrogen hubs

On expected supply volume, management aims to deliver to customers 1-10 tonnes of hydrogen per day. Although the range in expected volume is wide, we believe the upside is achievable. If we just look at Project Saturn alone and account for the expected daily production capacity of 1,500kg per plant, management's supply guidance is clearly realistic, albeit being on the lower end. However, we note that management is actively looking to expand its network of hydrogen hubs. Its success is reflected in its recent partnership with Wildfire Energy Pty Limited, a private Australian renewable energy company with a technology that can turn waste into hydrogen. It is expected that Wildfire will set up its plant in south of Brisbane, targeting daily hydrogen production of 1,500kg. In our view, this partnership has enabled PH2 to scale up and diversify its production hub network, which we expect to underpin its hydrogen supply volumes in the short to medium term.

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PH2 is rapidly assembling all parts of supply chain which will involve raw material supply, hydrogen supply, a refuelling network and the logistics required to store and transport hydrogen to potential end customers

PH2 is making solid progress in establishing all parts of its hydrogen value chain

PH2 owns and operates its own CSG gas field in Surat Basin, from which it can potentially source the natural gas required to run its hydrogen plants. This should minimise raw material supply disruption and therefore provide PH2 with a degree of margin control. Once hydrogen is produced at its satellite hubs, PH2 intends to leverage on the expertise of Pure Haul Pty Ltd, an experienced and accredited logistics operator who will arrange for the transportation of hydrogen to PH2's potential commercial customers. This will involve taking compressed hydrogen from PH2's production hubs at pressures of c.250 bar into long cylindrical vessels, which are then stacked onto Pure Haul's 20-foot truck trailers for delivery to customers' sites (Figure 7). As per management guidance, these trailers are expected to contain up to 500kg of hydrogen. Moreover, in 4Q FY21, PH2 entered into a commercial arrangement with H2H Energy Pty Ltd, a private Australian hydrogen specialist that has developed a range of hydrogen refuelling solutions. Its key asset, Gateway Refueller (Figure 8), is very attractive owing to its short lead-time, mobility and low-cost features. The intention is for H2H to supply and maintain these mobile refuelling stations on PH2's designated sites, which in turn can provide local customers with an opportunity to refuel if required. Overall, it's clear that PH2 is making solid progress in assembling the various parts of the supply chain for the eventual rollout of its hydrogen gas.

Figure 7: Pure Haul's hydrogen delivery truck

Source: Company

Figure 8: H2H's mobile hydrogen refueller

Source: Company

Being early to market is key to gain a dominant market position, in our view

Moving early will give PH2 an advantage in capturing market share...

PH2 aims to be one of the first companies to supply hydrogen to customers in the Australian domestic market, albeit on a small-scale initially. Importantly, given its technology has already been demonstrated, we believe PH2's investment case is considerably de-risked versus companies which are yet to prove-up their technologies; see peer analysis section for more detail. If successful in commercialisation, PH2's early mover advantage should help it to gain a dominant market share position, in our view.

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PH2's large-scale projects expected to drive long-term growth

In 3Q FY21, PH2 entered into a JV with Liberty Hydrogen with an aim to globalise its hydrogen production initiative. They plan to achieve this by initially developing four large-scale, export-grade hydrogen sites situated in various ports on the East Coast of Australia (**Error! Reference source not found.**). Their long-term vision is to export hydrogen to the lucrative APAC region, specifically Japan and Korea. At this stage, details on metrics such as expected production capacity and capex for the projects are light. But we are attracted to the following aspects of these projects:

- **Established infrastructure** – including road, rail and ship access. These are important in facilitating future exports.
- **Large land availability** – allow for renewables development such as large-scale solar farms which can be used to power PH2's technology, emission-free. Figure 10 shows an illustration for Project Mars.

PH2 has good hedging in place...

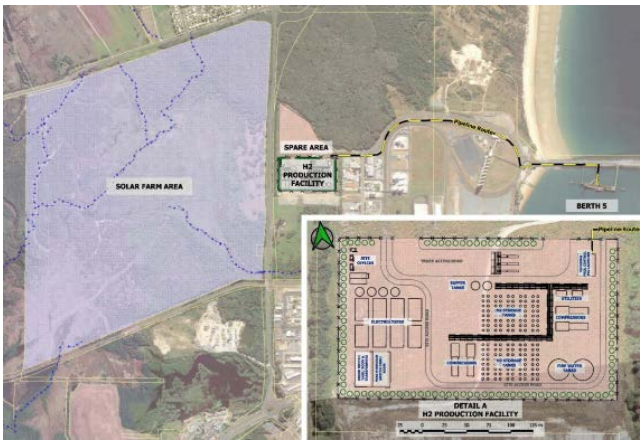
- **Upside of hedging** – There are a lot of commercial, political and technical risks in advancing these large projects to the point of commercialisation. By having multiple projects located in different ports/jurisdictions, we think there's good risk diversification and therefore good hedging for PH2. In our view, if any one of these large-scale projects succeeds, the upside potential can be significant, given the large market potential for hydrogen, as highlighted in next section of this report.

PH2 notes that it has recently lodged several proposals with the relevant port authorities to discuss any concern regarding its projects. As per our discussion with management, the estimated launch date for these projects will likely be some time around 2024.

Figure 9: PH2's large-scale hydrogen hubs

Source: Company

Figure 10: Plan for Project Mars



Source: Company

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Hydrogen – an immense market ahead

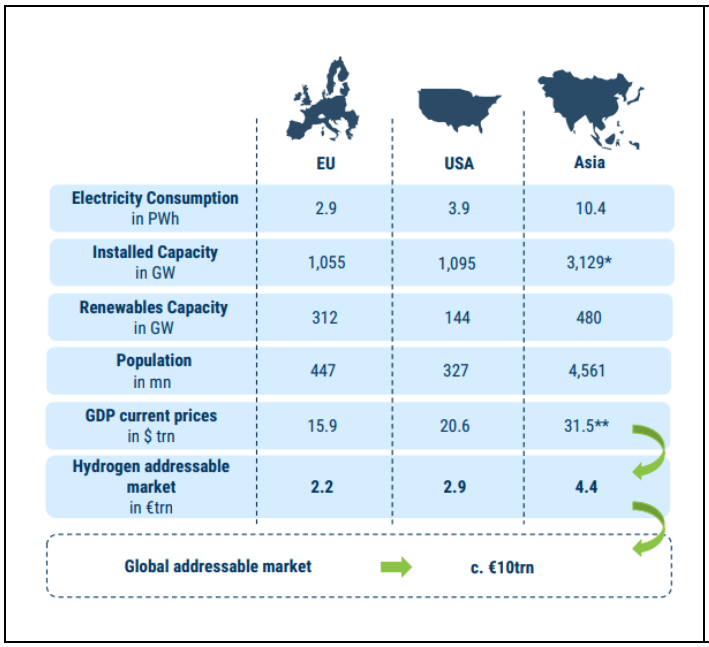
What is the potential global TAM for hydrogen?

According to Grand View Research, the global total addressable market (TAM) for hydrogen was c.US$120.8B in 2020. Looking ahead, this already large TAM is expected to experience further growth to reach c.€10T (c.US$12T[3]) by 2050, as per estimations provided in a Goldman Sachs report (Figure 11). Given the global structural shift towards decarbonisation and the increasing significance of hydrogen as a crucial energy transition pillar, we believe this expected long-term growth in market size is probable. Also, we are encouraged by the strong initiatives taken by governments, corporations and investors across the globe, as reflected in the three developments noted by Hydrogen Council[4]:

- >30 countries have issued hydrogen roadmaps,
- >200 hydrogen projects have been announced, and
- >US70B in public funding have been committed.

Figure 12 below shows a projection chart from a global demand perspective, as measured by millions of tons of hydrogen consumed. Importantly, it provides an idea of the potential sectors/customers and their estimated usage of the commodity. As we push through 2030 and 2040, it seems that overall demand growth will be largely driven by the transport and industry sectors, as they form a larger part of the broader sector mix. We tend to agree with this trend, given the unique benefits of hydrogen as a clean high energy fuel in 1) heavy-duty transport vs battery/diesel and 2) industrial applications such as steel and cement production.

Figure 11: Estimated global TAM for hydrogen for 2050E

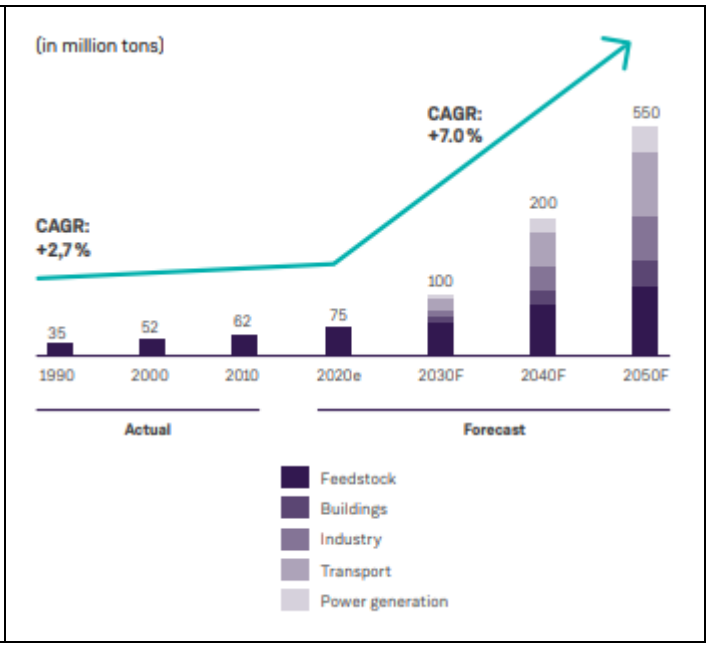


	EU	USA	Asia
Electricity Consumption in PWh	2.9	3.9	10.4
Installed Capacity in GW	1,055	1,095	3,129*
Renewables Capacity in GW	312	144	480
Population in mn	447	327	4,561
GDP current prices in $ trn	15.9	20.6	31.5**
Hydrogen addressable market in €trn	2.2	2.9	4.4

Global addressable market → c. €10trn

Source: Goldman Sachs, Green Hydrogen report, September 2020

Figure 12: Estimated global annual demand for hydrogen



Source: Siemens Gamesa

[3] Assuming an USD/Euro exchange rate of 1.17.
[4] Source: Hydrogen Council, McKinsey & Company, Hydrogen Insights Report, February 2021.

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PH2's near-term goal is to target the transportation and logistics segment of the broader hydrogen market, specifically the heavy vehicle industry.

Near term, PH2 is focused on supplying hydrogen to the transportation and logistics segment. This is because hydrogen is particularly useful for the line-haul heavy vehicle sector. When applied to fuel-cell electric vehicles (FCEVs), hydrogen can provide customers with significant advantages versus internal combustion engine (ICE) vehicles or battery-powered electric vehicles (BEVs).

Versus diesel ICE:

- **Zero emission** – Instead of emitting CO_2, FCEVs produce water vapour and as such, are more environmentally friendly.
- **Higher payload** – The lighter weight of hydrogen compared to full loaded diesel fuel means greater payload for FCEVs.
- **Lower total of cost of ownership (TCO)** – As shown in Figure 13, the TCO for FCEVs is estimated to be considerably lower than ICE-based vehicles in the heavy-duty line haul sector, not only on today's basis but over the long term. The key driver behind hydrogen's cost advantage appears to be its lower operation and maintenance (O&M) cost, which offsets its higher fuel cell and storage cost.

FCEVs best positioned for long-haul truck use

Versus BEVs:

- **Longer driving range** – Hydrogen's high energy density and light weight features enable FCEVs to travel longer distances without refuelling.
- **Faster refuelling** – It takes c.10-20 minutes for FCEVs to fully recharge versus c.8 hours for BEVs, in the context of long-distance trucking[5].
- **Higher payload** – The hydrogen carried by the vehicle is lighter than a battery pack of the same size.
- **Still a cost advantage, in our view** – Although Figure 13 shows that BEVs currently have lower TCO versus FCEVs, we note the underlying fuel cost for FCEVs is based on green hydrogen technology. As discussed earlier, PH2 aims to produce hydrogen via methane pyrolysis, which appears to be more energy-efficient versus the water electrolysis used for green hydrogen (Figure 5). Accordingly, we view the underlying fuel cost for FCEVs running on turquoise hydrogen as theoretically lower than green hydrogen, which means current TCO could still favour FCEVs.

An all-in cost business model for the hydrogen fuel initiative

Customers to pay fixed cost per month for truck lease, hydrogen supply and truck service

Management plans to apply an all-in, fixed cost model for its hydrogen FCEV initiative. This means potential customers will only have to pay a fixed cost per month for truck lease, hydrogen supply and truck service. This effectively removes the typical price volatility associated with diesel fuel and therefore provides customers with more assurance on their costs and margins. To date, PH2 submitted several proposals to potential customers with transport fleets, outlining the benefits of a hydrogen truck vs a diesel ICE truck. If one or more of these proposals get converted into sales agreements, PH2 investment case would be further de-risked, in our view. Furthermore, PH2 continues to work on securing partnerships with companies that share the same vision.

Developing export opportunities is PH2's medium to long term ambition

Management has listed export as part of their hydrogen use case agenda, with Japan and Korea the likely initial target markets. We expect management will exploit these export opportunities through the use of their four large-scale hydrogen hubs located on the East Coast of Australia. At this time, we view this export strategy as PH2's medium to long term focus.

[5] Source: Data from Transport & Environment, Comparison of hydrogen and battery electric trucks, June 2020.

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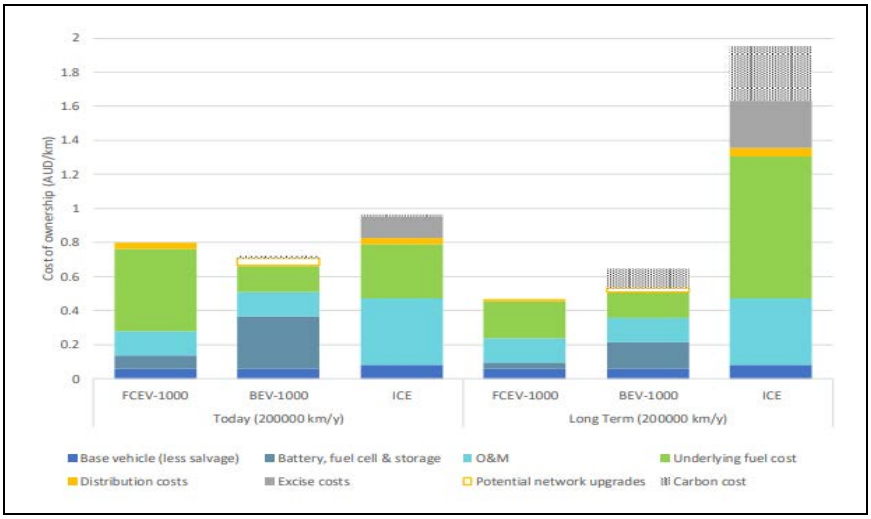
Figure 13: Heavy-duty vehicles (line haul) – cost of ownership



Source: Report prepared by Advisian, Australian hydrogen market study, 24 May 2021

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Gas business making solid progress

Apart from building a new hydrogen business, PH2 also concurrently operates its existing diversified gas portfolio comprising the following three assets:

Figure 14: Overview of PH2's gas assets

	Project Venus	Windorah Gas	Serowe Project
2C Contingent Resources (PJ)	130	330	-
Ownership	100%	100%	30%[6]
Gas Type	Coal seam gas	Tight gas	Coal seam gas
Stage of Development	Flow testing	Exploring funding	Drilling & flow testing
Location	Surat Basin, Queensland	Cooper Basin, Queensland	Botswana, Southern Africa

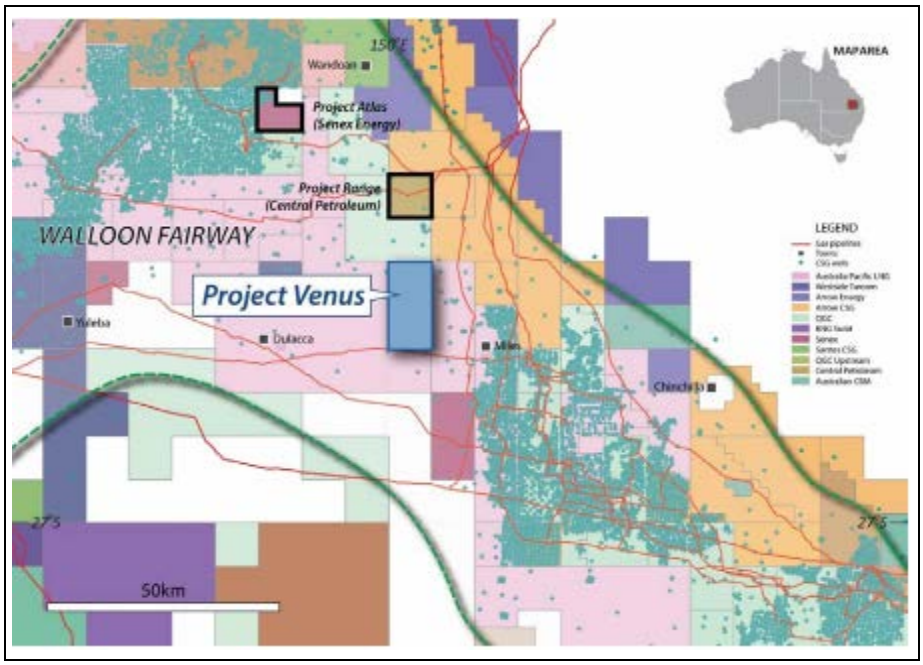
Source: Company, Pitt Street Research

Proving commercial gas flows at Venus 1 should de-risk the project, in our view

Project Venus – The immediate priority is to prove up commercial gas flows and thereby convert its 2C contingent resources to 2P reserves

Project Venus is a coal seam gas (CSG) project located in the Surat Basin in the south-east Queensland (Figure 15). It covers an acreage of c.154km^2 within the Walloon CSG Fairway, with existing gas pipeline infrastructure nearby. Its gas resource quantity was independently examined by Sproule in 4Q FY21, in which it reported a 2C Contingent Resources of 130.3 PJ.

Figure 15: Location of Project Venus



Source: Company

[6] PH2's expected stake in Project Serowe which will be free carried until December 2023.

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In order to convert its 2C Contingent Resources into 2P Reserves, PH2 needs to prove commercial gas flows from the ongoing testing of its Venus 1 pilot well. To date, the company has seen encouraging results from the first stage of its pilot program. In 4Q FY21, PH2 reported initial gas breakout at Venus 1, with a breakout gas rate of c.84,000 cfd. This was important as it showed that the target coals have high gas saturations. Management expects this gas flow rate to continue to improve as the control pressure drawdown further advances into the coal reservoirs.

If PH2 can achieve commercial gas flows, its 2C gas resource could potentially be converted into 2P gas reserves, which we expect to underpin future gas sales contracts. Further, we note there's optionality in Project Venus as PH2 can also use its gas to produce hydrogen, as part of its Project Saturn venture.

Windorah Gas Project – a medium-term focus

PH2's Windorah Gas Project is located in the Cooper Basin of Queensland (Figure 16). It is comprised of two permits – ATP927P and ATP1194PA, both fully owned by PH2. Its aim is to develop and produce basin-centred gas, also known as tight gas, which is an unconventional form of gas trapped in deep sandstone formations with low permeability. We discussed in-depth on this project in our RLE initiation report. Currently, management is focused on examining development options and securing funding for the project.

A structurally elevated East Coast gas price, coupled with a potential winter supply shortage could drive development of new gas fields, which would be a favourable tailwind for PH2, in our view

Over the recent years, manufacturing firms on the East Coast of Australia have been experiencing a surge in gas price. As shown in

A favourable macro tailwind for PH2 coming through…

Figure 17, the East Coast gas price had been trending upward from its historic $4/GJ level to c.$10/GJ by 2019. The main driver behind this price surge is due to the development of our LNG export activity that began around 2015-16, which effectively linked our domestic prices to international LNG prices. As a consequence, many manufacturing firms were pushed to breaking point as energy cost is a large part of their opex base. If East Coast gas price will likely to remain structurally higher than its historic pre-2015 levels, governments may need to consider strategies to drive down the price so to ensure the operational viability of domestic manufacturers. One potential strategy is to increase supply through the development of new gas fields, which we view as a positive tailwind for PH2's domestic gas projects.

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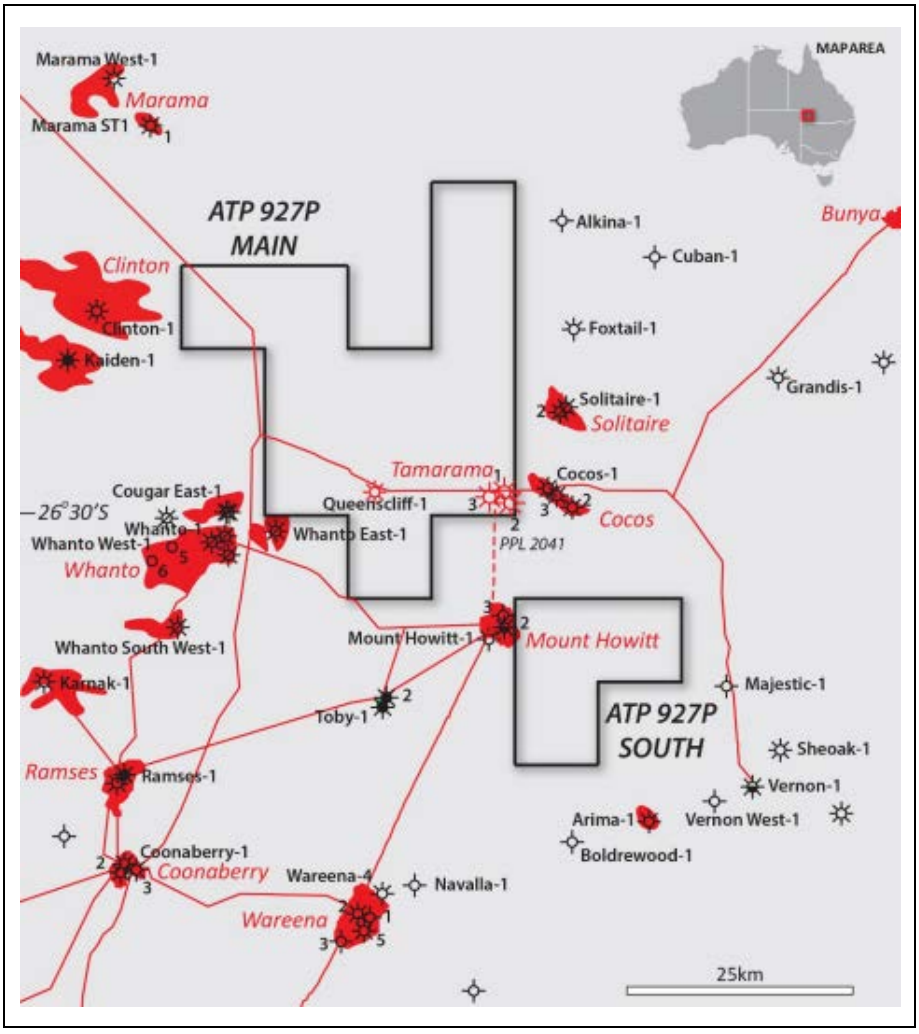
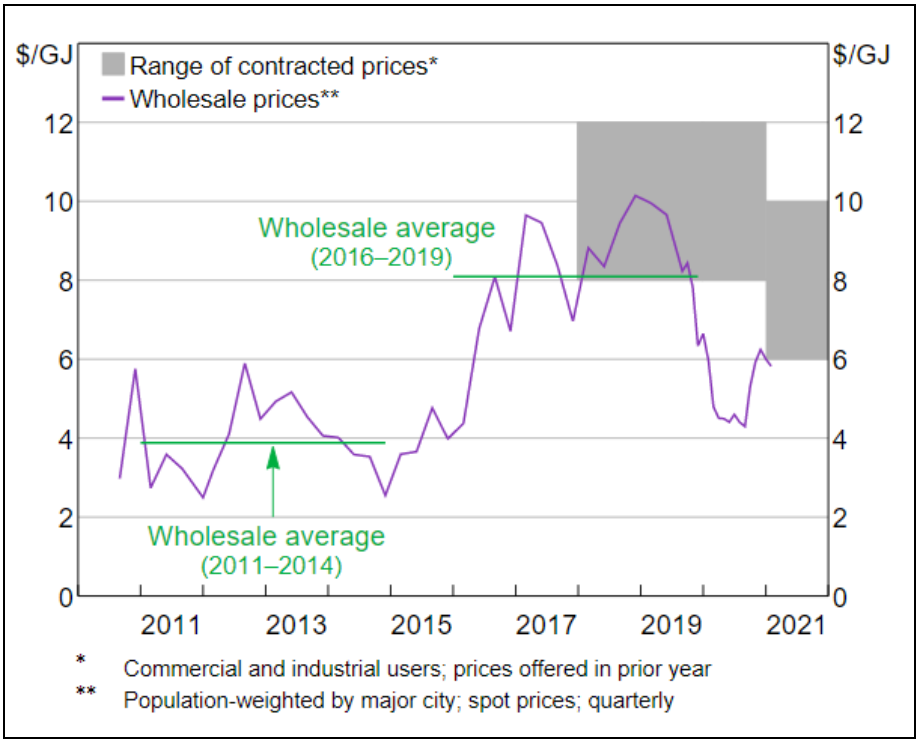
Figure 16: Location of the Windorah Gas Project



Source: Company

If East Coast gas prices will likely to remain structurally higher than its historic $4/GJ level, we think the government will explore ways to lift supply which could include encouraging energy companies to open new gas fields

Figure 17: East Coast Domestic Gas Prices

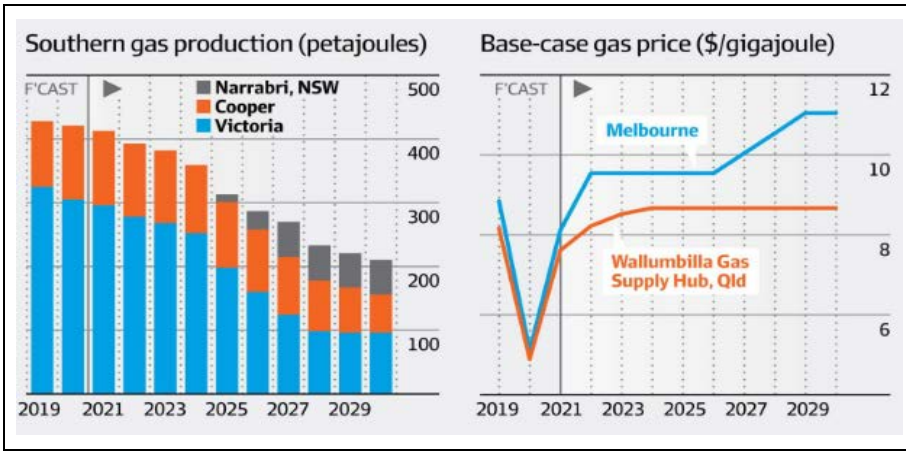


Source: Reserve Bank of Australia

According to recent analysis from EnergyQuest, gas output from fields in the south-east such as Bass Strait are projected to be in structural decline. This means users in these regions will likely experience a potential supply shortfall and therefore higher gas price in the distant future (Figure 18). The Australian Energy Market Operator warned that this supply gap may arrive as early as 2023. We view this potential supply gap as a positive for PH2, as we think it could expedite the development of its gas fields on the East Coast of Australia.

In our view, the expected rapid decline in gas fields such as the Bass Strait could potentially expedite the development of new gas fields such as the ones owned by PH2

Figure 18: Forecasts on south-east gas price & production



Source: EnergyQuest, Australian Financial Review

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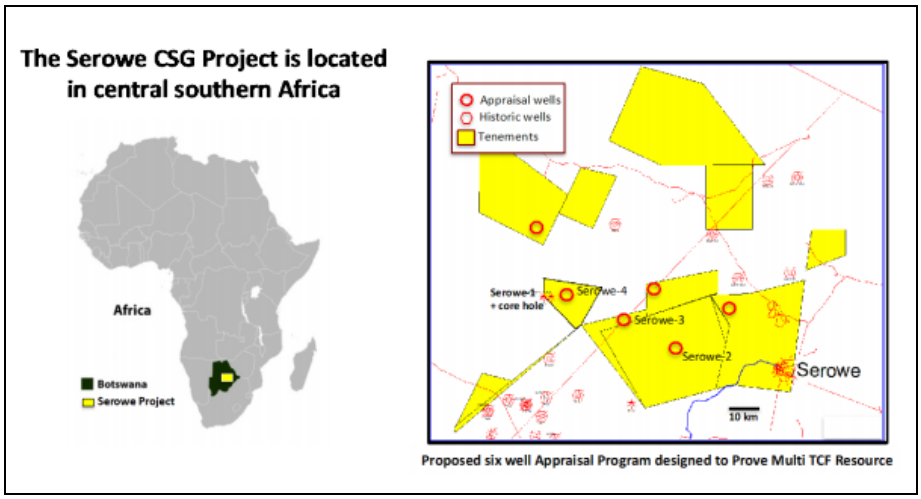
Project Serowe – a potential energy supplier to a country that is looking to transition from coal and imported fuels

Drilling results so far have exceeded expectations…

Project Serowe plans to prove up and extract high-grade coalbed methane in Botswana, Southern Africa. It has a prospective resource (best estimate) of 2.38 Tcf. Currently, PH2 and its JV partner BotsGas Pty Ltd, are in the middle of conducting a six well appraisal drilling program, with the aim to convert its prospective resource to a contingent resource. To date, drillings have been completed on two wells, being Serowe 2 and Serowe 3, with results exceeding management expectations. For instance, Serowe 3 encountered gassy coal seams that are +200% thicker than pre-drilling expectations. Free gas also broke out while drilling. These positive signs imply the potential presence of a large commercial gas field at the region. If PH2 can successfully progress the project to commercialisation, the upside potential can be material, given that Botswana is looking to transition from coal and imported fuels to become an energy independent country. Also, we note Botswana is planning to introduce renewable energy to its energy portfolio[7], which we expect to bode well for its recent Serowe Hydrogen Hub established in 1Q FY22.

Figure 19: Location of Project Serowe



Source: Company

[7] Source: Official Website of the International Trade Administration, Botswana - Country Commercial Guide, August 2020.

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Valuation

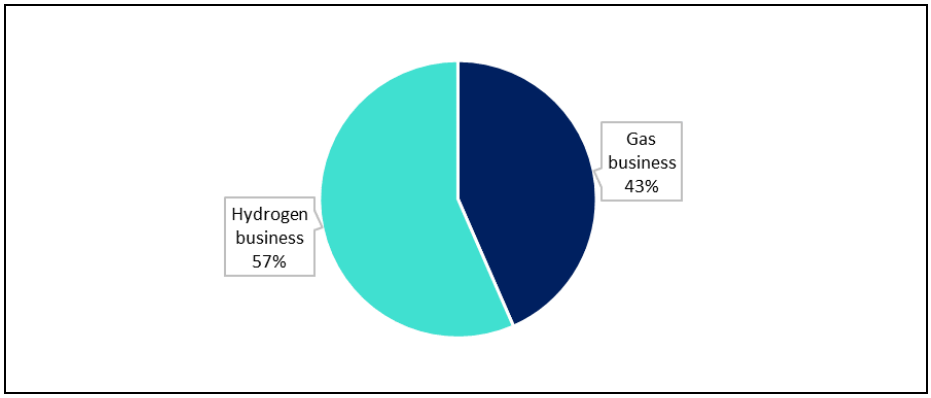
As PH2 has two distinct energy businesses, we think that the sum-of-the-parts approach is the best way to frame valuation. We have derived A$79-117M for PH2's gas business and A$103-140M for its hydrogen business, representing a 43:57 divisional split (Figure 21). After adding them together and adjusting for net cash and shares, we have obtained a fair valuation range of A$0.60-0.83 per share for the PH2 group (Figure 20).

Figure 20: Sum-of-the-Parts valuation summary

Sum-of-the Parts Valuation for PH2 (AUDm unless specified otherwise)	Base Case	Bull Case
Implied EV for gas business	79.1	116.6
Implied EV for hydrogen business	103.0	140.0
Combined EV	**182.1**	**256.6**
Net cash	(11.3)	(11.3)
Equity Value	**193.4**	**267.9**
Shares outstanding	321.2	321.2
Implied Price (AUD)	**0.60**	**0.83**
Current Price (AUD)	0.21	0.21
Upside	187%	297%

Source: Pitt Street Research

Figure 21: PH2's valuation, split by business



Source: Pitt Street Research

We value PH2's Australian gas assets at A$79-117M

Given that PH2's gas assets are still in the development phase, we don't think valuation through a DCF is appropriate as production and cashflows from gas sales aren't yet available. We think investors are rather trying to price the resources that PH2 currently has in its gas portfolio. Therefore, we have used an EV/Resource multiple-based approach to derive a fair valuation range for PH2's gas business.

Figure 22 shows some ASX-listed small energy businesses that we compiled. We view them as comparables for PH2 because they share some similarities 1) they are in the early exploration/development stage, 2) they have some exposures to unconventional gas sources such as coal seam gas and 3) all of them have proven contingent resources.

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Figure 22: Selected ASX-listed small energy companies

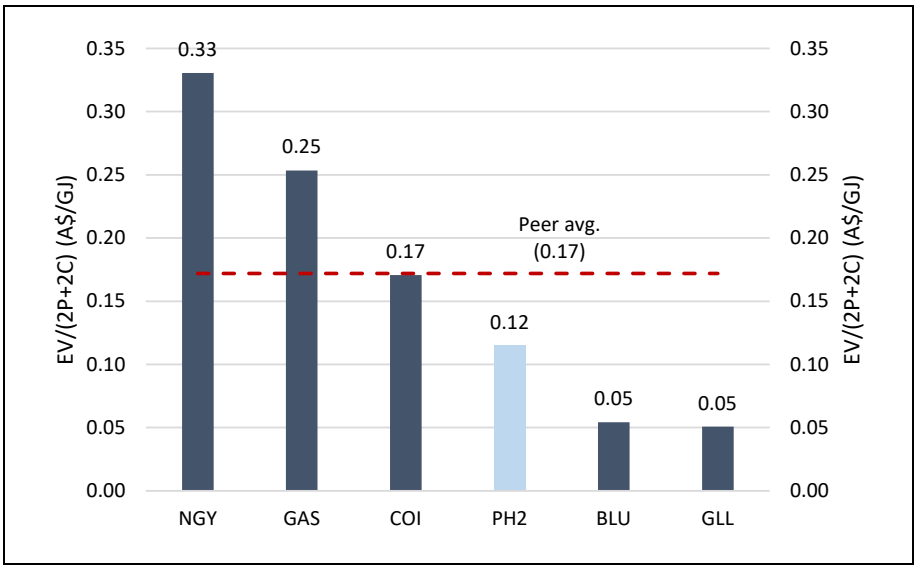
Comparable comp	Ticker	EV (A$M)	2P Reserves (PJ)	2C Contingent Resources (PJ)	EV/(2P+2C) (A$/GJ)
Galilee Energy	GLL	127	0	2,508	0.05
Comet Ridge	COI	71	106	309	0.17
Blue Energy	BLU	67	71	1,166	0.05
State Gas	GAS	55	0	217	0.25
NuEnergy Gas	NGY	43	78	52	0.33
Peer avg		**73**	**51**	**850**	**0.17**
Pure Hydrogen	**PH2**	**53**	**0**	**460**	**0.12**

Source: S&P Capital IQ, Pitt Street Research estimates of company data

Based on the share prices of these energy peers, we can see that investors are currently paying less for each GJ of PH2's resources versus peer average (Figure 23). To some extent, we acknowledge this discount as some peers like Comet Ridge (ASX: COI) and NuEnergy Gas (ASX: NGY) have already converted a part of their resources to reserves and therefore increased their chance of reaching commerciality. However, we also see attributes in PH2 that support its re-rate towards peer average 1) PH2 is getting close on achieving 2C to 2P conversion for its Project Venus gas asset, 2) an optionality to use the gas to run its hydrogen assets, which de-risks its project proposition, in our view, and 3) similar to State Gas (ASX: GAS), PH2 is also aiming to capitalise on the expected East Coast supply shortage opportunity, and yet investors are paying twice for each GJ of GAS's resources versus PH2's. As an aside, we note that our 2C estimate for PH2 are derived based on its Australian gas assets only, which means that any country risks attached to developing markets, such as Botswana, should not be discounted into PH2's Australian gas assets.

Therefore, we set our base case EV/(2P+2C) multiple at peer average, whilst our bull case reflects the multiple that investors are currently paying for GAS because in our view both GAS and PH2 faces a similar market opportunity set and are yet to convert their 2C resources to 2P reserves. If we work off these metrics, we would derive A$79M base case and A$117M bull case (Figure 24).

Figure 23: Peer comparative - EV/(2P+2C) (A$/GJ)



Source: S&P Capital IQ, Pitt Street Research estimates of company data

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Figure 24: Relative valuation summary for PH2's gas business

BASE CASE

PH2's gas business valuation (AUDm unless specified otherwise)	EV/(2P+2C)
Target Resource Multiple (A$/GJ)	0.17
2P+2C Resource	460.0
Implied EV	**79.1**

BULL CASE

PH2's gas business valuation (AUDm unless specified otherwise)	EV/(2P+2C)
Target Resource Multiple (A$/GJ)	0.25
2P+2C Resource	460.0
Implied EV	**116.6**

Source: Pitt Street Research

We value PH2's hydrogen assets at A$103-140M

Given PH2 has only recently begun building its hydrogen business and there's no production and cashflows yet, we will stick with a comparable valuation approach. We have put together a set of domestic small hydrogen peers (Figure 25). We view this as a tentative comparable comp set for PH2, although we note that most of these peers differs regarding 1) the types of hydrogen they aim to generate, 2) their production technologies and 3) their development status.

Figure 25: Small hydrogen companies

Comparable Comp	Ticker	EV (A$M)	Project	Type of Hydrogen	Est. Hydrogen Production	Development status
Province Resources	PRL	160.4	HyEnergy Zero Carbon Hydrogen Project	Green Hydrogen	Stage 1 (c.180kt/annum) Stage 2 (c.480kt/annum)	Feasbility studies to commence shortly
Hazer Group	HZR	141.2	Hazer Commercial Demonstration Project	Turquoise Hydrogen	100t/annum	Construction & installation works commenced
Hexagon Energy Materials	HXG	33.7	Pedirka Blue Hydrogen Project	Blue Hydrogen	na	Pre-feasbility study commenced
Pilot Energy	PGY	28.1	Blue Hydrogen Projects	Blue Hydrogen	na	Commencing feasbility studies
Lion Energy	LIO	11.8	Green Hydrogen Project	Green Hydrogen	na	Experts appointed to undertake further studies
QEM	QEM	15.0	Julia Creek Project	Green Hydrogen	na	Bench Scale Pilot plant under construction
Infinite Blue Energy (pre-IPO)	na	na	Arrowsmith Project	Green Hydrogen	25t/day	Expected to come online in 2022
Peer Average		**65.0**				

Source: Company websites & presentations, Pitt Street Research

Out of the whole basket of small hydrogen peers, we view Hazer Group (ASX: HZR) as the best comparable that could help us to form a view on PH2's valuation, due to the following three reasons:

- **Similar production technique** – Both PH2 and HZR are aiming to produce what we believe as "Turquoise Hydrogen" via a less well-known method called methane pyrolysis, which effectively produces both hydrogen and a high-value solid carbon by-product, as mentioned earlier.

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- **Developed technology** – Both PH2 and HZR have a developed technology and process in place for their hydrogen production, albeit being proven at a pilot scale. Therefore, we view their technology propositions as less risky than peers who are yet to prove-up their concepts and products.
- **Pure hydrogen play** – Unlike some of its peers that also operate projects adjacent to their hydrogen assets, HZR is a pure hydrogen play. Therefore, we view HZR's EV as a better yardstick to gauge the valuation for PH2's standalone hydrogen business.

However, we also note that HZR appears to have a faster development status than PH2, as HZR expects to commence operations by the end of 2021, versus PH2's expected production in 2H 2022. This factor, when considered alone, could tip the valuation scale more favourably towards HZR. But we also note that PH2 appears to have a higher expected production volume (c.548tpa[8]) versus HZR (c.100tpa), which should translate to higher expected sales and cashflows, in our view.

Overall, we conservatively set our base case valuation for PH2's hydrogen business at A$103M, which is around the mid-point of HZR and peer average. Our bull case is set at A$140M, reflecting a stronger view on the commonality between PH2 and HZR, as per our reasonings discussed above.

Valuation summary

In aggregate, we value PH2 at A$0.60-0.83 per share (Figure 20), representing a 57:43 valuation split between its hydrogen and gas assets. Therefore, we argue that either PH2's Australian gas business or its hydrogen business alone would sufficiently justify the current share price at 21c. We think the market has overly shifted their view on PH2 towards its new hydrogen business, and neglected the still important gas business. When both energy businesses are considered together, we believe there's a lot of upside potential based on the current share price.

Catalysts

We have identified a number of valuation catalysts, listed below, as critical facilitators of driving the re-rating of PH2 towards our valuation range:

- Locking in offtake agreements with commercial users/buyers, which could potentially result from the proposals being recently submitted to companies with large transport fleets;
- Entering into partnerships with well-known companies that shares the same hydrogen vision as PH2;
- Achieving commercial hydrogen production at Project Saturn;
- Achieving commercial gas flows at the Venus 1 pilot well;
- Signing of gas sales agreements;
- Positive results from continued drillings at Project Serowe.

[8] Estimated based on a daily production rate of 1,500kg per plant.

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Risks

We see the following as key risks related to our investment thesis:

- **Environmental risk** – Although gas is a cleaner burning fuel than coal, it is still a fossil fuel and hence, releases emission to the atmosphere. As such, there is a risk that the Australian states and territories may move against the idea of opening up new gas fields. If this risk materialises, PH2 would encounter difficulty with its Australian unconventional gas development.
- **Market development risk** – Regarding the looming shortfall risk in the East Coast gas market, there are multiple avenues to mitigate this risk, one of which includes importing LNG from offshore suppliers. The LNG import terminal at Port Kembla is about four months into construction and is positioned for gas import by early 2023. More import terminals are currently being discussed and planned. This could potentially help to plug the supply gap and therefore, reduce the need for developing new gas fields, such as the ones currently being developed by PH2.
- **Execution risk for the gas business** – There is a risk that PH2 may not be able to prove and deliver commercial gas flows at its pilot well. This would hamper its ability to convert 2C Contingent Resources to 2P Reserves, which in turn could negatively impact on PH2's ability to secure gas sales agreements, in our view.
- **Execution risk for the hydrogen business** – Likewise, there is a risk that PH2 may not achieve successful commercial outcomes with its hydrogen technology business, due to various reasons such as 1) unable to lock in agreements with potential commercial users/buyers, 2) disruption in the supply of raw material from its gas fields and/or external parties, which could interrupt PH2's hydrogen production process and, 3) issues with the storage and transportation of hydrogen to customers' site.
- **Funding risk** – PH2 has c.$10M in cash at FY21 year-end, which we think is sufficient for the completion of its initial hydrogen project. Our view is that PH2 will require additional funding to progress its four larger scale hydrogen plants. And there is the risk that PH2 may not able to secure the funding needed for its expansion.

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Appendix I – Glossary

Blue hydrogen – A type of hydrogen that's produced from natural gas via the steam methane reforming process. The CO_2 by-product is captured and stored by the technology.

Brown hydrogen – A type of hydrogen that's produced from inputs including coal/lignite, steam and oxygen. The CO_2 by-product is emitted into the air.

Coal Seam Gas – A form of unconventional natural gas, primarily methane, found in coal deposits formed over millions of years from fallen trees.

Contingent Resources – Resources which are estimated to be potentially recoverable from known accumulations, but aren't yet ready for commercial development due to some contingencies.

Electrolysis – A chemical reaction where electricity is used to split the water molecule (H_2O) into hydrogen and oxygen gases.

Gas flow rate – A measure of the volume of gas that passes through a particular point at a particular point in time. It can be expressed in various units, including actual cubic meters per hour (acm/h), linear feet per minute (lfm) and million standard cubic feet per day (mscfd).

Gray hydrogen – A type of hydrogen that's produced by splitting the chemical molecules contained in methane (CH_4) into hydrogen (H_2) and carbon dioxide (CO_2). However, unlike blue hydrogen, the CO_2 by-product is emitted into the atmosphere.

Green hydrogen – A type of hydrogen that's yielded using water electrolysis and renewable energy. Therefore, it's a zero-carbon way of manufacturing hydrogen. But the process is both water and energy intensive.

Methane pyrolysis – A chemical process where natural gas is heated to high temperature so to break up its chemical molecules into hydrogen gas and carbon. All carbon content will be captured in solid form, meaning no CO_2 will be emitted into the atmosphere.

Permeability – The ability of a rock formation to transmit fluids. It is generally measured in darcies or millidarcies.

Plasma pyrolysis – A variant of methane pyrolysis.

Seismic interpretation – The determination of geological significance of seismic data. The data is gathered through a survey wherein geologists use soundwaves to map geological structures.

Shale gas – An unconventional form of natural gas, located in the tight formations of shale rocks. These are fine-grained sedimentary rocks that are good reservoirs of petroleum and natural gas.

Turquoise hydrogen – A type of hydrogen that is produced via the methane pyrolysis process. It should be noted that this type of hydrogen can be zero-carbon if the electric heat is sourced from renewable energy.

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Appendix II – Board and management

Scott Brown, **Managing Director**, has over 25 years' experience as a director and executive in public companies. Prior to Pure Hydrogen Scott was instrumental in the listing of several companies on either US or ASX including Real Energy and Objective Corporation (ASX: OCL). Scott was the CFO of Mosaic Oil, a public Australian company with an extensive range of oil and gas production and exploration He was also CFO/Finance Director of Allegiance Mining NL and Objective Corporation Limited. He is also a non-executive director of Trisil Group Limited.

Ron Prefontaine, Non-Executive Chairman, has over 40 years of experience in the oil and gas industry and is the Chairman of Pure Energy Board of Directors. Between 2001 and 2011 he was an Executive and Managing Director of two successful Australian Securities Exchange listed companies, Arrow Energy and Bow Energy. Arrow Energy was taken over in 2010 for $3.5 billion and Bow Energy in late 2011 for $550 million. Ron received his BSc in Geophysics from the University of British Columbia in 1979. His strengths are asset growth recognition and the management of corporate growth. In 2009 Ron received a lifetime achievement award in recognition to his services to the Australian petroleum industry.

Lan Nguyen, **Non-Executive Director**, is a petroleum geologist, with c.20 of experience in the petroleum exploration and development industry. Nguyen has been recognised for his work in the development of several oil and gas fields in the Surat and Bowen Basins. He is also a member of PESA, AAPG and SPE[9].

Appendix III – Capital Structure

As of report date, PH2 has the following capital structure:

Class		% of fully diluted
Ordinary shares, ASX Code PH2 (million)	321.2	91.4%
Unlisted options (million)	30.3	8.6%
Fully diluted shares	351.5	

Appendix IV – Major shareholders

As at 23 March 2021, the top five shareholders in PH2 are:

- Scott Brown, Managing Director (3.43%)
- BNP Paribas Nominees Pty Ltd (3.06%)
- Mr Ronald Prefontaine & Mrs Annabel Frances Prefontaine (2.85%)
- Sixth Erra Pty Ltd (2.76%)
- Citicorp Nominees Pty Ltd (2.44%)

[9] PESA - Petroleum Exploration Society of Australia; AAPG - American Association of Petroleum Geologists; SPE - Society of Petroleum Engineers

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Appendix V - Analyst qualifications

Cheng Ge, lead analyst on this report, is an equities research analyst at Pitt Street Research.

- Cheng obtained a B.Com in Finance and LL.B from University of New South Wales, in 2013, and has passed all three levels of the CFA Program.
- Before joining Pitt Street Research, he has worked for several financial services firms in Sydney, where his focus was on financial advice.
- He joined Pitt Street Research in January 2020.

Stuart Roberts has been covering the Life Sciences sector since 2002.

- Stuart obtained a Master of Applied Finance and Investment from the Securities Institute of Australia in 2002. Previously, from the Securities Institute of Australia, he obtained a Certificate of Financial Markets (1994) and a Graduate Diploma in Finance and Investment (1999).
- Stuart joined Southern Cross Equities as an equities analyst in April 2001. From February 2002 to July 2013, his research specialty at Southern Cross Equities and its acquirer, Bell Potter Securities, was Healthcare and Biotechnology. During this time, he covered a variety of established healthcare companies such as CSL, Cochlear and Resmed, as well as numerous emerging companies. Stuart was a Healthcare and Biotechnology analyst at Baillieu Holst from October 2013 to January 2015.
- After 15 months in 2015 and 2016 doing Investor Relations for two ASX listed cancer drug developers, Stuart founded NDF Research in May 2016 to provide issuer-sponsored equity research on ASX-listed Life Science companies.
- In July 2016, with Marc Kennis, Stuart co-founded Pitt Street Research Pty Ltd, which provides issuer-sponsored research on ASX-listed companies across the entire market, including Life Science companies.

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