14 July 2023

Submission: Inquiry into the feasibility of undergrounding transmission infrastructure for renewable energy projects

The Australian Pipelines and Gas Association (APGA) represents the owners, operators, designers, constructors and service providers of Australia's pipeline infrastructure, connecting natural and renewable gas production to demand centres in cities and other locations across Australia. Offering a wide range of services to gas users, retailers and producers, APGA members ensure the safe and reliable delivery of 28 per cent of the end-use energy consumed in Australia and are at the forefront of Australia's renewable gas industry, helping achieve net-zero as quickly and affordably as possible.

APGA welcomes the opportunity to provide a submission to the NSW Legislative Council Standing Committee on State Development's Inquiry into undergrounding transmission infrastructure for renewable energy projects. It is critical that the costs and benefits of different approaches to renewable technologies be closely examined.

APGA supports a net zero emission future for Australia by 2050[1]. Renewable gases represent a real, technically viable approach to lowest-cost energy decarbonisation in Australia. As set out in Gas Vision 2050[2], APGA sees renewable gases such as hydrogen and biomethane playing a critical role in decarbonising gas use for both wholesale and retail customers. APGA is the largest industry contributor to the Future Fuels CRC, which has over 80 research projects dedicated to leveraging the value of Australia's gas infrastructure to deliver decarbonised energy to homes, businesses, and industry throughout Australia.

To date it has been assumed that renewable energy generated in REZs will be transmitted via high voltage transmission lines. APGA would like to present a more cost-effective alternative: renewable energy transmission via pipeline, in the form of green hydrogen. A combination of publicly available and ongoing analysis demonstrates that hydrogen pipelines are a superior energy transmission alternative:

- Pipelines are inherently installed underground, avoiding most social licence issues;
- Underground pipelines are cheaper than overhead powerlines and much cheaper than underground powerlines;
- Dispatchable renewable electricity through hydrogen pipelines and power stations is anticipated to be cost competitive with batteries and aboveground powerlines, and cost less than batteries and underground powerlines; and
- Pipelines have additional benefits beyond energy transmission, including storage.

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[1] APGA, *Climate Statement*, available at: https://www.apga.org.au/apga-climate-statement
[2] APGA, 2020, *Gas Vision 2050*, https://www.apga.org.au/sites/default/files/uploaded-content/website-content/gasinnovation_04.pdf

Social license of infrastructure

The cost of energy transmission infrastructure options must be balanced with community concerns about potential impacts. As has been experienced in the development of wind farm assets as well as electricity transmission towers, visual amenity, land access and use, and safety are all real and valid concerns for communities directly affected by or adjacent to these developments. For rural landholders their ability to access and use their properties as they need are also high priorities when it comes to considering new infrastructure.

The gas transmission pipeline industry has long had an exceptional social licence record, in part due to the comparative advantage of gas pipelines in regard to key social licence concerns. Transmission pipelines are inherently underground infrastructure as per design under the Australian Standard AS2885. Other than occasional easement fencing and signage, the occasional aboveground facility is the only visual evidence of the presence of a pipeline. Easements can typically be maintained as recreational corridors or remain available to landholders for most common use cases.

Safety and environmental impacts

Compared to overhead transmission lines, gas transmission pipelines are safer, more reliable, and with fewer environmental impacts.

Transmission towers are vulnerable to extreme weather conditions causing damage and outages, which are becoming more frequent with climate variability. The system black event in South Australia in 2016 resulting from storms and storm-induced failure of six 500kV towers in northwest Victoria in 2020 are indicative of such weather induced failures.

When damaged in storms, aboveground powerlines can introduce bushfire ignition risk.[3] Other interference, such as foreign object impacts and third-party damage also increases this risk. Powerlines themselves are vulnerable to damage from bushfires, as has been seen as recently as the 2019-20 bushfire season.

Pipelines on the other hand have a much more robust track record. The *Pipelines vs Powerlines* study,[4] commissioned by APGA, examined the reliability of energy infrastructure, in terms of 'loss of supply' incidents per 1000km per annum. Pipelines were found to have ten times lower incidence of loss of supply events compared to high voltage transmission powerlines (Table 1). This is largely due to underground pipelines being physically removed from most environmental risks.

Not only do pipelines represent a much lower bushfire risk, but they are also resilient to bushfires. As a bushfire passes above a pipeline it is cooled by the fluid that it transports,

[3] Energy Networks Australia, 2020, *Bushfire factsheet*, https://www.energynetworks.com.au/resources/fact-sheets/bushfire-factsheet-2020/

[4] GPA Engineering, 2022, *Pipelines vs Powerlines: A Technoeconomic Analysis in the Australian Context* available at https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/pipelines_vs_powerlines_-_a_technoeconomic_analysis_in_the_australian_context.pdf; APGA, 2022, *Pipelines vs Powerlines: A Summary*: https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/pipelines_vs_powerlines_-_a_summary.pdf

meaning it is able to continue operating. This means vital energy can continue to be supplied to bushfire-ravaged townships even as the electricity supply is interrupted.

Table 1: Loss of supply events for gas transmission pipelines and high voltage transmission powerlines

Infrastructure	Period of review	Approximate length (km)	Loss of supply events	Event per annum (average)	Events per annum per km
Electricity	2010-2019	43,000	164	18.2	0.42
Gas	2009-2018	39,000	10*	1.1	0.03

* 9 leaks, 1 rupture

Source: GPA Engineering, 2022, *Pipelines vs Powerlines: A Technoeconomic Analysis in the Australian Context*.

As underground infrastructure, pipelines are also exposed to less third-party damage. Overhead high voltage transmission towers are exposed to third party impacts, in turn representing physical risk to people, wildlife and vehicles including electrocution, arcing and entanglement.

Costs of pipelines vs powerlines

Energy transport by natural gas transmission pipeline has historically been substantially cheaper than energy transport via transmission powerlines. Now, studies are showing that the same is also true for hydrogen, with energy transport via hydrogen pipeline is 2-to-4 times cheaper than energy transport via aboveground powerlines,[5] and in the order of 6-to-24 times cheaper to build than underground powerlines.

History of cheaper energy transport via pipeline

Direct comparison of like-for-like gas and electricity infrastructure demonstrates that gas infrastructure is consistently costs less to deliver equal or higher capacity, while drawing lower revenues from customers in comparison to electricity infrastructure. Table 2 and Table 3 below demonstrate comparisons of the regulated asset bases (RABs) of comparable gas and electricity infrastructure in Victoria and the ACT.

Table 2: Costs and deliveries of Victoria's energy infrastructure (2019)

Transmission and Distribution Infrastructure	Regulated Asset Base ($m)	Actual Annual Revenues ($m)	Actual Energy Delivered (GWh)	Max Demand Capacity (MW)
Electricity	17,329	2,825	41,480	8,684
Gas	5,631	774	64,722	23,250

Source: APGA, 2021, *Submission: Victorian Gas Substitution Roadmap Consultation Paper*.[6]

[5] Ibid.

[6] APGA, 2021, *Submission: Victorian Gas Substitution Roadmap Consultation Paper*, https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/210816_apga_submission_to_the_victorian_gas_substitution_roadmap_consultation_paper.pdf

Table 3: Relative cost of energy delivery for gas and electricity distribution in the ACT

Energy distribution networks	Regulated asset base ($m)	Actual annual revenues ($m)	Actual energy delivered (GWh)	Average cost to deliver a GWh ($)
Electricity	981	140	2,851	49,106
Gas	377	67	2,201	30,436

Source: APGA, 2023, *Submission: Regulating for the prevention of new fossil fuel gas network connections*.[7]

In Victoria, the RAB of gas transmission and distribution infrastructure is a third of the size of that of electricity infrastructure, but delivers a third more energy, and can support peak demand 60% higher.[8] Relevant to customer interests, gas infrastructure also generates only 27% of the revenue of electricity, which is related both to the capital cost of the infrastructure and ongoing operational expenditure. Similarly, ACT gas infrastructure delivers 80% of the capacity of electricity infrastructure at 40% of the cost.

Further evidence of the historically lower cost of pipelines compared to powerlines is the consistency to which gas power generation is designed close to existing powerlines, utilising pipelines to transport gas to the power station. This indicates that it is a lower cost option to move the gas to the powerlines, than the powerlines to the gas. Indicative of this dynamic includes the Braemar and Darling Downs power stations and the Kurri Kurri power station.

Costs of building new energy transmission infrastructure

The approximate cost of delivering aboveground powerlines and belowground pipelines is demonstrated through recent project announcements:

- APA's 50km Western Outer Ring Main pipeline is expected to be completed for approximately $185 million, or $3.7 million per kilometre.
- Australian Gas Infrastructure Group's (AGIG) proposed 950km Amadeus to Moomba pipeline is expected to cost $1.2 billion, or $1.3 million per kilometre.
- AGIG's 440km Tanami Natural Gas Pipeline, completed in 2019, cost $346 million or $786,000 per kilometre.
- The 360km HumeLink overhead transmission powerline project is expected to cost approximately $3.3 billion, or $9.1 million per kilometre.
- The proposed 400km Victoria – New South Wales Interconnector West overhead transmission project is also expected to cost approximately $3.3 billion, or $8.25 million per kilometre.

Costs of building undergrounding powerlines

Several studies have examined the potential costs and benefits of undergrounding power lines in Australia. The magnitude of these costs vary, but all are much more expensive than

[7] APGA, 2023, *Submission: Regulating for the prevention of new fossil fuel gas network connections*, https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/230420_apga_submission_-_act_gas_connections.pdf
[8] APGA, 2022, *Pipelines vs Powerlines: A Summary*.

using existing overhead high voltage transmission technology, with the technical challenges also adding considerable time to delivery.

The transmission technology also matters: both HVAC and HVDC are options for long distance transmission lines, and both offer pros and cons. HVDC lines are typically cheaper to underground than HVAC and are suitable for point to point transmission, but HVAC is more flexible and can more readily accommodate network expansion or new equipment.

- In NSW, TransGrid's 2021 report on undergrounding the HumeLink estimated undergrounding preferred routes would cost at least $9 billion (HVDC) and up to $17.1 billion (HVAC), or 3-5 times the total cost.[9] The underground options would also delay completion of the project by several years.
- In Victoria, Moorabool Shire Council's report on undergrounding AusNet's proposed 190km HVDC Western Victoria Transmission Network estimated it would cost approximately $2.7 billion, or 5-6 times the cost of the overhead option.[10]

These studies are consistent with international commentary around undergrounding of electricity transmission infrastructure.

Levelised cost of energy transport/dispatchable energy

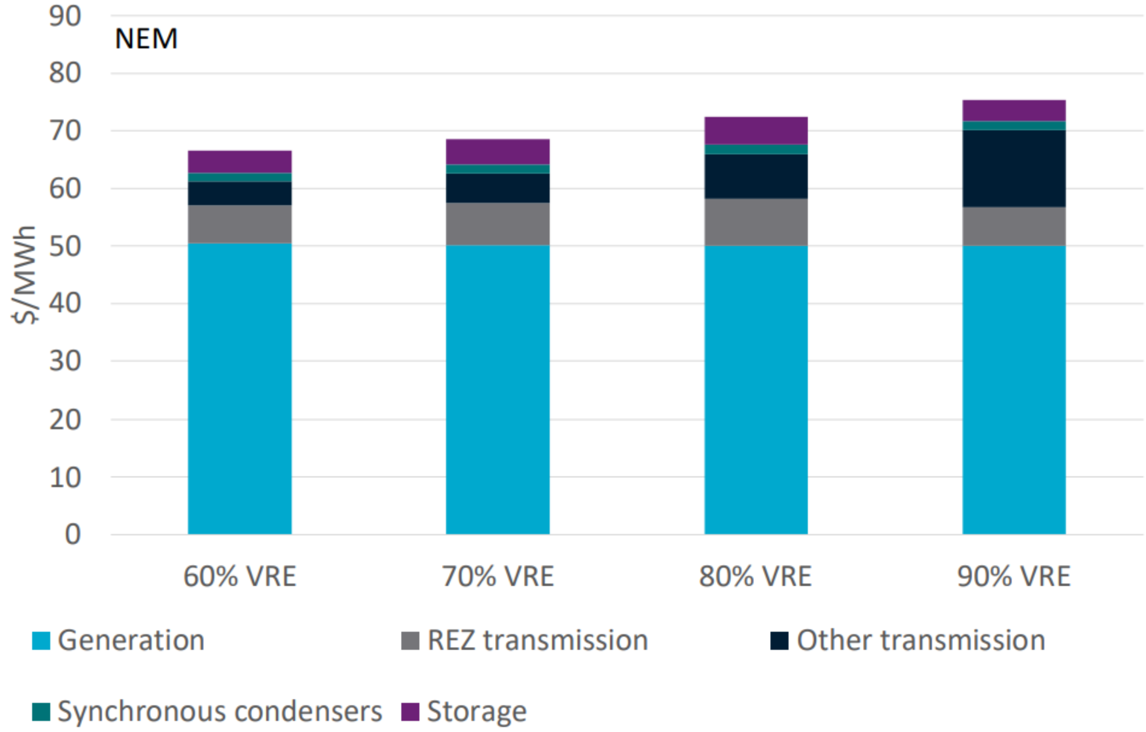
The impact of higher infrastructure costs means that energy delivered by powerlines is much costlier than that of energy delivered by pipelines. This is largely due to the cost of the infrastructure that transports it. To fully understand why this is, it is important to understand the relationship between increasing variable renewable energy (VRE) and increasing cost.

The CSIRO recently modelled what would happen to energy cost at certain percentages of VRE in the NEM. It found that while the cost of generation itself generally remains the same, the relative cost of transmission increases in proportion to the amount of modelled of VRE generation in the NEM (Figure x).

[9] GHD, 2022, *HumeLink Project Underground Report*, commissioned by TransGrid, https://www.transgrid.com.au/media/y0mpqzvw/humelink-project-underground-report-august-2022-final.pdf

[10] Amplitude Consultants, 2021, *Western Victorian Transmission Network Project - High-Level HVDC Alternative Scoping Report*, commissioned by Moorabool Shire Council, https://www.moorabool.vic.gov.au/files/content/public/about-council/large-projects-impacting-moorabool/western-victoria-transmission-network-project-western-renewables-link/wvtnp-high-level-hvdc-alternative-scoping-report.pdf

Figure 1. Levelised costs of achieving 60%, 70%, 80% and 90% annual variable renewable energy shares in NEM in 2030

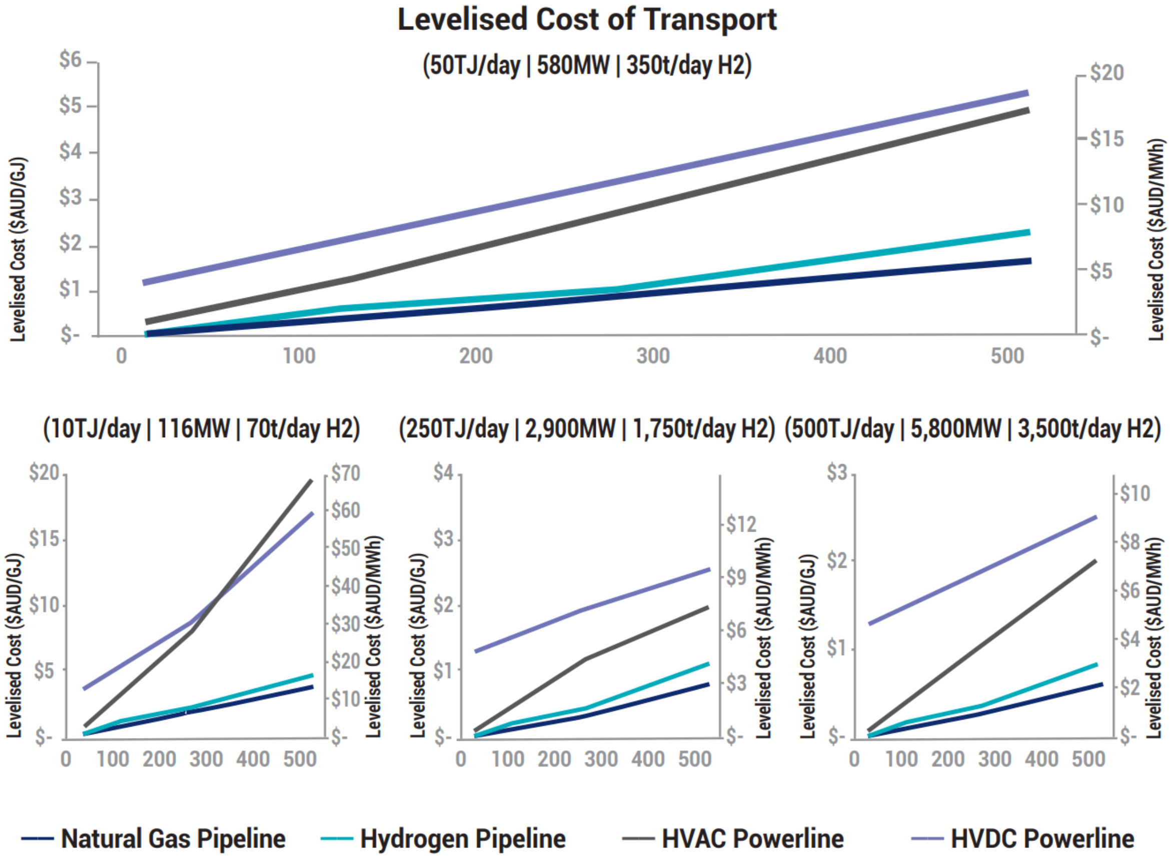


Source: CSIRO, 2022, *GenCost 2021-22 Final Report*, Figure 5-2, p. 56[11]

GPA Engineering's *Pipelines vs Powerlines* report provides further details on this relationship. Both gas and hydrogen transmission pipelines consistently cost less to deliver the same quantity of energy across the same distance in comparison to electricity transmission powerlines. An example of this relationship can be seen in Figure 2, outlining the cost of energy transport for a range of energy capacity scenarios over 500km. This outcome has since been supported by academic research within the Future Fuels CRC.

[11] CSIRO, 2022, *GenCost 2021-22 Final Report*, https://publications.csiro.au/publications/publication/PIcsiro:EP2022-2576

Figure 2: Levelised cost of energy transport via pipelines and powerlines



Source: GPA Engineering, 2022, *Pipelines vs Powerlines: A Technoeconomic Analysis in the Australian Context*

Bonus benefits of pipeline infrastructure

Beyond energy transmission, gas and hydrogen pipelines have additional benefits in providing low-cost energy storage, and in providing much simpler and faster development timeframes due to operating in a contract carriage market.

Quicker, cheaper infrastructure delivered via the contract carriage form of market

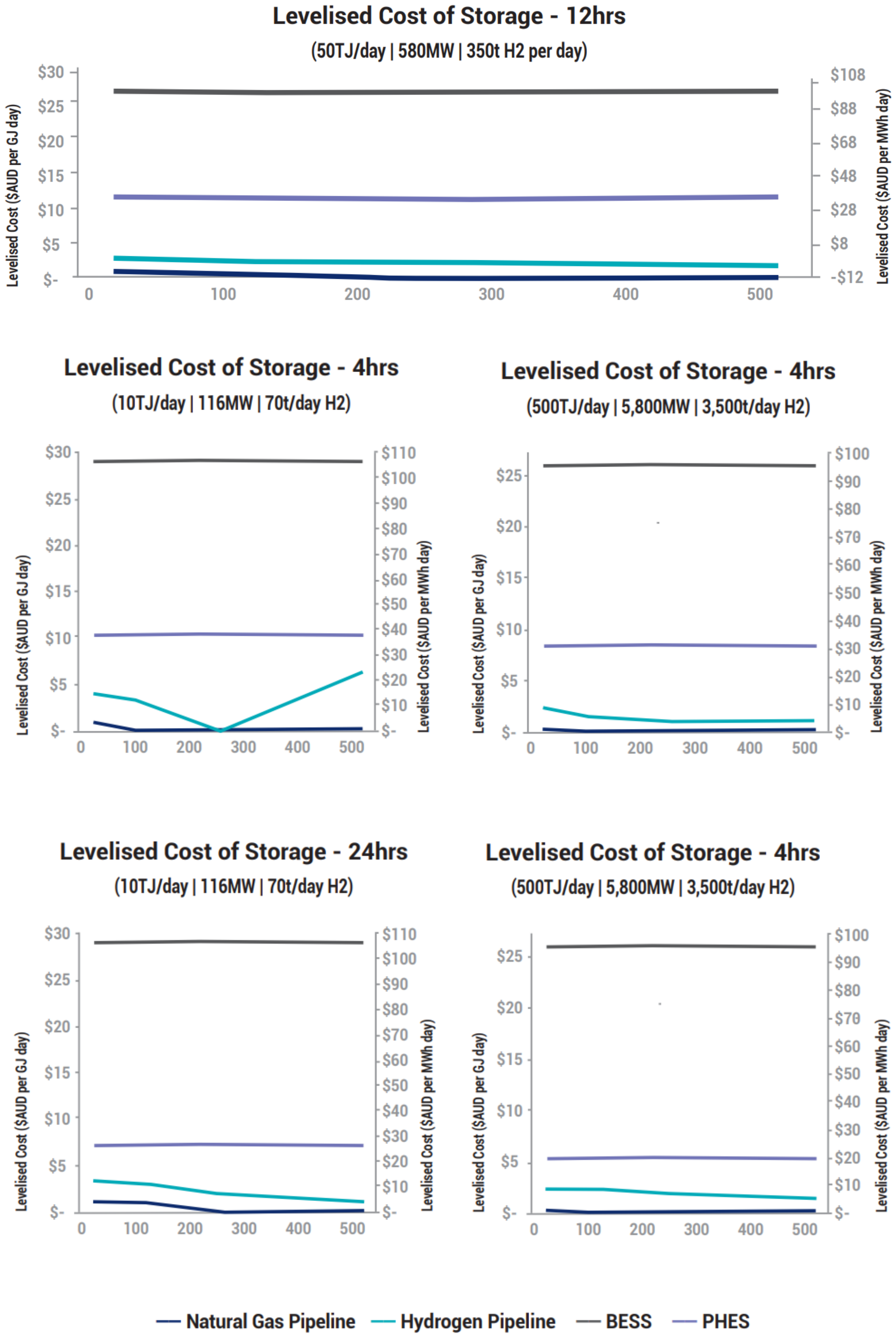
As well as being cheaper, pipelines can be developed much faster than overhead powerline infrastructure. Pipeline infrastructure development is supported by long-term firm supply contracts that provide the necessary certainty for investment. Pipelines can be developed much faster than powerlines as a result of a more streamlined investment process, unburdened by the regulatory hurdles of powerline development.

Due to the commercial nature of the contract carriage model, new pipeline development is inherently the outcome of a workably competitive market. This delivers more economically efficient infrastructure much less susceptible to gold plating in comparison to powerline infrastructure as well.

Lower cost energy storage

GPA Engineering's research examined the levelised cost of energy storage between pipelines and battery (BESS) and pumped hydro (PHES) energy storage solutions, finding that energy storage in pipelines can be hundreds of times cheaper than energy storage in utility scale batteries or pumped hydro (Figure 3). GPA Engineering found that energy storage in hydrogen pipelines can be 2-to-36 times cheaper than energy storage in utility scale batteries or pumped hydro, excluding the instances in which it is essentially free.

Figure 3: Levelised cost of energy storage via pipeline linepack, BESS and PHES



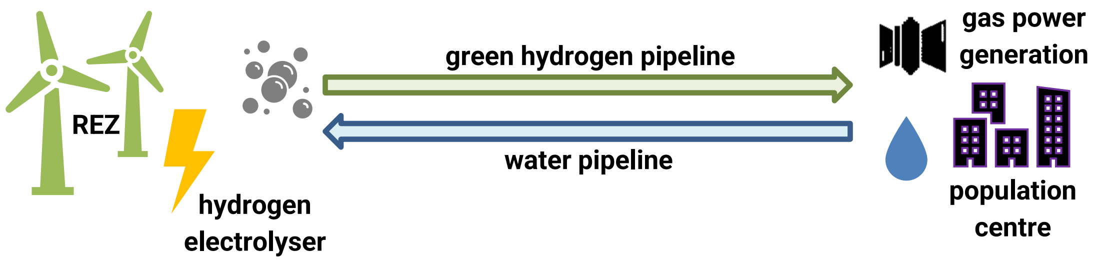
Source: GPA Engineering, 2022, Pipelines vs Powerlines.

An alternative option for New South Wales: transport energy generated in REZs via renewable gas pipelines

It is true that wind and solar deliver lowest cost electricity generation today. However, an electricity system solely comprising of wind and solar generation is not a cheap energy system. As described above, this is why CSIRO projects energy prices to rise with successively higher variable renewable electricity penetration.[12] In short, solar and wind renewable energy is cheap to produce, but can be very expensive to transport to where it is actually needed and store.

Introducing hydrogen infrastructure into the equation can help solve the electricity system cost challenge. By co-locating hydrogen electrolysers with renewable energy generation, i.e. 'behind the meter' alongside wind and solar farms, least cost hydrogen can be produced then transported and stored via hydrogen pipelines. This hydrogen can then be used to generate dispatchable renewable electricity (Figure 4).

Figure 4: A green hydrogen supply chain for REZs



This pathway is anticipated to be a cost-effective way to transport renewable energy across long distances from remote renewable electricity generation and population centres to where the energy is needed. Furthermore, such supply chains would provide much needed dispatchable generation.

Several projects to directly develop or support the development of green hydrogen hubs have been announced recently:

- In South Australia, a $593 million, 200 MW hydrogen facility is being co-located with renewable energy generation near Whyalla, with 250 MWe of electrolysers, 200 MW of power generation, and storage for 3,600 tonnes of hydrogen;
- The Western Australian Government has announced a 1% target for energy generation using renewable hydrogen in the South West Interconnected System;
- Numerous demonstration projects in Queensland are underway to co-locate hydrogen electrolysers with solar farms, such as the Kumbarilla Renewable Energy Park, the Kogan Renewable Hydrogen Demonstration Plant, and the Edify Green Hydrogen project.

[12] CSIRO, 2022, GenCost 2021-22 Final Report.

As noted in the previous sections, hydrogen transmission pipelines are considerably cheaper to build than standard overhead high voltage transmission lines, and substantially cheaper than underground transmission lines. This option would also solve a key conundrum in increasing the share of variable renewable electricity in the grid – that of storage, which pipelines also provide at low cost.

To discuss any of the above feedback further, please contact me on +61 422 057 856 or jmccollum@apga.org.au.

Yours Sincerely,

JORDAN MCCOLLUM
National Policy Manager
Australian Pipelines and Gas Association