15 September 2023

Submission: Climate Change Authority consultation on economic modelling of potential Australian emissions reduction pathways

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 contribute to the Climate Change Authority (CCA) consultation on economic modelling of potential Australian emissions reduction pathways (the **Consultation**). We commend the CCA on its dedication to delivering accurate modelling standards to drive the most economically efficient decarbonisation pathways for Australia.

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.

The Australian public and business community deserve equal access to all economically viable energy decarbonisation options to decarbonise their energy needs. The scale of the decarbonisation challenge is immense. We need access to all tools in the tool chest if we are to be successful. Economic modelling is critical to enabling access to these tools – a simple sniff-test rarely recognises the broader complexities of the energy transition.

For example, the most energy efficient energy decarbonisation choices are not always the most economically efficient choices. The misnomer that Australia requires the most energy efficient decarbonisation pathway demonstrates the complexity that can be missed without economic modelling. Rather than the most energy efficient decarbonisation pathway, Australian citizens and businesses – and especially low-income Australian households – deserve access to the most *economically* efficient energy decarbonisation choices.

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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

In the pages that follow, APGA provides general advice relating to effective economic modelling practices required to identify economically efficient energy decarbonisation pathways. Many of these practices increase complexity and hence difficulty in modelling. The opportunity to identify lower cost or cost competitive pathways for energy customers must beheld above the desire for a simple model or simple model outputs.

Based upon its general advice, **APGA recommends that the CCA:**

- Provide the Australian public with greater choice, opportunity, and capacity to decarbonise their energy use by analysing renewable energy options for all energy vectors, be they solid, liquid, gas or electric, on equal grounds to one another.
- Endorse a shift away from using and producing single datapoints in economic modelling, and a shift towards using and producing more robust data ranges as a minimum standard.
- Consider renewable energy options to be cost competitive where combined cost ranges for firm renewable energy supply and appliance use overlap significantly.
- Recognise the impact of customer choice on purely economic outcomes by making recommendations which recognise that some customers may choose to pay more for the decarbonisation option which they prefer for non-economic reasons.
- Consider the cost of firm energy supply in its modelling, rather than energy generation/production costs alone.
- Consider the application of Diffusion of Innovation theory in projecting potential new technology uptake rates rather than straight line trajectories.
- Include analysis of job and emission offshoring, potentially as a relative impact between decarbonisation pathway choices.
- Commission research into how to best address difficult to factor aspects of Australian decarbonisation such as sector coupling and supply chain constraints.

APGA also provides details of macroeconomic modelling which it has commissioned and is currently underway to demonstrate the economic impacts of a Renewable Gas Target. It is hoped that this analysis can be used as an example of why cross sectoral modelling is needed to understand decarbonisation options for all energy vectors in Australia.

Beyond general advice, APGA provides feedback on the 6 questions posed within the consultation. To these questions, **APGA recommends**:

- **Q1:** The CCA seek to create decarbonisation plans for each energy vector by introducing a third modelling question – What are the likely emissions reduction pathways, outcomes, risks and opportunities for Australia’s four energy vectors (solid, liquid, gas and electric energy vectors) under different national emissions pathways to net zero?
- **Q2:** The CCA note of the lack of gas system modelling capability within the CSIRO. APGA and its members offer direct engagement with CSIRO or any modelling resource the CCA engages to provide expertise in support of robust gas system modelling.
- **Q3:** The CCA ensure that Australian data be used ahead of more generic global data for supply chain economics and all renewable energy alternatives where available.

- **Q4:** The CCA would gain the most valuable modelling insights from analysis of scenarios which include a gas supply chain which is allowed to or driven to decarbonise towards net zero emissions by 2050.
- **Q5:** The CCA should consider advanced manufacturing practices to lower the cost of renewable energy component production onshore in Australia, and separately consider modelling of increased risks to low-income and other disadvantaged communities through emission reduction pathways and scenarios.
- **Q6:** While regional analysis was ruled out by the CCA, some aspects of analysis will need to be regional in order to deliver robust results. In particular the cost of decarbonising heat in the home and in industry between cold and warm climates requires regional analysis.

Robust economic modelling of all renewable energy pathways provides the opportunity to identify and enable better decarbonisation outcomes for all Australian citizens, businesses, and industry. APGA looks forward to supporting the CCA in delivering the most robust analysis practical for gas use decarbonisation options.

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

Detailed feedback

General advice on robust economic modelling

APGA provides the following general feedback in review of other economic modelling observed within the energy decarbonisation sphere. For too long, poor modelling practices have mislead the Australian public and business communities to inaccurate beliefs around the cost competitive renewable energy alternatives which they can access. It is hoped that through the below advice, the CCA can introduce a new era of robust economic modelling into energy decarbonisation analysis.

Basis for whether to consider alternate decarbonisation pathways

APGA Recommends the CCA provide the Australian public with greater choice, opportunity, and capacity to decarbonise their energy use by analysing renewable energy options for all energy vectors, be they solid, liquid, gaseous or electric, on equal grounds to one another.

The renewable electricity vector is the most mature vector for energy decarbonisation. Vectors other than renewable electricity are often dismissed for all or some customers based on range of reasons, rather than robust economic analysis. Not undertaking economic analysis of decarbonisation options risks missing valid, economically viable alternatives for the majority 80 per cent of domestic energy consumption which is not supplied by electricity today.

The ability to decarbonise additional energy vectors via renewable solid, liquid, and gaseous fuels provides multiple additional decarbonisation vectors to energy customers. The simplicity of purchasing a renewable fuel with little to no need to invest CAPEX in appliance changes often skews the economics of renewable fuels in their favour. No CAPEX means that this can be the case even where renewable fuel prices are higher than their fossil or renewable alternatives. Unfortunately, these renewable fuel options are often explained away rather than analysed on equal grounds alongside renewable electricity options.

The following are a few examples of this occurring in prevalent analysis commonly referenced today. In these cases, not undertaking equal economic analysis has obscured the opportunity for Australian citizens and businesses to access more cost competitive energy decarbonisation options. The gas pipeline industry welcomes robust economic analysis of all three of the below options in equal comparison with renewable electricity options.

- <u>Hydrogen energy efficiency</u>
  Economic comparisons with hydrogen are often foregone by electrification advocates on the basis that hydrogen supply chains are less energy efficient than electricity supply chains[3]. This is true. However, as all hydrogen supply chain aspects beyond production are lower cost than electricity supply chain components, delivered costs per unit energy for firm hydrogen supply can be cost competitive with firm renewable electricity supply when robust economic analysis is undertaken.

[3] Saul Griffith, 2022, *The Big Switch: Australia's electric future*

- Biomethane feedstock availability or dispersion
  Economic comparisons with biomethane are often foregone by electrification advocates on the basis that current feedstock analysis shows less feedstock than current gas demand either nationally or in a state, or on the basis that feedstock is widely dispersed[4]. Both points are true. Feedstock estimates do however represent more than half of current domestic gas consumption – a not insignificant amount of decarbonisation potential. Further, transport of biomethane from interstate or regional production zones is made possible through existing and new gas pipeline infrastructure. Once analysis is undertaken, decarbonisation via firm biomethane supply is found to be cost competitive for all current gas users.

- Renewable gas (biomethane or hydrogen) to decarbonise of gas use in the home
  A range of reasons are provided to not undertake effective economic analysis of using renewable gases to decarbonise gas use in the home. These include the efficiency of heat pump appliances and the idea that it is possible to have minimum or average combined appliance and energy costs lower through renewable electricity options than through renewable gas options[5]. These points can be true. However, as is explored further below (including Figure 2 and Figure 3), an exploration of appliance and energy cost ranges uncovers substantial overlap of all three decarbonisation options. This indicates cost competitiveness between the three options, which if pursued together removes many negative impacts of an electrification only approach to gas use decarbonisation in the home[6].

Care must also be taken to not allow rhetoric about alternate renewable energy options prevent robust economic analysis, especially where indications of alternate outcomes have been flagged by industry. The gas infrastructure industry has been flagging the above opportunities for some time but is often dismissed as having a vested interest in the outcome. While true, the experience within the gas infrastructure industry also makes the industry well placed to observe the opportunity that renewable gases represent to our current gas customers – customers which use gas today due to its greater economic viability[7].

It is hoped that the CCA will robustly model the opportunity for customers to decarbonise through renewable gas uptake – it is, after all, the customers who will bear the greatest burden if genuine decarbonisation opportunities are not analysed on robust grounds.

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[4] ACT Government, 2022, *Our Pathway To Electrification*, https://www.climatechoices.act.gov.au/__data/assets/pdf_file/0009/2052477/Powering-Canberra-Our-Pathway-to-Electrification-ACT-Government-Position-Paper.pdf
[5] Victorian Government, 2022, Victoria's Gas Substitution Roadmap, https://www.energy.vic.gov.au/__data/assets/pdf_file/0025/586411/Victorias-Gas-Substitution-Roadmap.pdf
[6] The Grattan Institute, 2023, *Getting of Gas: why, how, and who should pay*, https://grattan.edu.au/wp-content/uploads/2023/06/Getting-off-gas-why-how-and-who-should-pay.pdf
[7] Boston Consulting Group, 2023, The role of gas infrastructure in Australia's energy transition, https://jemena.com.au/documents/reports/the-role-of-gas-infrastrcuture-in-australia-s-ener

Recognition of variation in data used and produced by economic modelling

APGA Recommends the CCA endorse a shift away from using and producing single datapoints in economic modelling, and a shift towards using and producing more robust data ranges as a minimum standard.

A single number rarely accurately reflects the complex reality of energy systems. In instances where there are multiple cost competitive decarbonisation solutions for energy customers, undertaking economic analysis using single-figure input data risks delivering results which produce single-figure outputs which inaccurately support single, apparently absolute, one-size-fits-all solutions. Such modelling practices risk:

a) Obscuring customer understanding of equally valid decarbonisation solutions; and
b) Government policy which curtails cost competitive decarbonisation options rather than supporting them[8].

APGA proposes a hierarchy of robust input data options in order of least to most robust, also considering the relative complexity of data identification:

- Single data point [lowest robustness | lowest complexity]
  A single number representing a breadth of real-world data including averages, minimum or maximum values.
- Data range [moderately robust | low complexity]
  Consideration of the range of data between minimum and maximum values representing the full range of real-world data with care to exclude outlier data.
- Probabilistic likelihood data range [high robustness | high complexity]
  Data demonstrating the probabilistic likelihood of data between minimum and maximum values representing the full range of real-world data.
- Data isoquant [highest robustness | highest complexity]
  A likelihood comparison curve as a result of probabilistic likelihood and other influences such as customer choice to consider the relative likelihood of data outcomes between two competing outcomes.

APGA recommends that data ranges become the minimum standard for economic modelling data inputs and outputs. This can ensure that economic modelling outputs can at least consider the full range of comparative outcomes. This is important in understanding relative cost competitiveness of different renewable energy options.

International case study: IPCC AR6 Chapter 6 energy cost data

IPCC AR6 Chapter 6 energy cost data includes probabilistic ranges of future energy use. The ability to produce such outputs is a prime example of the value of using data ranges for inputs. This data could not have been produced with single datapoint inputs and is substantially more robust in informing the range of possible outcomes in a net zero energy future.

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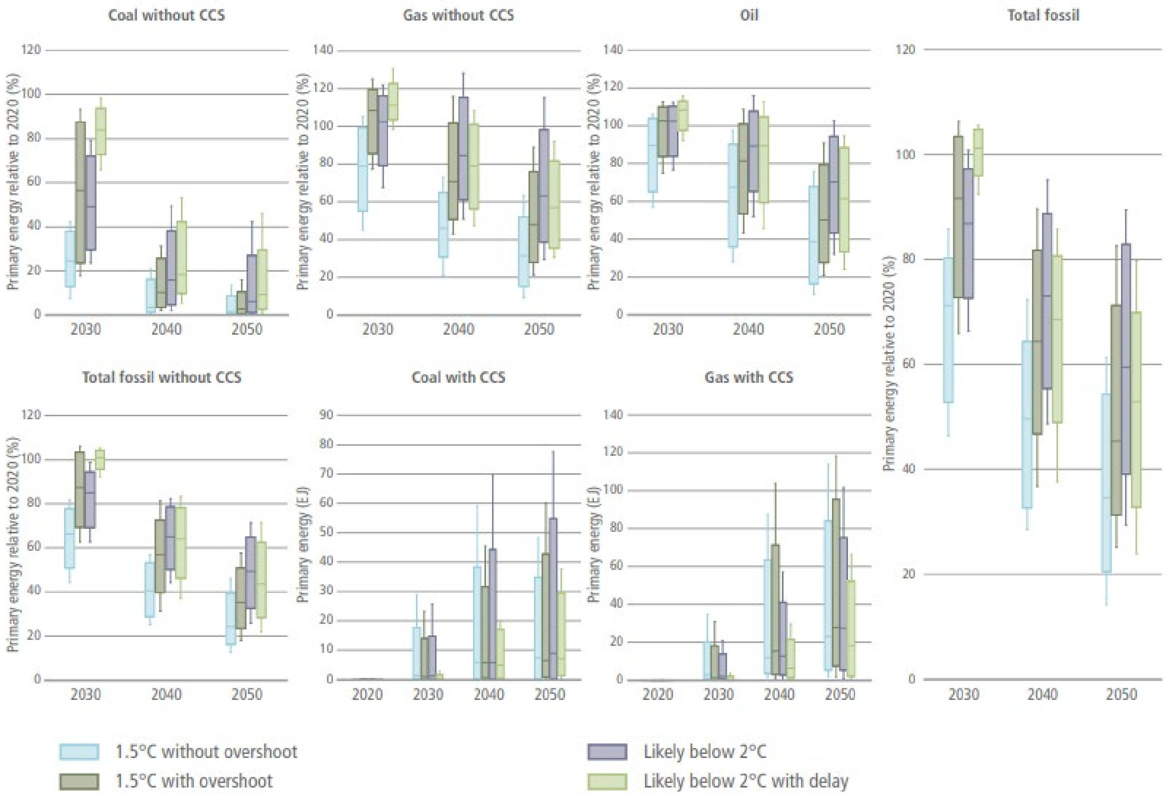
[8] Ore, 2023, *Victoria announces ban on gas connections to new homes from January 2024*, https://www.theguardian.com/australia-news/2023/jul/28/victoria-announces-ban-on-gas-connections-to-new-homes-from-january-2024
Note: DEECA advised in a 2023 forum that the ban extends to 100% renewable gas connections.

Figure 1: IPCC AR6 Chapter 6 ranges of future fossil fuel use



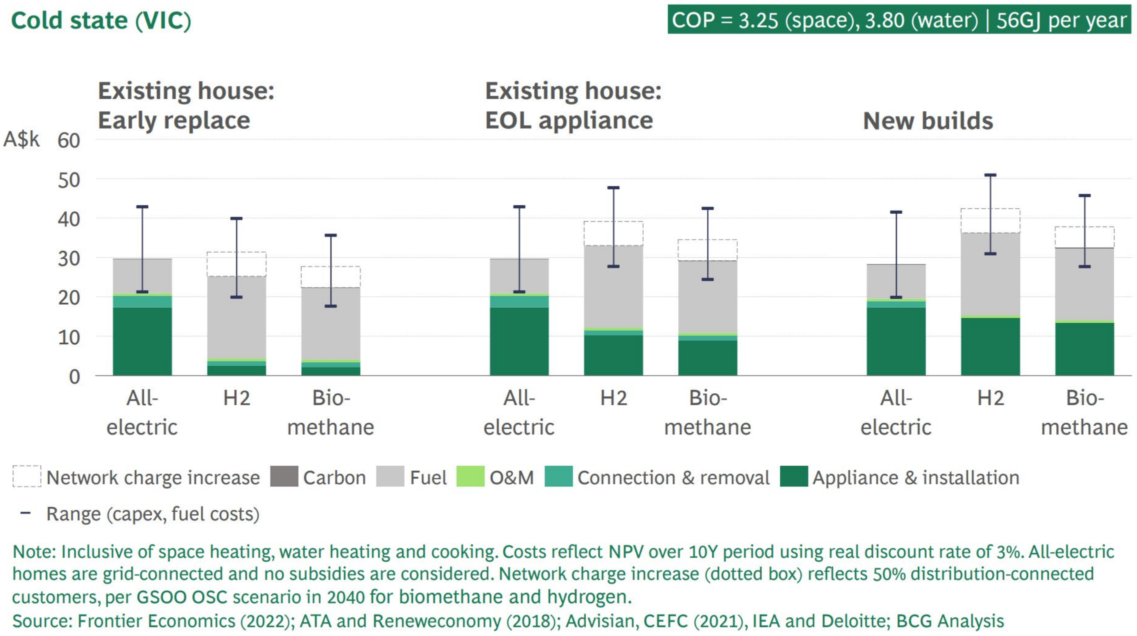
Source: IPCC AR6 Chapter 6 Energy Systems, 2023

Case study: household appliance and energy costs

The majority of economic analysis for decarbonisation of gas use in the home considers single datapoints for appliance costs and energy costs. In doing so, analysis tends to compare single datapoints for decarbonisation cost, resulting in a binary statement about one option being more affordable than the other – typically, this is found in favour of renewable electricity, resulting in recommendations to abandon renewable gas options for households.

Recent analysis by Boston Consulting Group (BCG) demonstrates what is missed when only single datapoints are considered. Instead of considering single datapoints for appliance cost and energy cost, this analysis considered data ranges for both. This better reflects what we all know to be true – these is no one-size-fits-all appliance cost across all homes, even homes that use the same quantity of energy, and these is no one-size-fits-all energy cost between all energy retailers. The result of this more robust approach to household gas decarbonisation analysis can be seen in Figure 2 below.

Figure 2: Cost comparison for electricity, green hydrogen and biomethane for residential users in 2040, at different points of appliance replacement



Source: BCG, 2023, The role of gas infrastructure in Australia's energy transition

If only the average, minimum or maximum single datapoints for appliance and energy costs were considered in this analysis, only the average, minimum or maximum single datapoint results in Figure 2 would have resulted from the analysis. Looking at only the average, minimum or maximum results in the New Builds section of Figure 2, these numbers in isolation would lead to the conclusion that the All-electric option is the least cost option. However, as BCG used data ranges, these conclusions can be seen to be an incomplete representation of the bigger picture.

As can be seen in Figure 2 and as is drawn out in Figure 3 below, BCG analysis demonstrates that these is significant overlap in the combined appliance and energy cost to customers across all three renewable electricity and renewable gas options. This means that all three options are cost competitive across a substantial portion of the total range of potential cost outcomes.

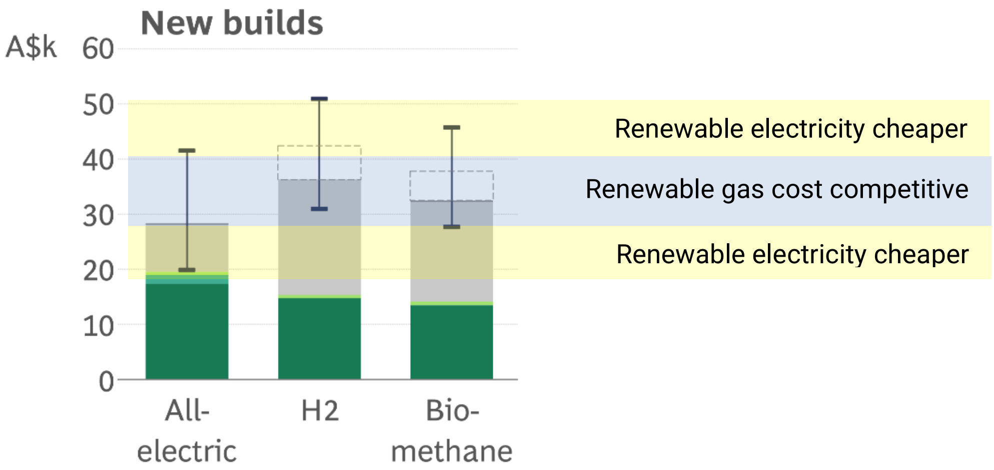
The conclusion from the BCG analysis is that governments should ensure that household gas customer are supported to access all three decarbonisation options. This is a substantially different conclusion to the conclusion of only supporting all-electric decarbonisation options which reasonably arises when only considering single datapoints.

The implications for government policy are immense. Using single datapoints risks falsely concluding that there is only one solution to household gas decarbonisation, which in turn risks legislation which stops household gas customers from accessing parallel, cost competitive decarbonisation solutions.

Not only does this risk reducing valid customer options, but this also risks increasing the cost of the one option which is supported by relying on a single supply chain of energy and appliances. In doing so, the risk of supply constraint at all points of the supply chain increases, as does the risk of monopoly or oligopoly behaviour by market participants which no longer experience competitive tension from alternate energy supply chains.

The Climate Change Authority owes it to Austrian household energy consumers to ensure cost ranges are considered at a minimum when analysing gas use decarbonisation in the home. Ineffective analysis of household gas decarbonisation could quite literally lead to low-income households choosing between heating and eating in a net zero future, or even result in increased homelessness due to unnecessary increase in household value, and hence rents, through mandates to install appliances which cost more than is truly necessary to decarbonise.

Figure 3: Overlap of the cost ranges for new build dwellings



Source: APGA analysis of BCG, 2023, The role of gas infrastructure in Australia's energy transition

Consideration of cost competitiveness

APGA recommends the CCA consider renewable energy options to be cost competitive where combined cost ranges for firm renewable energy supply and appliance use overlap significantly.

The above discussion about using and producing data ranges expands to a discussion about how to interpret the more complex results of more robust economic modelling. Moving towards the more robust approach of economic modelling using and producing cost ranges for energy decarbonisation options, it is possible for these ranges partly or fully overlap. Where this is the case, the reasonable conclusion is that these options are cost competitive. This holds true despite the differences in the single datapoints of average, minimum or maximum cost.

Cost competitiveness is an extremely powerful concept when considering multiple pathways to undertaking the costly and important exercise of decarbonising energy use. Customers can access the following benefits if they have more than one cost competitive renewable energy vector to decarbonise:

- Component supply chains for all parts of each energy supply chain are less likely to become constrained. Ie steel and copper for transmission infrastructure, specific appliances, exotic materials, and even specifically skilled workforces.

- All energy customers benefit from competition between two competing energy and appliance supply chains vying for their business, avoiding the high price risk of monopoly or oligopoly energy and appliance supply.
- Each renewable energy supply chain has different advantages, enabling a broader range of customer circumstances to be addressed. Ie low-income and rental households can more readily decarbonise their gas use contracting renewable gas rather than spending tens of thousands of dollars upfront on electric appliances or being exposed to higher home rent costs.
- Parallel and complimentary renewable energy supply chains can support each other at points of intersection, making both supply chains more resilient for energy customers. Ie through renewable gas power generation and hydrogen production.

When access to cost competitive renewable energy vectors benefits customers at every turn, there is no justification for picking a single winner. Cost competitiveness must be a legitimate outcome when undertaking economic modelling of decarbonisation options.

Case Study: Expanding on household gas decarbonisation cost
Exploring this through circumstance explored in Figure 3 above, all four of the following statements hold true:

- The lowest range value of all three options being the All-electric minimum indicates that it is possible for some customers to achieve a lower cost outcome via the All-electric option;
- The existence of an All-electric range indicates that it is unlikely that all customers will be able to achieve the lowest possible outcome on the All-electric option range of outcomes all of the time;
- The overlap of hydrogen and biomethane ranges with the All-electric range indicates that it is possible for some customers to achieve equal or lower cost outcomes via the hydrogen or biomethane options; and
- The substantial span of the overlap of hydrogen and biomethane ranges with the All-electric range indicates that there is likely a substantial proportion of customers which can achieve an equal or lower cost outcome via the hydrogen or biomethane options.

APGA considers the above to be a reasonably firm indication of cost competitiveness between two options. To prevent access to the last three dot points by not undertaking range based economic modelling is unconscionable when considering decarbonisation of household energy demand.

Elephant in the room: Customer choice

APGA recommends the CCA recognise the impact of customer choice on purely economic outcomes by making recommendations which recognise that some customers may choose to pay more for the decarbonisation option which they prefer for non-economic reasons.

Customer choice is the hardest variable to consider in economic modelling. While not experts in how to introduce customer choice into modelling, APGA recommends engaging with experts in the field of behavioural economics to better understand options for modelling customer choice. The isoquant concept introduced above is one tool which can be used to introduce customer choice between options into modelling once understood.

Even without introducing customer choice into modelling, it can be recognised in modelling conclusions. Where cost comparisons are close in value to each other (or comparable), it is possible that customer choice could be sufficient to drive some level of uptake of higher cost options. Importantly, it is only reasonable for recognition of customer choice to drive softening of absolute conclusions, rather than being a basis to conclude that all customers will always choose a higher cost option.

Of course, where renewable energy options are cost competitive, customer choice will play a greater role in determining which option customers choose compared to where one option is clearly more costly than the other.

Case Study: Brisbane gas use
On a purely economic basis there should be no residential reticulated gas use in Brisbane today. Retail gas costs Brisbane households substantially more than electricity due to the relatively low volumes used by homes in Brisbane's warm climate[9]. This has been the case for decades. Nevertheless, there is substantial retention of reticulated gas use in homes across Brisbane.

This demonstrates that a substantial number of current energy customers choose to use gas despite its additional cost. This provides indication of how more expensive renewable gas may be received, whether it is cost competitive with its renewable electricity alternative or not. In either case it is clear that the economics alone do not drive the choice to use natural gas today – and will not drive the choice to use renewable gas alone tomorrow – in the sunny city of Brisbane, Queensland.

Recognition of firm energy costs

APGA recommends the CCA consider the cost of firm energy supply in its modelling, rather than energy generation/production costs alone.

The low generation cost of variable renewable electricity (VRE) is often identified as the reason that it is a superior solution compared to renewable energy alternatives. While VRE generation is cheap, an electricity system based on VRE alone is anticipated to be expensive. A truer measure of customer energy costs from a majority VRE energy system would consider the cost of all infrastructure required to deliver firm renewable electricity.

On the other hand, it is unlikely that renewable gas production costs will be cheaper on a per unit energy produced basis than VRE generation. This comparison is often used to dismiss the need to undertake robust analysis of renewable gas supply chains. However, renewable gas is cheaper and easier to firm. Lower cost pipeline transport and storage and lower cost appliances both contribute to the cost competitive outcomes seen in Figure 2 & Figure 3.

[9] Australian Energy Regulator, 2022, *State of the Energy Market 2022 Chapter 6: Retail energy markets*, https://www.aer.gov.au/system/files/State%20of%20the%20energy%20market%202022%20-%20Chapter%206%20-%20Retail%20energy%20markets.pdf
Note: See Figure 6.3

Case study: CSIRO GenCost levelized cost modelling
Many energy analysist in Australia, most notably the Australian Energy Market Operator (AEMO), rely upon CSIRO GenCost modelling to project energy prices in future electricity markets with high VRE penetration. This analysis appears to demonstrate future electricity prices well below that of today (Figure 4).

Figure 4: CSIRO GenCost modelling of NEM and WEM wholesale energy prices excluding sunk costs of existing infrastructure

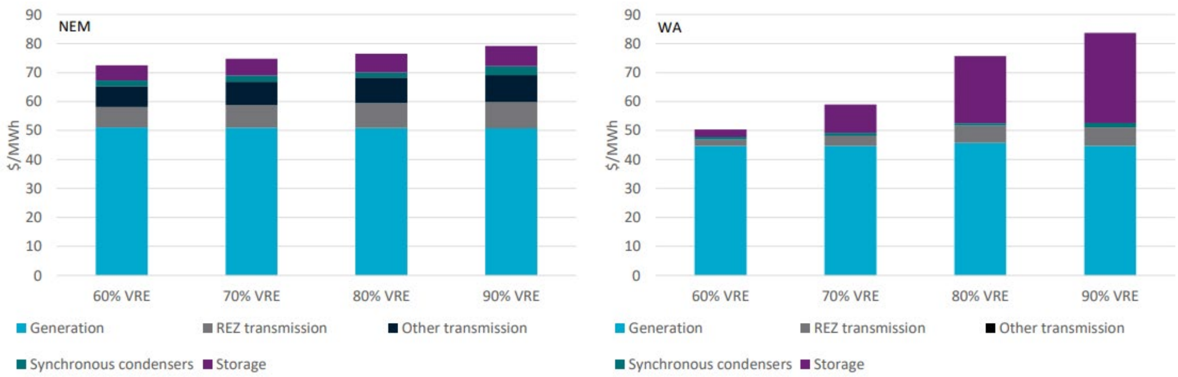


Figure 5-2 Levelised costs of achieving 60%, 70%, 80% and 90% annual variable renewable energy shares in NEM and WA in 2030

Source: CSIRO, 2023, GenCost 2022-23 Final Report

However, GenCost analysis excludes NEM infrastructure costs prior to 2030 as "sunk costs", treating these as zero cost. Section D.2.3 in Appendix D of the report addresses *the appropriateness of treating past investment costs as sunk in 2030 LCOE calculations*. This section states that *the market does not owe the owner a reasonable return on investment* in costs that *relate to the capital items of generation and storage infrastructure* prior to 2030. Statements later in the section relating to the cost of transmission being *recovered separately from the generation spot market* and *being included it as part of variable renewable integration costs given its importance to variable renewable deployment* indicates that the bulk of existing NEM electricity transmission infrastructure may also be also excluded from GenCost analysis.

It is not possible to believe that the GenCost report can provide accurate wholesale electricity costs of a future majority VRE NEM while excluding the value of transmission and storage infrastructure deployed prior to 2030. This is especially true noting that the $12bn Snowy Hydro 2.0 project is one of the costs excluded from analysis on this basis.

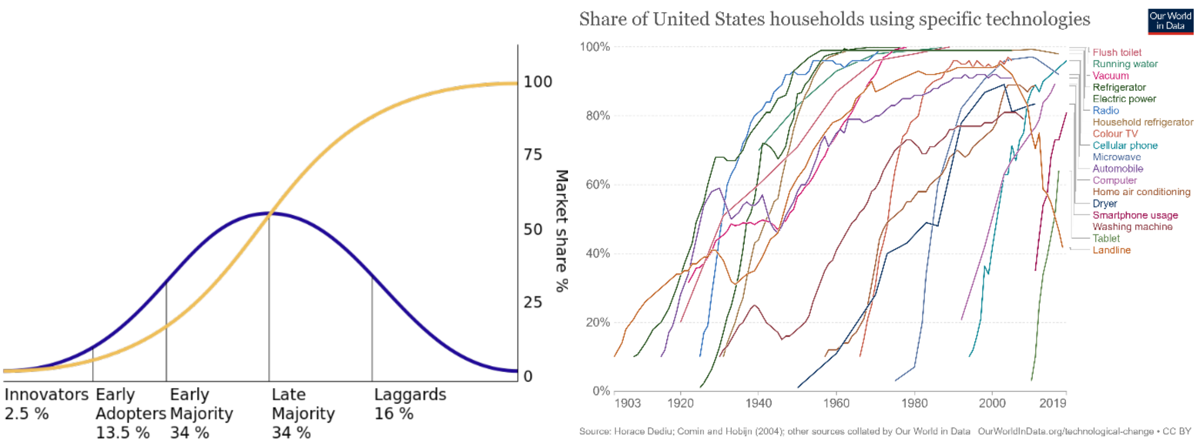
APGA notes that neither CSIRO nor AEMO have published firm gas decarbonisation cost modelling for a transition of the gas system to renewable gases, and that both tend to dismiss the need to do so in reports such as GenCost and GSoO.

Consideration of uptake rates

APGA recommends the CCA consider the application of Diffusion of Innovation theory in projecting potential new technology uptake rates rather than straight line trajectories.

The uptake rate of new technologies can be difficult to predict or project. Diffusion of Innovation theory is based on decades of observations and provides an insight into how a new technology can diffuse into an existing market. The theory observes that most new technologies will at least approximately follow a normal distribution s-curve when taking over an incumbent market –referred to as the *Diffusion of Innovation Curve* (Figure 5)[10].

Figure 5: Diffusion of Innovation Curve alongside Diffusion of Innovation Curve examples



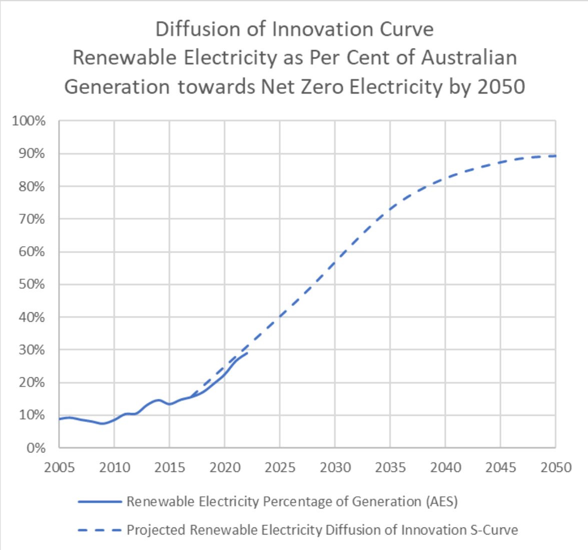
Source: The Australian Pipeliner, May 2023, Why a renewable gas target is critical to gas use decarbonisation

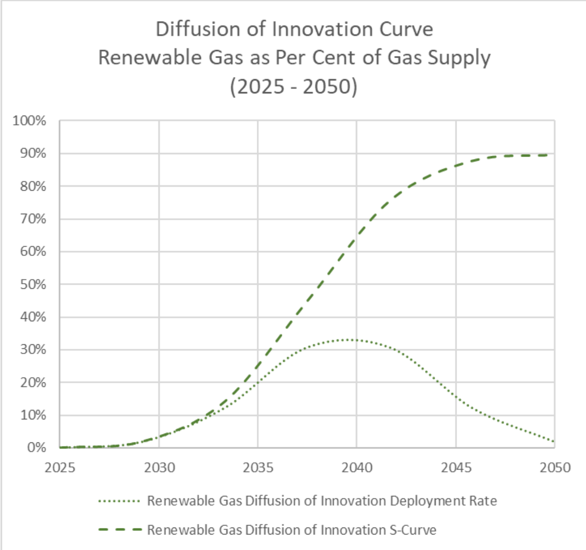
Following the diffusion of innovation curve, whether intentionally or accidentally, has factored into the success of the Renewable Energy Target. As can be seen in Figure 6 below, the impact of the RET has driven renewable electricity uptake within Australia's electricity generation market through the early stages of the Diffusion of Innovation curve. Projecting this curve from the past 20 years put renewable electricity on target to securing 90% of the electricity market by 2050 in line with achieving net zero electricity sector emissions. The fact that the RET drove beyond the 16% combined Innovators and Early Adopters levels of Diffusion of Innovation theory is observed to have likely provided sufficient uptake momentum for renewable electricity to continue diffusion into the incumbent electricity market along the Diffusions of Innovation curve once the RET no longer applied.

This curve can be used to project the uptake of renewable energy within other energy vectors as well. Applying the curve to renewable gas can demonstrate a practical pathway to achieving net zero gas emissions by 2050 (Figure 6). APGA proposes that the CCA endorse the use of the Diffusion of Innovation Curve when projecting new renewable energy technologies within solid, liquid and gaseous energy vectors, both within its modelling and that of other, in particular in the design of other potential renewable energy targets.

[10] McCollum, May 2023, *Why a renewable gas target is critical to gas use decarbonisation* in The Australian Pipeliner, https://issuu.com/primecreativemedia-2016/docs/tap0523_lr/12

Figure 6: Renewable Electricity and Renewable Gas Diffusion of Innovation Curves





Source: APGA Analysis

Modelling of job and emission offshoring

APGA recommends the CCA include analysis of job and emission offshoring, potentially as a relative impact between decarbonisation pathway choices.

The offshoring of emissions and jobs is a difficult to model aspect of the renewable energy transition. However, the relative impact of some renewable energy choices could be simpler to model. In particular, the offshoring impact of choice to constrain to one of multiple cost competitive renewable energy options could be able to be modelled.

Restricting cost competitive decarbonisation options risks unnecessary closure of otherwise viable industry. Rather than reopening somewhere else in the country, these facilities are likely to relocate offshore to jurisdictions that have less stringent emissions policy. These impacts should be included in modelling of energy decarbonisation outcomes.

The lifecycle emissions of materials mined and components manufactured internationally are also hard to identify and control. These also need to be considered within analysis.

Ways around difficult to factor considerations

APGA recommends that the CCA commission research into how to best address difficult to factor aspects of Australian decarbonisation such as sector coupling and supply chain constraints.

Sector coupling between parallel complimentary renewable energy vectors such as renewable electricity and renewable gas has the potential to reduce customer costs and increase resilience in both supply chains. This is however a difficult to model aspect of the energy transition. One option which the CCA could research is the combined electricity and gas supply chain modelling capability which the University of Melbourne has developed as part of the Future Fuels CRC.

Similarly, the relative risk of material, component and workforce supply chain constraints is difficult to model outright. However, modelling of supply chain demand differences could be achieved when comparing pursuit of two parallel cost competitive renewable energy supply chains with comparing pursuit of only one. Such analysis could be considered an additional cost risk to customers of pursuing a single pathway rather than more diversified solutions.

Macroeconomic modelling of a Renewable Gas Target

APGA have commissioned a consultant to undertake macroeconomic modelling research of the impacts of a Renewable Gas Target. This research has helped inform this submission and includes a number of the recommendations which we put forward. APGA looks forward to being able to share preliminary modelling findings with the CCA in early October and anticipates project delivery by late October / early November.

This modelling considers the relative impact of a renewable gas target compared to other gas use decarbonisation options on Australian GDP and customer cost. It is hoped that by demonstrating the potential for lower cost emission reduction outcomes through robust modelling, APGA can pique the interest of organisations such as the CCA in undertaking broad economic analysis of renewable gas uptake as a decarbonisation pathway for all current gas customers.

Responses to consultation questions

Consultation question 1

What are your views on the two modelling questions? Are there other questions the authority should explore through economic modelling to inform its advice?

APGA recommends the CCA seek to create decarbonisation plans for each energy vector by introducing a third modelling question – What are the likely emissions reduction pathways, outcomes, risks and opportunities for Australia's four energy vectors (solid, liquid, gas and electric energy vectors) under different national emissions pathways to net zero?

80% of Australian final energy consumption is consumed as solid, liquid and gaseous fuel today[11]. Each of these three fuel energy pathways have the possibility of transitioning to renewable fuels within each vector. Each vector has the possibility that it may or may not be more economically efficient to transition customers across to another pathway. Failing to undertake combined economic analysis of these alternatives fails to consider potentially cheaper or cost competitive decarbonisation options for Australia.

Undertaking this analysis per end use sector as proposed in Question 2 will be more difficult without having undertaken per energy vector analysis of cost competitive renewable energy alternatives first. This additional question supports user focused analysis by centralising analysis of firm energy supply costs before considering appliance costs. This of course would be somewhat of an iterative process, with end user appliance costs in part determining the economic viability of individual renewable energy pathways.

[11] Australian Government, 2023, *Australian Energy Update 2022*, https://www.energy.gov.au/sites/default/files/Australian%20Energy%20Statistics%202022%20Energy%20Update%20Report.pdf

Case study – Electricity sector decarbonisation plan
Having a set national plan for electricity sector decarbonisation makes it easy to determine how all electricity consumers will decarbonise their electricity use. Being able to say that there is a national plan for 82% renewable electricity by 2030 removes the need to consider how each electricity use sector will decarbonise their electricity use specifically as all customers are being supported to decarbonise via a national electricity sector decarbonisation plan.

The same approach could be applied to the gas supply chain. All gas customers could be supported to decarbonise via a whole of gas system plan to phase in renewable gases via a Renewable Gas Target. A Renewable Gas Target could provide a national plan for 20% renewable gas by 2035 and net zero gas by 2050. This would simplify the question of how each individual gas use sector will decarbonise its gas use specifically as all gas use sectors would be supported to decarbonise via a national gas sector decarbonisation plan.

The same logic can be equally applied to solid and liquid fuel sectors as well.

Consultation question 2

What are the strengths or limitations of these models the authority should keep in mind when interpreting their outputs? Are there other models that would provide valuable insights into the questions the authority is trying to answer?

APGA recommends the CCA note of the lack of gas system modelling capability within the CSIRO. APGA and its members offer direct engagement with CSIRO or any modelling resource the CCA engages to provide expertise in support of robust gas system modelling.

There is no evidence that the CSIRO has developed whole of gas system modelling capability able to deliver robust modelling of the existing gas supply chain, let alone the introduction of renewable gases into this system. This is indicated through references by AEMO within its 2023 Gas Statement of Opportunities, founded upon CSIRO modelling, which states:

The feasibility of hydrogen transportation at high pressures and percentages remains uncertain, and therefore the impact of hydrogen on mid-stream infrastructure is also uncertain.

This is incorrect and only demonstrates that analysis has not been attempted. APGA engaged GPA Engineering in 2021 to deliver the 2022 study *Pipelines vs Powerlines: A Technoeconomic analysis in the Australian context*. This report clearly demonstrated the cost effectiveness of energy transport and storage in hydrogen pipeline infrastructure relative to powerlines, gas pipelines and electricity storage options. Despite this, AEMO, and by proxy the CSIRO, have not attempted to analyse hydrogen pipelines themselves or integrate this option into their modelling.

Current CSIRO modelling capability cannot be considered sufficient to model the breadth of the Australian energy system without substantial uplift in gas supply chain modelling capability. APGA and its members have decades of experience in understanding gas energy supply chains – experience upon which its advocacy for renewable gases is based. We offer our advice and support to the CCA and CSIRO to facilitate robust gas system modelling in search of least cost decarbonisation for Australian citizens, businesses, and industry.

Consultation question 3

Do you think the proposed global action pathways provide an appropriate context for assessing potential Australian emissions pathways? Are there alternatives you think are higher priority pathways to consider? Are the IPCC, IEA and GLOBIOM assumptions appropriate for the proposed scenarios?

APGA recommends the CCA ensure that Australian data be used ahead of more generic global data for supply chain economics and all renewable energy alternatives where available.

Using assumptions from the IPCC, IEA and GLOBIOM is a good starting point where topics have not been explored in an Australian context. However, Australian data will likely be more robust and accurate for Australian circumstances. As noted above, care needs to be taken in considering all aspects required to deliver firm energy supply.

Firstly, the relative economics of existing and renewable energy supply chains vary substantially between countries. For example, the vast distances traversed by Australia's gas pipeline industry and the contract carriage gas market makes the Australian gas supply chain commercially and economically unique its European counterparts. This is likely the case for other supply chains as well.

Secondly, Australian renewable energy supply chain proponents, including proponents of the Australian renewable gas supply chain, have spend extensive time and effort to understand renewable energy supply chains in the Australian context. In particular, please consider the following Australian analysis:

- *The role of gas infrastructure in Australia's energy transition*, Boston Consulting Group, 2023, available at https://jemena.com.au/documents/reports/the-role-of-gas-infrastrcuture-in-australia-s-ener
- *Pipelines vs Powerlines: A technoeconomic analysis in the Australian context*, GPA Engineering, 2022, 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
- *Australian Biomass for Bioenergy Assessment 2015-2021*, AgriFutures Australia, 2021, available at https://arena.gov.au/assets/2021/04/australian-biomass-for-bioenergy-assessment-final-report.pdf
- *Australia's Bioenergy Roadmap*, ENEA, 2023, available at https://arena.gov.au/assets/2021/11/australia-bioenergy-roadmap-report.pdf
- *2030 Emission Reduction Opportunities for Gas Networks*, ENEA, 2023, available at https://www.energynetworks.com.au/miscellaneous/2030-emission-reduction-opportunities-for-gas-networks-by-enea-consulting-2022/

- *Cost of switching from gas to electric appliances in the home*, Frontier Economics, 2023, available at https://gamaa.asn.au/wp-content/uploads/2022/07/Frontier-Economics-Report-GAMAA.pdf

Consultation question 4

What potential Australian emissions pathways or scenarios do you think would provide the most valuable modelling insights and inputs to support the authority's advice?

APGA recommends the CCA would gain the most valuable modelling insights from analysis of scenarios which include a gas supply chain which is allowed to or driven to decarbonise towards net zero emissions by 2050.

The most prevalent "ambitious" Australian emissions reduction pathways have considered mass electrification as the predominant pathway. This is not the only solution. Such analysis needs to be modelled against pathways which consider all renewable energy vectors without artificial constraint.

In particular, a scenario which considers decarbonisation of the gas supply chain alongside a decarbonisation of the electricity supply chain is expected to produce economically superior outcomes compared to analysis chooses to electrify customer which have other cost competitive decarbonisation options. This is what APGA has asked to be analysed within macroeconomic modelling of a Renewable Gas Target which it has commissioned. This analysis is due for deliver in late October / early November 2023 at which point APGA will be happy to share its findings with the CCA.

Consultation question 5

How do you think the authority should capture the potential benefits of stronger action to reduce national and global emissions in its modelling? Are some approaches better than others?

APGA recommends the CCA should consider advanced manufacturing practices to lower the cost of renewable energy component production onshore in Australia, and separately consider modelling of increased risks to low-income and other disadvantaged communities through emission reduction pathways and scenarios.

In particular, modelling of impacts to low-income homeowners and renters from forced electrification of household gas demand alongside allowance for decarbonisation through renewable gas uptake is expected to demonstrate lower upfront costs for low-income homeowners and less risk of increased rents due to deployment of higher cost appliances.

Consultation question 6

Are there any other issues the authority should consider as part of its modelling exercise?

APGA recommends that some aspects of analysis will need to be regional in order to deliver robust results. In particular the cost of decarbonising heat in the home and in industry between cold and warm climates requires regional analysis.

The CCA has noted in its consultation paper that it does not intend to undertake analysis at a regional level. This approach cannot deliver robust results for energy use for heat. In particular energy use for heat in the home changes substantially between cities like Melbourne or Canberra and cities like Brisbane or Darwin. The Australian Building Code Board Climate Zone Map represents a robust approach to considering different climate regions relative to household heat demand[12].

Please note that while APGA endorses consideration of the Climate Zone Map relative to differing household heating needs, APGA does not endorse the Australian Building Code Board approach to consideration of energy appliances in the home which fails to consider renewable gases and incentivises construction of higher emission electric homes over lower emission natural gas homes[13].

[12] Australian Building Code Board, 2023, *Climate zone map*, https://www.abcb.gov.au/resources/climate-zone-map

[13] APGA, 2021, *Submission: National Construction Code 2022 public comment draft (stage 2) consultation*, https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/211015_apga_submission_-_ncc_public_comment_draft_stage_2_consultation.pdf

APGA, 2021, *Submission: National Construction Code 2022 Consultation Regulation Impact Statement*, https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/211109_apga_submission_-_ncc2022_cris.pdf