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23 June 2025

Australian Energy Market Operator

By email: ISP@aemo.com.au

Lochard Energy submission – Draft 2025 Gas Infrastructure Operations Report

Lochard Energy (**Lochard)** appreciates the opportunity to provide feedback on the draft 2025 Gas Infrastructure Options Report, published by the Australian Energy Market Operator (**AEMO**) in May 2025 (**GIOR**).

As the owner and operator of the Iona Underground Gas Storage Facility in Port Campbell, Victoria (**Iona**), we have witnessed increasingly frequent inter-dependency of electricity and gas systems with the buildout of renewables. We also recognise the important role that gas and gas-fired generators will play in delivering secure, reliable, and more affordable energy to Australian households and businesses while moving towards a lower carbon future.

Lochard applauds the recent rule change to enhance gas analysis in the ISP and improve consistency across AEMO's planning reports. Lochard also supports the scope including renewable gas developments and incorporating some cost estimates in the ISP planning horizon. This is a good first step in establishing the availability and supply limitations in the existing system before overlaying various development options. As the process matures, Lochard recommends that AEMO incorporates an element of the repurpose and utilisation of existing infrastructure and evolves towards an approach of cost estimates based on recent benchmarks.

Our feedback on these issues is set out below. If you would like to discuss this submission, please contact EE Siew Ong, Senior Operations Specialist at EeSiew.Ong@lochardenergy.com.au.

Sincerely,

DocuSigned by:
Becky Nguyen
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Becky Nguyen
GM Commercial
Lochard Energy

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Section 1: Consultation question responses

1. *Do you have any feedback on the gas infrastructure base costs, adjustment factors and escalation indices provided by GHD?*

Overall, the costs for wells and pipelines are lower than our experience with projects delivered over the years in delivering progressive expansion of Iona.

The GHD cost data, particularly for wells (cost and performance), appears to be indicative of a project development in an onshore Queensland basin. It is recommended that GHD differentiate the basin location for these costs as underground gas storage developments in other regions can have differing well performance and drilling costs. The costs also need to differentiate between onshore and offshore developments.

Separately, as biogas production increases in Australia, "behind the meter" installations will be less common, resulting in more biogas ultimately being injected into the gas distribution or transmission networks. To facilitate injection, biogas requires upgrading (removal of common contaminants) to meet AS 4564 Natural Gas specifications, as well as additional gas compression and gas pipeline installation. GHD cost data appears to exclude the costs associated with biogas upgrading and connection to the gas distribution or transmission network. This can contribute an additional 15-20% capex.

2. *Do you have any feedback on the methodology for the gas infrastructure base costs and forecasts provided by GHD?*

Prior to settling on factors to be used, a wider industry consultation seeking benchmark from recent projects is recommended.

3. *Do you agree with the proposed forecasting approach of applying a single set of cost escalation indices for gas infrastructure components across all ISP scenarios?*

The use of such factors needs to be carefully considered. Other factors which could have significant impacts on cost are:

- Greenfield projects versus augmentation of existing assets. Augmentation projects will often have a lower incremental capex and opex than new greenfield developments.
- Location: well costs are not the same for each location.
- Onshore vs offshore.
- Scale: higher overhead and mobilisation/demobilisation factors for smaller projects or shorter distance pipelines.
- Other unique aspects for each individual project that could affect capex.

4. *Of the list of gas infrastructure options mentioned in Section 3.2.2 and provided in Appendix A2, are there any options that should not be included, or any further options that should be considered?*

Otway onshore has one of the best geological settings for underground gas storage development. Lochard is working to identify further possible prospects in the region for development post HUGS.

5. *Will AEMO's proposed gas supply and pipeline zone limitations be effective in limiting fuel availability for GPG?*

The zone settings look appropriate for the base case reflecting the setting of the existing infrastructure network and approach to supply in each region, however Lochard expects the zone settings will evolve as the optimal infrastructure options are explored.

6. *Considering the purpose of the assessment, is it reasonable to apply priority to residential, commercial, and industrial customers ahead of GPG?*

Lochard proposes GIOR adopts the same approaches currently used in VGPR and GSOO for supply and demand responses. This approach recognises the work front to enable effective demand response and to make it more visible in the supply and infrastructure planning process. This approach also recognises the need to consider the cost and benefits of demand responses across electricity and gas combined.

7. *Are there any supply zones missing? Are there any supply zones that will be unrealistically represented by the proposed constraints to gas supply?*

Lochard is of the view that careful consideration is required for the Southwest pipeline zone. As currently proposed in the draft report, the South West Pipeline zone is limited by the capacity of SWP without taking into account ~900TJ/d of production capacity available in the region. In addition, there is potential to add further volume of UGS within close proximity of the Otway region.

The capacity of SWP may be appropriate as a constraint for GPGs located in the Melbourne zone. However, GPGs can establish direct connection with the storage or production facility, in lieu of connecting into the SWP. This option provides the best possible supply certainty and flexibility to a fleet of GPGs, therefore Lochard proposes establishing a stand-alone Iona CPP zone to test its effectiveness in the ISP.

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Section 2: Hydrogen considerations

Section 2.1: UHS Depleted Gas Field

Section 2.5.1 of the GHD Gas Infrastructure Cost report states that: "Currently there are no salt caverns in operation in Australia, and the location of potentially suitable geological formations is such that there appears to be no reasonable reason to include this category of gas storage in this section", yet section 2.9.4 of the report has been dedicated to this technology which is unexplored, has very complex geotechnical and environmental challenges, is locationally challenged, and has significant project progression time scales.

Lochard believes that the GIOR and Gas Infrastructure Cost report needs to contemplate hydrogen storage in porous rock formations / depleted gas fields as an important, emerging low-carbon intensity option for long duration energy storage in the horizon of the ISP, and recommends a new section under Hydrogen be included as "UHS Depleted Gas Field" to address the emerging technology.

This section is based on research and investigations undertaken by Lochard's proposed H2RESTORE Project, with a Feasibility Study partly funded by ARENA due to complete in Q4 2025, and is focussed on the use of hydrogen for large (utility) scale underground hydrogen storage in porous rock formations / depleted gas fields.

Depleted gas fields are located across Australia and a number of these are proximate to significant existing infrastructure including gas pipelines, gas facilities, power infrastructure including high voltage transmission grid lines and gas fired power stations (GPG). The H2RESTORE project is targeting the high capacity and high deliverability sandstones of the onshore Otway Basin of southwest Victoria and the proximity to a 500kV transmission line and multiple grid connection options in an area where either recycled wastewater or ample deep aquifer water is available. See Figure 1 below.

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Figure 1: The Infrastructure of the Onshore Otway Basin, Southwest Victoria

While there are many similarities to developing an underground gas storage field, some differences should be noted and adjustments for UHS will be required. The equipment required to develop and operate a UHS project for use in firming the electricity is expected to include:

1. Storage Field(s) and associated Hydrogen Storage Site (HSS) for access to wells: Depleted gas field(s) with storage wells suitable for hydrogen.
2. Bi-directional hydrogen pipe to/from hydrogen production / hydrogen GPG site to HSS. Alternatively, the Hydrogen Storage and Hydrogen Production and Generation facilities could be co-located, with connection to the NEM via a dedicated high voltage transmission line.
3. Hydrogen Production Facility (HPF) / Hydrogen Powered Generator (HPG). Lochard considered sizing from 200 – 500 MW for electrolysis and 400-600 MW of hydrogen powered generators.
4. Compression – Hydrogen compression would be required to inject the hydrogen into storage.
5. Water – Demineralised water is required for electrolysers. Depending on localities either deep aquifer water or water treatment plant waste-water can be processed to a demineralised state. Water can be piped to suitable HPF/HPG locations.

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Section 2.2: Cost estimates for UHS in Salt Caverns

Lochard would also like to comment on the cost assumptions in the Gas Infrastructure Cost report, section 2.9.4 Salt Cavern. This section states that "These costs are from US projects that have been converted from USD to AUD. A location factor of 1.4 to 1.527 is recommended, however due to the lack of existing projects like this in Australia a factor of 1.5 is applied".

Lochard believes that the location factor should be increased to up to 3 times. First, a 1.5 factor would barely cover the normal cost difference between a US-based petroleum well and an equivalent Australian well. Second, salt deposit locations in Australia are extremely remote, adding cost and, third, there is a time factor which has not been taken into account to cover salt deposit exploration, salt dome delineation, and geomechanical assessments, prior to any consideration of development. Personal (Rod Harris, Lochard) communications with established European salt cavern operators (Storag Etzel[1], Hystock[2], Uniper[3]) indicate that the leaching or solution mining process for a new cavern can take 4-7 years to leach and establish gas tightness.

Further, given the remoteness of any possible salt deposit in Australia, connection of this storage option to existing infrastructure and facilities is strongly challenged.

Our view is Underground Hydrogen Storage in depleted gas reservoirs is much more viable within the Australian context. Depleted gas fields suitable for UHS are already within areas which have excellent proximity to the East Coast Gas Market.

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1 Storag Etzel has 75 salt caverns established since the early 1970's. Their H2CAST UHS project which is operational, is based around the conversion of existing caverns. Home | STORAG ETZEL

2 Hystock which is owned by the Dutch utility Gasunie, is also a UHS in salt cavern pilot project. The caverns at Zuidweding are developed and operated by Nobian a specialist salt solution mining company. HyStock

3 Uniper are also pilot testing UHS in salt caverns at Krummhorn in northern Germany. Currently they have developed a 3,00m3 cavern for test purposes. They have caverns they can convert in the 500,000m3 range but have also indicated 3-4 years for solution mining new caverns. HPC Krummhörn | Uniper

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APPENDIX 1: Underground Hydrogen Storage in Depleted Gas Fields

In a similar way to Underground Gas Storage[4], Underground Hydrogen Storage (UHS) in depleted gas fields is progressively being determined to be technically feasible[5]. UHS offers the potential for utility-scale energy storage. Compared with above-ground storage solutions, Lochard considers large-scale geological storage to be safer and more economic. It is a developing technology which could support variable renewable energy generation in a similar way to UGS for GPG peaking generation but with lower carbon intensity[6].

While UHS in depleted gas fields has been an emerging technology, significant progress has been made, with European pilot projects and reports leading the way:

- RAG Austria AG - USS203 Project. They are ready to deploy UHS at commercial scale. Refer to https://www.rag-austria.at/en/contact/press-releases/seasonal-electricity-storage-in-the-form-of-hydrogen-ready-for-scale-up
- Uniper's Hystorage Project. HyStorage | Uniper
- The IEA Hydrogen Technical Collaboration Programme - Task 42. Final report https://www.ieahydrogen.org/tasks-reports/Both the International Energy Agency and the International Renewable Energy Association cites hydrogen storage as a complementary technology to renewable energy.

In terms of scale, UHS holds the potential within Australia to store GW to TW hours of energy[7], refer to Figure 2 below.

[4] Section 2.5.1 Underground Gas Storage, Gas Infrastructure Cost | Building Block costs for gas infrastructure, AEMO, 15 May 2025
[5] IEA Hydrogen TCP Task 42 Final Report, https://www.ieahydrogen.org/tasks-reports/
[6] Boyukagha Baghirov, Denis Voskov, Rouhi Farajzadeh, Exergetic efficiency and CO2 intensity of hydrogen supply chain including underground storage, Energy Conversion and Management: X, Volume 24, 2024, 100695, ISSN 2590-1745, https://doi.org/10.1016/j.ecmx.2024.100695.
[7] Jonathan Ennis-King, Karsten Michael, Julian Strand, Regina Sander, Chris Green, Project number: **RP1-1.04** Underground storage of hydrogen: mapping out the options for Australia, Future Fuels CRC, July 2021, https://www.futurefuelscrc.com/project/underground-storage-of-hydrogen-mapping-out-the-options-for-australia-rp1-1-04/

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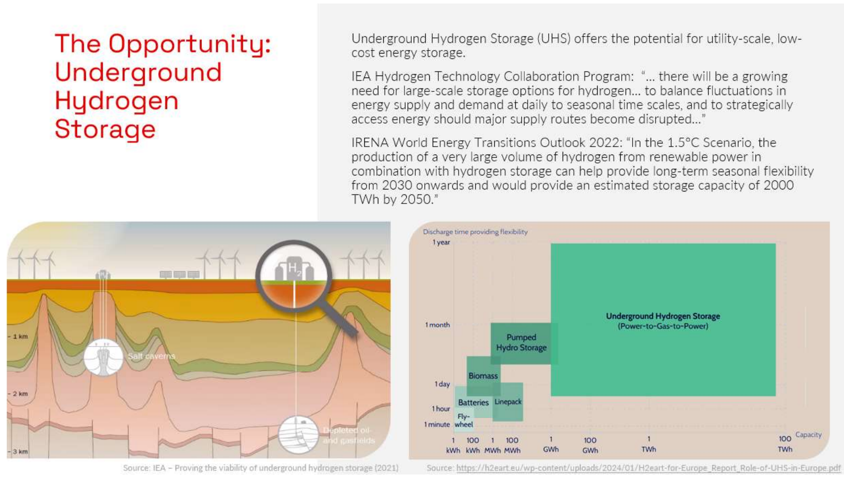
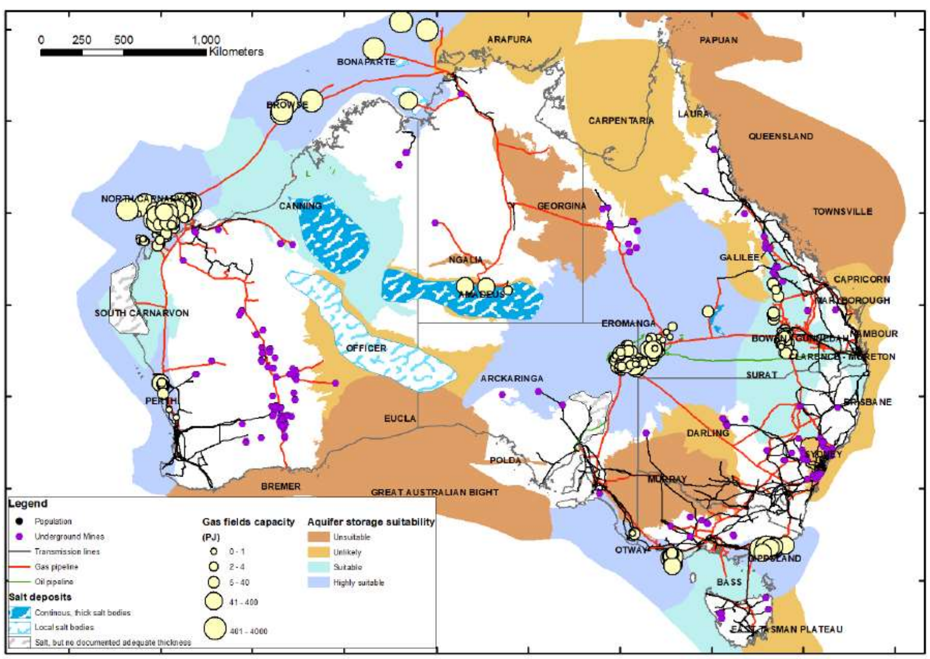
Figure 2 The opportunity for Underground Hydrogen Storage



In Australia, the Future Fuels CRC report: RP1.1-04 Underground storage of hydrogen: mapping out the options for Australia provides a comprehensive overview of suitably located depleted gas fields which could be developed for UHS in strategic locations across Australia. [RP1.1-04 Underground storage of hydrogen: mapping out the options for Australia - Future Fuels CRC]

Figure 3 UHS Options in Australia[8]



8 [RP1.1-04 Underground storage of hydrogen: mapping out the options for Australia - Future Fuels CRC]

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APPENDIX 2: H2RESTORE Long Duration Storage Concept

Lochard is proposing to develop the H2RESTORE Project, which aims to commercialise the storage of hydrogen in existing depleted gas reservoirs. The project is currently in the feasibility stage and its progression is subject to commercial, regulatory, approvals, and other factors.

Large scale underground hydrogen storage may assist in a reduction in the cost of producing hydrogen by utilising low-cost electricity generated during times of high renewable generation.

The stored hydrogen could be used as a deep energy reserve to support the National Electricity Market (NEM) during times of energy supply shortages which could include low renewable energy production or market events. It also has the potential to provide a consistent supply of lower-cost hydrogen to the emerging clean fuels industry and other hard-to-abate sectors.

Figure 4 H2RESTORE – Long Duration Storage Concept