16 February 2023

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Key messages

- ENA supports AEMO's overall modelling approach through the Integrated System Plan to inform the planning for the electricity transmission network.
- Care should be taken when using these inputs, assumptions and scenarios to inform gas market planning because assumptions about electrification of gas use are incomplete. This risks sending uncertain investment signals.
- The opportunity of hydrogen is only recognised in the Green Energy Exports scenario and the assumptions unnecessarily constrain hydrogen in the other scenarios.
- ENA recommends an additional sensitivity that removes the hydrogen constraints.
- IASR assumptions around hydrogen transport raise concerns of additional costs for domestic customers.

On 16 December 2022, AEMO released its draft 2023 Inputs, Assumptions and Scenarios report (Report) for consultation. Energy Networks Australia (ENA) welcomes the opportunity to provide comments on the Report.

ENA is the industry body representing Australia's electricity transmission and distribution and gas distribution networks. Our members provide more than 16 million electricity and gas connections to almost every home and business across Australia.

This submission reflects the views of ENA's gas distribution network members on issues principally impacting the gas sector. Views of our transmission network members have been provided in their own submissions.

ENA supports AEMO's overall modelling approach through the Integrated System Plan to inform planning for the electricity transmission network.

ENA supports the role of the IASR and ISP in providing tangible and credible scenarios on which to make informed and least regrets decisions for planning and investment in the transmission system in the NEM. It also plays an important role in signalling long-term investment needs in the generation and firming capacity needed as the power system transitions to meet net-zero emissions commitments.

AEMO should also be alive to the increasing demands on the ISP as a source of truth for broader energy system modelling. Reinforcing this context, Energy Ministers have decided to review and 'supercharge' the 2024 ISP and future integration of system planning across the gas and electricity sectors.[1]

Given this context it is important to ensure scenarios, inputs and assumptions that relate to the complex interactions between the gas and electricity systems do not inadvertently favour particular technologies or approaches to decarbonisation. Instead, they should, at this early stage in understanding the interactions, maintain an openness to testing a range of scenarios.

The current approach is not appropriate to inform gas market planning because assumptions about electrification of gas use are incomplete. This risks sending uncertain investment signals.

As noted above, the scenarios and assumptions of the IASR's are principally used to determine the future needs of the electricity system as it transitions. This includes the NEM Electricity Statement of Opportunities (ESOO), the Gas Statement of Opportunities (GSOO) for eastern and south-eastern Australia, and the Integrated System Plan (ISP).

In its current form, care should be taken when using the assumptions developed for the power sector scenario planning in gas system planning. The assumptions lack critical information needed to accurately assess the impact of electrification.

For example:

> *AEMO engaged consultants CSIRO and ClimateWorks Centre (CWC)* ***to model least-cost pathways*** *for the Australian economy to achieve emissions targets within the parameters of scenario-based demand drivers, including economic growth, CER and road transport EV forecasts, and alternative gas uptake (such as hydrogen and biomethane). (Emphasis added)(Report , pg 42)*

However, the CSIRO and ClimateWorks modelling cannot determine the least cost pathways as it does not consider the full range of costs associated with electrification and/or conversion to renewable gas. These costs include, but are not limited to:

» the additional costs for the electricity distribution networks to meet the increased peak demand from fuel switching gas heating to electrical heating during winter. The analysis for Gas Vision 2050[2] indicated that net zero emissions could be reached while continuing to use gas infrastructure at half

[1] Energy Ministers' Meeting Communique, 28 October 2022, p2.
[2] https://www.energynetworks.com.au/resources/reports/2020-reports-and-publications/gas-vision-2050-delivering-a-clean-energy-future/

the cost compared to full electrification. This is a cost savings of between $12 and $14 billion per year by replacing natural gas with hydrogen instead of electrifying the end use of gas.

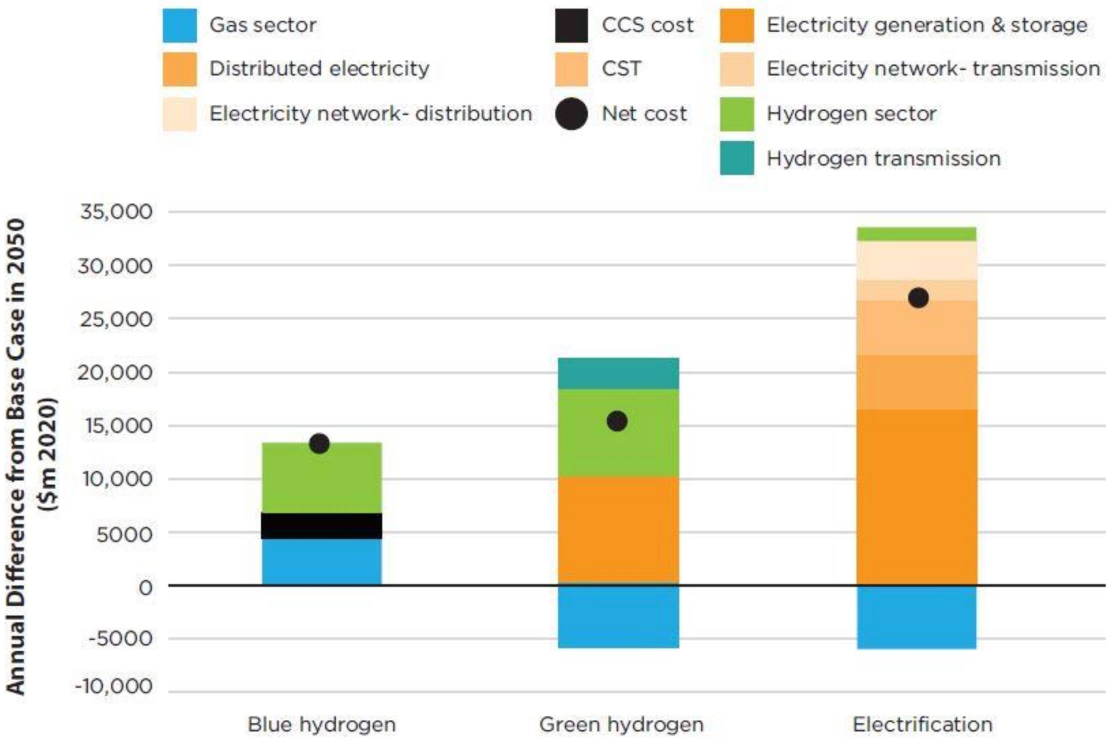


Figure 1: Net cost of decarbonising gas by scenario (Source: Gas Vision 2050)

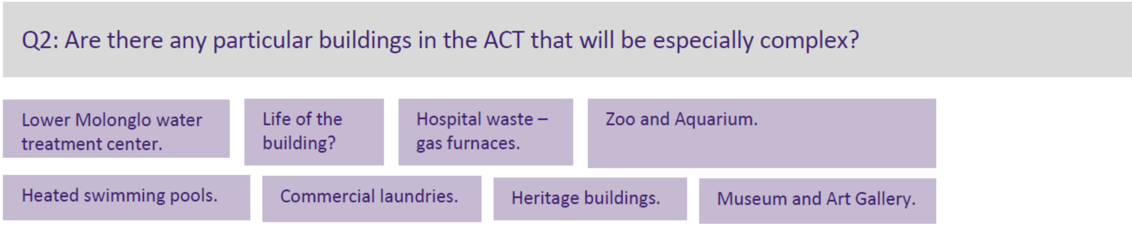
- the relative costs of upgrading to electrical appliances compared to gas or renewable gas appliances. A recent report by Frontier Economics[3] found that electrifying Victorian homes (and assuming whole of home heating and cooling is required) could cost between $14 to $31 billion more than replacing them with new gas appliances capable of burning hydrogen.

Furthermore, the modelling by CSIRO and ClimateWorks assumes that all buildings can be electrified, but in the real world this is not the case. There are many instances where electrification is not suitable based on:

- whether the building is heritage listed,
- available space for larger heat pump appliances compared to gas appliances,
- heat duty of apartment blocks that cannot be met with electrical alternatives without major infrastructure upgrades, and
- the suitability of existing meters to provide 3 phase power.

At the recent ACT Gas Transitions Pathway workshop, it was recognised that there are a range of “complex” buildings that could not easily be electrified including:

[3] https://gamaa.asn.au/wp-content/uploads/2022/07/Frontier-Economics-Report-GAMAA.pdf



Source: ACT Government (Nov 2022), *Powering Canberra – our Pathway to Electrification – Forum Snapshot Report.*

The IASR has not reasonably considered the challenges with electrification and the assumptions within the multi-sector modelling which does not address the known complexities of electrifying buildings. Furthermore, the IASR does not appropriately account for consumer preferences for gas or electrical appliance use. As such, using the IASR as a basis for modelling the implications of electrification on the gas sector is unlikely to produce clear and robust results that can helpfully inform decisions in the gas sector.

The opportunity of hydrogen is only recognised in the Green Energy Exports scenario but the assumptions unnecessarily constrain hydrogen in the other scenarios.

Three of the four scenarios limit hydrogen blending to 10 per cent. This restriction necessarily results in electrification (once the electricity sector is decarbonised) being selected to decarbonise the gas sector instead of exploring the opportunity for renewable hydrogen. The Green Energy Exports scenario shows a major role for hydrogen in all sectors by 2050.

This limitation appears to be based on hydrogen blend limits for current natural gas appliances and that any transition to a higher level of hydrogen would require an appliance changeover. What is not considered, is that an appliance changeover will also be required when electrifying the gas load.

The Hy4Heat program in the UK has developed certified household appliances that work on 100 per cent hydrogen. These appliances include cooktops, space heaters, boilers, hot water heaters and meters. Components for gas appliances have also been developed including meter sets, a pressure regulator, an emergency control valve, an excess flow valve and flexible hose and fittings suited for hydrogen applications. Leaflets from the manufacturers for these range of appliances have been produced. https://www.hy4heat.info/wp4

These appliances and components have been certified and are being demonstrated in the UK's hydrogen home – HyGrove[4]. These appliances were also showcased at the COP26 meeting in Glasgow in late 2021[5].

The UK's four largest gas appliance manufacturers, who have developed the certified gas appliances, have committed to produce hydrogen-ready boilers at the same price as their natural gas systems today[6].

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[4] https://www.northerngasnetworks.co.uk/2021/07/15/first-hydrogen-homes-open-to-the-public/ or https://www.youtube.com/watch?v=4ciu4qiVaDo
[5] https://www.hy4heat.info/wp8
[6] Energy & Utilities Alliance (2021), *The Upfront Cost of Decarbonising Your Home*, available from: https://eua.org.uk/resources/residential-heat-the-upfront-cost-of-decarbonising-your-home/

> Whilst hydrogen-ready boilers are not readily available today, they have been deployed for testing under the UK Government's Hy4Heat programme, and UK boiler manufacturers Worcester Bosch, Vaillant, Baxi, and Ideal have committed to produce them at the same price as their natural gas systems today. The UK Government will soon consult on mandating hydrogen-ready boilers by 2026.

Figure 2: Commitment of boiler manufacturers to delivers hydrogen ready boilers at the same price as their natural gas systems today.

To minimise the impact on conversion to hydrogen, ENA (UK)[7] is supporting an approach to mandate hydrogen-ready boilers from 2025. The intention of this mandate is to replace gas boilers at the end of their life with a new equivalent that can easily be converted to hydrogen once networks are fully converted to hydrogen. These hydrogen-ready boilers can be converted by replacing some minor components within the boiler, and this reduces the conversion time to around 1 hour. Mandating hydrogen-ready boilers before a conversion to hydrogen allows the stock of appliances to be partially replaced with hydrogen-ready appliances and minimises the total number of boilers that need to be upgraded when the network converts to 100 per cent hydrogen. This both minimises disruptions and costs of the conversion.

Australia is not as well advanced as the UK in developing appliances dedicated to the Australian market. There are several hydrogen BBQs available in Australia[8] used to demonstrate the role of hydrogen.

Australia's gas appliance manufacturers are actively engaged in the appliance research program[9] at Future Fuels CRC and are also independently pursuing the development of hydrogen appliances for the domestic market.

Restricting the role of hydrogen does not adequately reflect the potential opportunities for hydrogen to be used more to reach net zero emissions at lower cost (as noted above) but results in modelled outcomes that potentially overstate electrification. At the very least, the uncertainty in potential future pathways and costs for a hydrogen transition should be recognised in scenarios and sensitivities.

ENA recommends an additional sensitivity that removes the hydrogen constraints. As noted above, a limitation in the modelling is the unnecessary constraint of hydrogen in the scenarios (except Green Energy Export). Removing these constraints would remove the electrification bias and see a higher hydrogen demand. This could result in a different role of renewable gases in gas networks.

IASR assumptions around hydrogen transport raises concerns of additional costs for domestic customers.

The Report assumes that electricity will be delivered to the end user via electricity transmission lines and then converted to hydrogen.

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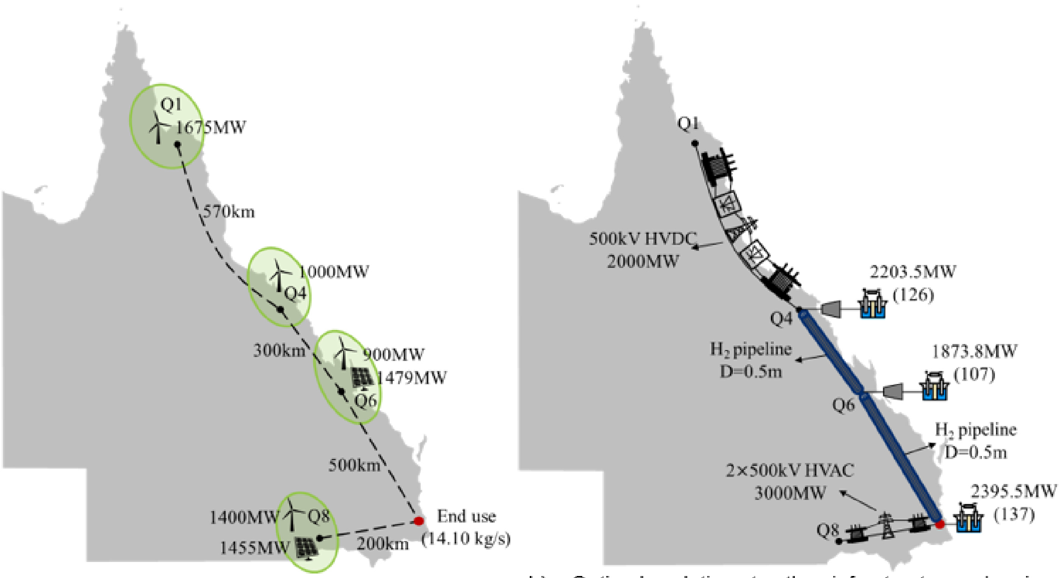
[7] https://www.energynetworks.org/newsroom/why-were-backing-mandating-hydrogen-ready-boilers-for-homes
[8] For example: https://www.australiangasnetworks.com.au/news-and-articles/life/hydrogen-bbq-callum-hann-grilled-lamb
[9] https://www.futurefuelscrc.com/program_area/compatibility-of-end-user-equipment-with-future-fuels-rp1-4/

<u>3.12 Hydrogen infrastructure:</u> The ISP model is currently configured to transport electrons via electricity transmission, with electrolysers located at export ports or close to domestic electrical load centres. At this stage AEMO is not proposing to increase the complexity of the model's derivation to incorporate the alternative configuration (pg 148 of Report)

This may be a valid simplification and aligns with the primary purpose of the ISP to be used for planning of the power system. However, it may not provide the best option for delivering hydrogen to customers. The most efficient way of producing and delivering hydrogen should consider a broad range of factors such as:

- the amount of hydrogen required,
- the variability of that hydrogen demand throughout the year,
- the need for short term and long storage,
- the availability of water,
- the distance between the renewable generation and the hydrogen demand centre,
- other demand centres.

Future Fuels CRC[10] is developing a range of models that can be used to inform the planning of this infrastructure. A hypothetical scenario, for hydrogen demand in south eastern Queensland shows that both electricity transmission lines and gas pipelines have a role to play in an optimised system to deliver hydrogen to customers.



a) RES capacity in 2040 according to AEMO's REZ [10].

b) Optimal solution to the infrastructure planning problem in Figure 3 a).

<u>Figure 3: Case study for optimal infrastructure planning for a hydrogen demand in south eastern Queensland (source: FFCRC RP1.1-02B - Transport and Storage Options for Future Fuels[11])</u>

[10] https://www.futurefuelscrc.com/project/rp1-1-02b-transport-and-storage-options-for-future-fuels/

[11] Mhanna, S, et al (2022), *Towards optimal integrated planning of electricity and hydrogen infrastructure for large scale renewable energy* transport, 11th Bulk Power Systems Dynamics and Control Symposium, Banff, Canada.

Separate research in the UK has also reached a similar conclusion that electricity transmission lines are not necessarily the lowest cost option to deliver the electrons needed to produce hydrogen:

> *Imperial College's 2018 analysis on heat decarbonisations pathways, demonstrated that investment costs for a national hydrogen transmission system is approximately 5.5 times cheaper than the equivalent investment required for onshore electrical transmission system, and 7.1 times cheaper than subsea transmission. (Source: Hydrogen UK, 2023[12])*

While the above is an example of a case studies, the assumption by AEMO that all transport will occur via electricity transmission lines will not be optimal and risks customers paying too much for unnecessary energy infrastructure.

A similar concern arises with the assumption that hydrogen export projects will be connected to the NEM. We note that the IASR states that not all hydrogen production for export will be connected to the NEM but it is unclear how much continues to be NEM connected.

If you would like to discuss the contents of this submission, please contact Dr Dennis Van Puyvelde at dvanpuyvelde@energynetworks.com.au

Regards,

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[12] Hydrogen UK (2023), *Recommendations for the acceleration of hydrogen networks.*