APGA Study Summary

Supply chain analysis methodology for total customer cost

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Introduction

The task of decarbonisation couldn't be more important and is extremely challenging. The challenge is exacerbated by simple assumptions on the-cost of decarbonisation pathways based upon the cost effectiveness or efficiency of individual components of energy supply chains. What matters most are the impacts on customer cost as a result of end-to-end energy supply chains.

The APGA study 'Supply chain analysis methodology for Total Customer Cost' analyses customer costs based on the entirety of energy supply chains. Components from wholesale production right the way through to customer appliance costs and efficiencies are considered.

The study considers the total customer cost of heat in a freestanding Victorian home which use gas appliances today. These homes have the opportunity to replace their existing gas appliances with electric appliances today, or simply replace their appliances with other gas appliances when necessary. To decarbonise their gas demand, these households can either utilise net zero emission gas supply in existing or upgraded gas appliances or convert to electric appliances and use net zero electricity.

The study demonstrates the households which continue to use gas will enjoy lower cost heat in the home compared to those that electrify their gas demand. This remains the case considering retail energy price increases forecast within the October 2022-23 Federal Budget.

More importantly, the study showsthat transitioning to net zero gas will be cost competitive with electrification for decarbonisation of gas use in freestanding Victorian homes. This is contrary to the prevailing assertion that renewable electricity is the superior alternative for gas use decarbonisation in the home.

As net zero gas is cost competitive with net zero electricity when decarbonising gas use in the home, renewable gases provide customers with greater choice, greater opportunity, and greater capacity to choose from a wider range of emission reduction options. Importantly, more pathways to decarbonisation presents Australia with less risk, fewer bottlenecks and lower cost.

The assertion that renewable electricity is the least-cost approach to gas use decarbonisation tends to be based upon the fact that solar and wind have a low short run marginal cost of production. This does not translate to a low cost energy supply chain, the study demonstrates that the the renewable gas supply chain has greater economic efficiency than the electricity supply chain.

The findings of the study lead to a number of policy implications. The markedly different implications to customer cost achieved through undertaking the Total Customer Cost supply chain analysis methodology indicates that governments, customer advocates and climate advocates alike need to start undertaking analysis on this or a similar whole-of-supply-chain basis.

The findings that renewable gas use in the home could be a cost competitive approach indicates that Energy Ministers need to seriously consider how renewable gas production development can be supported through the implementation of a federally backed Renewable Gas Target. Further, raising the minimum gas appliance standard to 90% efficient hydrogen-ready appliances in the latter half of this decade must also be a national priority.

This study is the beginning of a journey in which we consider the full cost impacts upon energy customers of choosing between different renewable energy supply chains. Following publication of the study, APGA will engage an independent consultant to ensure robust and transparent application of the method is combined with the most up to date data available.

Undertaking analysis such as this always comes back to customers. Future analysis will focus upon a broader range of gas users and seek to engage user advocates. Engagement with climate advocates will also help to ensure that the most up to date and accurate information is fed into modelling based upon this methodology.

APGA invites customer and climate advocates interested in being involved in subsequent rounds of modelling to contact us via apga@apga.org.au. We also invite other institutions to undertake analysis of total customer cost using the supply chain analysis methodology, or variations of it, demonstrated within this study and encourage you to share your results

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Net zero energy cost

Net zero energy cost is often oversimplified and rarely consider the full supply chain. This is neither helpful nor useful to Australia's decarbonisation challenge. The energy supply chain is a highly sophisticated and complex undertaking and each factor in it needs to be fully considered.

Supply chain factor	Fact	Implication
Wholesale energy production	Renewable electricity is converted into green hydrogen[i]	Renewable electricity will cost customers less than renewable gas
	Renewable gases are 1.5x – 4x the cost of natural gas (circa FY2020)[ii]	Renewable gases will cost customers more than natural gas
	$2 per kg hydrogen and $15 per GJ biomethane are both cheaper than modelled net zero NEM price range of $75 to $100 per MWh[iii]	Renewable gases will be cheaper than renewable electricity.
Energy infrastructure	Repurposing gas infrastructure for hydrogen can cost up to 28% of new infrastructure above existing infrastructure costs[iv]	Renewable gases will cost customers more than natural gas to be delivered to customers
	Existing gas infrastructure is cheaper than electricity infrastructure[v]	Gas can be delivered cheaper than electricity
	New hydrogen and methane pipelines are cheaper energy transport than new HVAC and HVDC powerlines	Renewable gas delivery costs customers less than renewable electricity delivery
Energy Storage	Battery energy storage system costs are reducing towards $100 per MWh	Customers will pay less for electricity storage in the future
	Energy storage in hydrogen pipelines is typically below $12 per MWh for 24hrs storage capacity, reaching as low as $3 per MWh[vi]	Renewable gas energy storage will cost customers less than renewable electricity storage
Retail energy prices	The October 2022-23 Federal Budget indicated that retail gas prices will increase by 44% by 2024	Gas will cost customers more in the future
	The October 2022-23 Federal Budget indicated that retail electricity prices will increase by 56% by 2024	Electricity will cost customers more in the future
Customer Appliances	Heat pumps are many times more efficient than gas appliances	Electric appliances will cost customers less
	Gas appliances are substantially cheaper than electric appliances	Gas appliances will cost customers less

A comprehensive assessment of customer cost of energy

Considering all of these different factors of customer cost of energy is challenging. The complexity of this task starts to become a more manageable once a focus on the similarities between energy supply chains, rather than the differences, is used.

Figure 1 demonstrates the similarities between the constituent components of the gas and electricity energy supply chains from wholesale energy production through to customer appliance utilisation. Supply chains similar to these can be identified for liquid and solid forms of energy as well.

Considering energy supply chains from a systems perspective helps to frame how different energy supply chains can be compared with one another, while accounting for all currently available information about the different dimensions of customer cost of energy.

If we understand how each component will change in a net zero future, this can be used alongside how each component contributes to the total customer cost of energy use today in order to model how each component may impact customer cost of energy use in a net zero future.

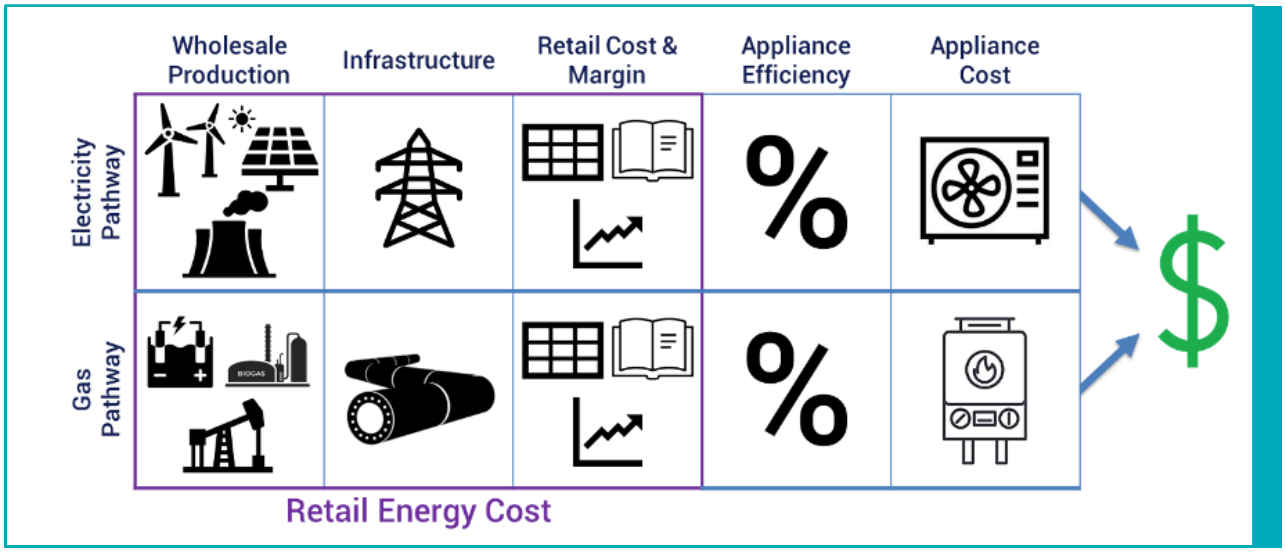

Figure 1: Electricity and gas supply chain components

Supply chain analysis methodology

On this basis, APGA has derived the Supply Chain Analysis Methodology for Total Customer Cost. The Supply Chain Analysis Methodology combines real or modelled retail energy price ranges with ranges for appliance cost and efficiency. Or put simply, bill cost per unit of energy output from the appliance, plus appliance cost per unit of energy output from the appliance.

Total Customer Cost =
(Energy Cost x Appliance Efficiency) + (Annualised Appliance Cost / Annual Energy Use)

Energy cost within this formula could either be a reported figure such as that provided by the Australian Energy Regulator (AER)[vii], derived through a bottom-up Whole of System Cost approach as proposed by Frontier Economics[viii], or by a top-down approach of modelling anticipated changes to the breakdown of retail energy costs.

APGA used this third approach in demonstrating the Supply Chain Analysis Methodology for Total Customer Cost. This comprised of a top-down model of retail energy price breakdown for FY2020-21 based upon data from the AER. Or put simply, how much net zero energy and infrastructure will cost relative to these costs in FY2020-21.

Retail Energy Cost net zero
= ∑(Retail Energy Component Cost FY2020-21 * Net Zero Energy Scalar)

Here the importance of considering all aspects of the energy supply chain becomes clear. While some individual aspects of energy supply chains imply they may be lowest cost, this is not always the case when considering the total customer cost.

Methodology Application: Heat in the home FY2019-20

To ensure that the modelled outcomes are logically consistent in known conditions, the methodology was first applied to reported data from FY2020-21. Average retail energy costs were sourced from the AER State of the Energy Market Report (Chapter Six), while appliance efficiency ranges were sources from the Australian Building Code Board Whole of Home Efficiency Factors standard.

Appliance costs were sourced from *Cost of switching from gas to electric appliances in the home* by Frontier Economics, which considers the cost of switching appliances for freestanding homes which use all gas appliances today. Analysis based on this data is only relative to Victorian homes, as this study focused on appliance costs in Victoria alone.

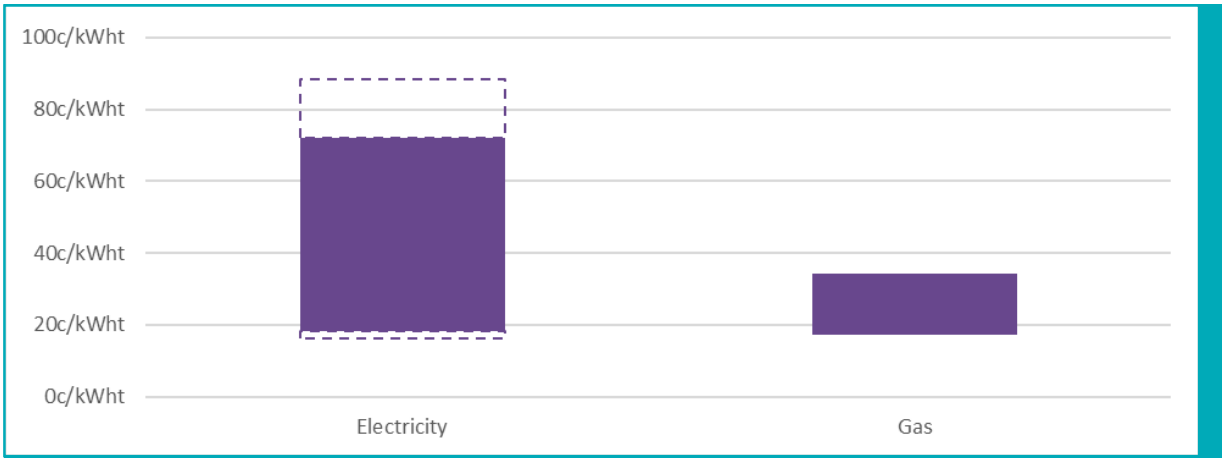

Figure 2: Victorian Total Customer Cost of Heat in the Home FY2020-21 including Sensitivity Analysis Scenario D & E

The solid bars within Figure 2 demonstrate the ranges of Total Customer Cost of heat in a gas using freestanding Victorian home including retail energy and appliance costs circa FY2020-21. Electricity costs had a much broader range than gas costs, with prices double that of gas at the top of the range. This correlates to the lived reality that gas use in the home was a lower cost energy alternative to electricity circa FY2020-21.

The dotted lines represent two sensitivities applied through the analysis. The lower dotted bar represents increasing the upper electric appliance efficiency from 550 per cent to 900 per cent, while the upper dotted bar represents deceasing the lower electric appliance efficiency from 250 per cent to 100 per cent in line with resistive heating elements.

These sensitivities demonstrate the law of diminishing returns suffered by heat pump appliances. Adding more and more efficiency to a heat pump appliance reduces a smaller and smaller amount of energy used by the appliance. On the other hand, if heat pump appliances are undersized for heating demand, supplementing them with resistive space heaters introduces a substantial cost increase through a reduction in efficiency back down to 100%.

Methodology Application: Heat in the home circa 2024

Retail energy customers were warned within the October 2022-23 Federal Budget that energy costs are predicted to increase substantially. Retail electricity prices were anticipated to increase by 56 per cent while retail gas prices were anticipated to increase by 44 per cent.

Gas customers are rightly worried about a 44 per cent increase in gas prices, with some seeking to transition from gas to electric heating in order to avoid the hike. However, analysis from the previous section raises the question – if both electricity and gas prices are set to increase, and electricity is set to increase more than gas, will gas customers be better or worse off making the switch to electricity?

To determine the outcome for switching gas customers, the same model from the previous section was ran with a 56 per cent increase in electricity prices and a 44 per cent increase in gas prices. The result can be seen in Figure 3.

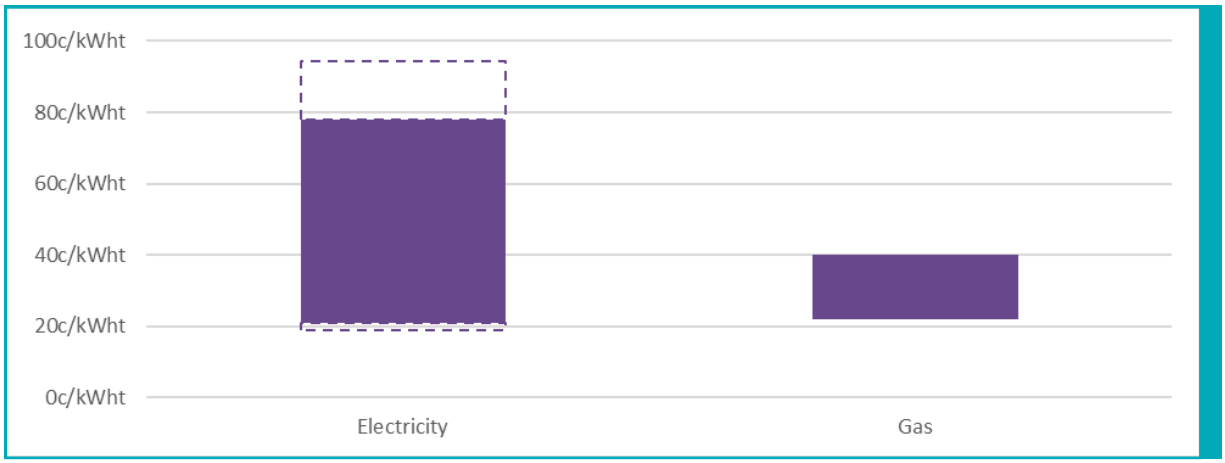

Figure 3: Victorian Customer Cost of Heat in the Home FY2020-21 including Sensitivity Analysis Scenario D & E + Federal Budget Price Increase (E:^56%, G:^44%)

This analysis demonstrates that the Total Customer Cost of Heat in a freestanding Victorian home that uses gas today increases across both options. Importantly however, the relative cost comparativeness of gas use in the home remains.

No energy customer likes rapidly increasing energy prices, and the correlation between high Australian energy prices and Russia's unjust war in Ukraine indicates that energy prices should subside in time. Gas customers should be reassured however that they remain connected to the most cost-competitive form of energy available for heating freestanding homes in Victoria today.

Methodology Application: Net Zero Heat in the home

Based on the formulas identified within the Study and data available to the public today, it is possible to predict the Total Customer Cost of Heat in the home via net zero energy pathways. This analysis is critical to understanding the true costs of our various renewable energy pathways, and particularly in understanding whether there is value in pursuing parallel net zero electricity and net zero gas supply chains for residential energy customers.

Modelled retail net zero energy prices

Prior to completing Total Customer Cost analysis, retail net zero energy prices need to be modelled. This has been achieved by considering how each component of the AER's breakdown of retail gas and electricity prices may change in a net zero future. The result of applying the data identified within the Study can be seen in Figure 4.

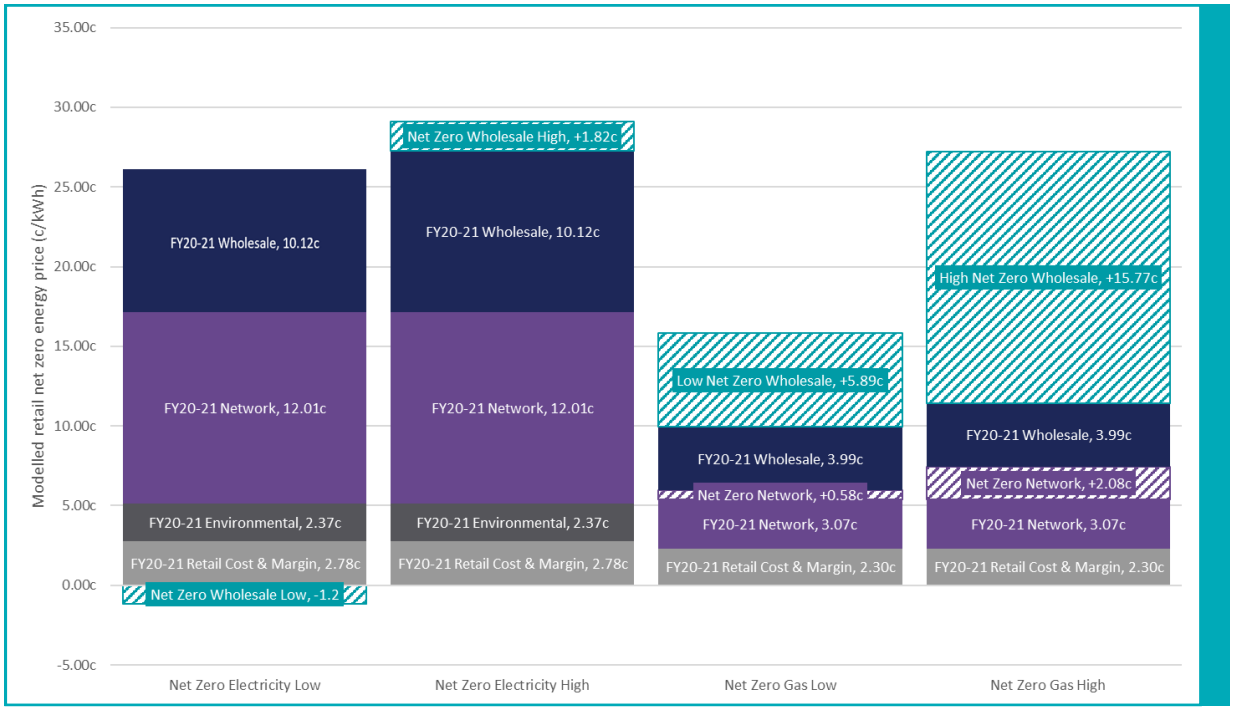

Figure 4: Modelled retail net zero energy prices Victoria

Through this analysis it is clear that the modelled range of retail net zero electricity price does not change much from retail electricity prices today, while the modelled retail net zero gas price increases substantially. This is predominantly due to how much further renewable gases have to come down the cost curve across the coming years.

Note that the retail net zero gas price range stretches lower than retail net zero electricity.

What has not been considered here is the possibility of increased electricity distribution costs. AER data did not make it practical to model changes to electricity distribution costs, hence these were conservatively considered to be zero. Additionally, net zero gas network costs are modelled on the assumption that hydrogen use is prevalent. These cost premiums fall to zero where methane centric renewable gases are used.

Total Customer Cost of net zero heat in the home

With modelled retail net zero energy prices considered, it was possible to combine these once again with ABCB appliance efficiencies and Frontier Economics appliance cost data to model Total Customer Cost of heat in a freestanding Victorian home which uses gas today.

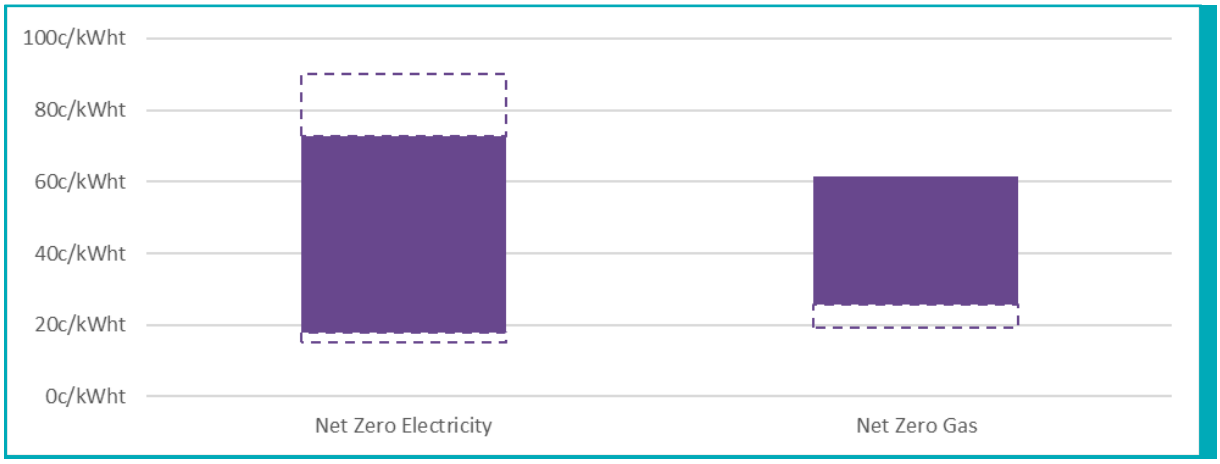

Figure 5: Victorian Customer Cost of Heat in the Home FY2020-21

The solid bars within Figure 5 demonstrate the ranges of Total Customer Cost of heat in a gas using freestanding Victorian home including retail energy and appliance costs in a net zero energy future. The net zero electricity bar has barely changed relative to the FY2020-21 result, however the range of net zero gas prices have broadened and increased compared with analysis of natural gas. Both price ranges are aligned with the median (centre point) of both solid bars being within 2c/kWht of each other.

This indicates that retail net zero gas is cost-competitive with retail net zero electricity for heating free standing homes in Victoria which use gas appliances today, making renewable gases a viable, cost comitative option for gas use decarbonisation in these homes.

Sensitivities included in this analysis built upon those mentioned in the FY2020-21 analysis. While the upper sensitivity for electricity is still a return to 100 per cent efficient electric appliances, the lower sensitivity for electricity has added 900 per cent appliance efficiencies to 40 per cent of heating energy coming from rooftop solar. Only direct use during generation was considered, however battery costs could be considered in future analysis.

The lower gas sensitivity considers two possible future renewable gas scenarios – renewable gases approaching $1/kg renewable hydrogen or $7.50 per GJ renewable methane, and a removal of the hydrogen infrastructure cost premium in the event that renewable sources of methane become the prevalent renewable gas. This indicates the potential for retail net zero gas prices post the 2040-50 horizon.

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Implications of Methodology and Applications

This methodology along and applications demonstrated within this Study have significant implications for the future of Australia's net zero energy transition.

A new tool for considering decarbonisation costs

Given a new, holistic way of considering Total Customer Cost, governments, customers, and renewable energy advocates have a new tool at their disposal to advocate for the least-cost renewable energy outcomes. Such a tool can cut through the rhetoric of individual statistics used to justify one pathway or another, getting down to the total cost impact on customers.

Getting Total Customer Cost right at this point in Australia's renewable energy transition is critical. While the simple message of "electrify everything" has been seen as necessary to start the transition to renewable energy, we now know that renewable electricity is not always the lowest cost net zero answer.

It is the responsibility of governments to deliver the least-cost decarbonisation trajectory for Australian businesses and citizens. APGA hopes that with the Supply Chain Analysis Methodology for Total Customer Cost, governments may be one step closer to achieving this end.

Greater choice for residential gas customer decarbonisation

If net zero gas is cost-competitive with net zero electricity when decarbonising gas use in the home, then renewable gases provide customers with greater choice, greater opportunity, and greater capacity to choose from a wider range of gas use emission reduction options.

If this is the case, it is the responsibility of state and Federal governments of Australia to ensure renewable gases are supported equal to and alongside renewable electricity for gas use decarbonisation in the home.

Impeding renewable gas uptake through pursing policies such as gas connection bans, or preferentially replacing gas appliances with electric appliances, acts in opposition to providing gas customers with the greatest choice, greatest opportunity, and greatest capacity to decarbonise gas use in the home.

Policy Recommendations

Such significant implications from the Total Customer Cost Supply Chain Analysis Methodology and its initial application lend themselves to substantial government policy recommendations.

1. Utilisation of Total Customer Cost methodology

Recommendation 1: governments to move towards renewable energy supply chain analysis methodologies which consider the total cost to customers, rather than a subset of total customer costs.

Policy based upon consideration of some, not all, customer costs is common in the renewable energy space, with many jurisdictions publishing bill savings without highlighting the appliance and rectification costs of transitioning to different appliances.

Now that there is a methodology at hand, and substantial differences in outcomes have been identified, it is recommended that governments consider all customer costs of transitioning to new renewable energy supply chains through the uptake of the Supply Chain Analysis Methodology for Total Customer Cost, or similar holistic methodology. Further, we recommend utilisation of the Total Customer Cost methodology, or methodologies like it, to consider the relative economics of using renewable gases to decarbonise the current range of gas users in order to underlie policies in support of developing a renewable gas industry.

2. Secure renewable gas supply via a National Renewable Gas Target

Recommendation 2: deploy a National Renewable Gas Target.

A National Renewable Gas Target is the most practical and powerful way in which the Federal and state and territory governments could support development of the renewable gas industry in Australia.
Founded as a scheme similar in function as the Renewable Energy Target, a Renewable Gas Target would include a Federal Renewable Gas Certificate scheme. Gas users could purchase certificates to confirm that they are using Federally-certified renewable, gas producing zero emissions when consumed.
Similar to the Renewable Energy Target, a Renewable Gas Target would be best served by having a quantity of certificates purchased by governments on an annual basis. This will help to de-risk early renewable gas investments, supporting rapid growth of the renewable gas industry.

3. Support for high-efficiency, hydrogen-ready gas appliances

While 90 per cent efficient gas appliances are available today, the current minimum gas appliance efficiency threshold is 70 per cent for gas heating and 75 per cent for gas hot water. Without some form of certainty provided by government, there is no business case for appliance manufacturers to produce hydrogen-ready gas appliances today.

Recommendation 3: a Federal mandate for all household gas appliances be 90 per cent efficient and hydrogen-ready by 2027.

Such a policy would address both these challenges and ensure every new gas appliance is 20 per cent more efficient than the cheapest gas appliances today while provide the certainty appliance manufacturers need to develop hydrogen-ready appliances in a reasonable timeframe.

Recommendation 3 supports the transition to high-efficiency hydrogen-ready appliances through an appliance replacement funding program, similar to the Victorian Energy Upgrades program for electric appliances.

Accelerating gas appliance replacement through discounting the cost of high-efficiency hydrogen-ready gas appliances will duplicate available renewable energy appliance uptake pathways. Further, as gas appliances are markedly cheaper than electric appliances, renewable energy ready appliances can be deployed per government dollar spent.

Next Steps

The Study recognises that its outputs are only as good as the data available for use in the methodology, and that is only considers one specific subset of gas use decarbonisation. Publishing the methodology study is only the first step in a much longer journey to understand the Total Customer Cost of gas use decarbonisation.

Across the coming year, APGA will engage with government departments, customer advocates and climate advocates to understand the different subsets of gas users which need to be analysed, as well as the broader range of data available to be fed into models based on this methodology.

APGA will engage a consultant to take on the methodology and engage with the abovementioned stakeholders in order to undertake independent implementation of the model based upon the sectors and data made available by stakeholders

If you want to be involved in this body of industry research, feel free to reach out to APGA via apga@apga.org.au and we will forward your details to the relevant consultant once the next phase of this study gets underway.

References

i Based upon technoeconomic principle that energy cost plus process cost must be more than energy cost alone.

ii Based on analysis by CSIRO and the Future Fuels CRC indicating $# - $# per kg hydrogen cost range in 2030 and $15 - $29 per GJ biomethane range today
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iii Based on CSIRO Gencost Report indication of $75 per MWh net zero NEM wholesale cost of energy and The Grattan Institute Go for Net Zero report indication of $100 per MWh net zero NEM wholesale cost of energy.
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