Review of ATCO AA6 Submission Documentation - Undertaken for the Economic Regulation Authority (ERA)

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1.0 EXECUTIVE SUMMARY

The Task 1 objectives were set out as:

1. What level of confidence could the ERA have in the findings from ATCO's customer engagement that these meaningfully and realistically reflected the views of customers?
2. Given the level of information and the timing of ATCO's specific engagements (qualitative and quantitative) with various stakeholders (e.g. on ATCO's operating and capital investment program scale and the effects on pricing), how valid is any stakeholder sentiment on qualitative and quantitative analysis used in support of its expenditure and investment programs?

1.1 CONFIDENCE IN ATCO CUSTOMER ENGAGEMENT FINDINGS

PRG believes that the ERA can be very confident that the sampling and statistical analysis of the survey data has been conducted at industry standards. However we have significant reservations over the extent to which the findings would be repeated in an environment in which customers were adequately informed about the issues they were asked to evaluate.

Certainly, current gas users want to be able to continue using gas. The KANTAR survey has reliably shown that ATCO consumers want to have a gas connection into the immediate future, and support the steps required to ensure that the gas network continues to function.

However it has also shown that gas customers have a quite strong interest in reducing greenhouse gasses from the energy mix. The survey only explored that ambition by tweaks to the gas content and reticulation system. It did pose a question asking if there were plans to switch from gas to electric appliances, but this was not in connection with the clear desire to reduce GHG emissions.

When the issue of GHG reduction strategies was addressed, the options were confined to support for up to 15% injection of non-fossil fuel into the gas network, and support for an increase in the amount of mains pipelines renewal from 60 to 100 kms per annum.

However the technical issues around these strategies were not addressed at all. The ERA can have very little confidence that the KANTAR research findings are an accurate reflection of the opinions of an informed sample of ATCO customers, with respect to the GHG reduction strategies.

It also does not seriously consider the prospect for changes in the energy profile of current customers over the AA6 period.

The very strong price sensitivity for gas supply is evident in the rate at which support for GHG reduction strategies falls as the potential cost to consumers rise. Consumers have a strong desire for reductions GHG emissions but do not appear willing to pay for it. The implication being that consumers will follow the least cost option when seeking to reduce their GHG emissions regardless of the technology involved.

The submissions from other stakeholders reflect the positions they hold in the energy mix.

ATCO is aware of the possibility of the network becoming a stranded asset and seeks to achieve an accelerated rate of depreciation of the network. The question of who should pay for that is not addressed at all with consumers. Given the strong price sensitivity, it seems doubtful that the gas customers would be willing to contribute materially to a scheme to fund ATCO's accelerated depreciation program.

1.2 VALIDITY OF REPORTED STAKEHOLDER SENTIMENT IN SUPPORT OF ATCO'S INVESTMENT PROGRAMS?

At the survey outset, fewer than half of the ATCO residential customers had any awareness of ATCO at all. Moreover they did not have sufficient understanding of the implications of many of the investment strategies to be able to express an informed ranking of importance. There was clear evidence of this lack of understanding in the early consumer engagement process (see section 3.1). By their own assessments, consumers were ill-equipped to make the judgements they were subsequently asked to make.

The survey included a quite detailed outline of the "innovations" that ATCO was developing to enable a net zero future, supporting the image of ATCO actively seeking to achieve a net zero outcome. Certainly the survey provided brief explanations of what the various investment strategies entailed, but there was no information about the effectiveness of each strategy. So consumers were providing their support for the **idea** of each strategy with little understanding of the **effectiveness**.

Some of the supporting information around the strategy were simple and clear. Others only partly explained the issue.

For example,

- The information about smart meters made no reference to how the meters would improve the customer experience.

- The gas mains replacement does not mention that 40% of ATCO's emissions are from leaks (Expert Consumer Panel). This additional piece of information may have had the effect of boosting the support for this strategy.

- The supporting information around gas from renewables simply lists the areas in which ATCO could invest, suggesting that the investment would enable ATCO to "move to a situation" where some of the gas delivered to households is renewable. This sounds positive but omits to mention that H2 leaks are materially more damaging than Co2 (according to the Intergovernmental Panel on Climate Change). This observation was also made by the Expert Consumer Panel in feedback to ATCO.

The reported stakeholder support is valid to the extent that it reflects the level of support that the population of customers would have when they have very limited understanding of the issues.

2.0 INFORMATION PROVIDED

This document presents the findings of a review of the following documents, as provided by the ERA.

- Access Arrangement Information – Section 4 (public) – 17 pages

  This was the ATCO justification for its submission to the ERA. It drew heavily on the findings of the KANTAR research program.

- AA6 Voice of the customer insights report (public) – 123 pages

  This document reported on the findings of the KANTAR research program, covering both the qualitative consumer and stakeholder engagement and the large-scale quantitative customer research survey.

- Feedback on ATCO's Draft Plan (confidential) – 12 pages

  This document provided feedback on the ATCO plan from key stakeholders.

- ATCO Customer Insights report – Summary (public) – 14 pages

  This document was a summary of the findings of the customer survey conducted by KANTAR.

- Kantar Public - Consultation Strategy (confidential) – 19 pages

  The Kantar Public consultation strategy is simply the document outlining the research procedures that they would be undertaking.

- Stakeholder submissions to the ERA's Issues Paper – 12 submissions

  The stakeholder submissions were of interest to provide background understanding of the issues and the attitudes of key stakeholders.

Additionally PRG requested access to the KANTAR questionnaire used for the customer quantitative survey, the resultant data tables and the Q analysis file. These proved to be important in understanding the research strengths and weaknesses, and the resultant confidence that the ERA can have in the findings used to support the ATCO submission.

In short, the survey was implemented at industry standards, but in our view, invited opinions and comments from customers without an adequate attempt to ensure that customers had sufficient understanding of the issues involved to be able to provide an informed opinion.

3.0 GENERAL OBSERVATIONS

3.1 ATCO'S CUSTOMER ENGAGEMENT PROCESS

The design of the engagement process in the form of qualitative research endeavour appears sound – in that it canvassed qualitative discussion amongst:

- Six online discussion groups with consumers. The purpose being to inform the design of the planned quantitative consumer survey to take place over the two subsequent months.
- It also engaged with:
- Nineteen Perth ATCO customers in a 3-hour forum,
- Eight retailers
- Eleven Commercial and Industrial customers, and
- Two builders, and finally with
- Five peak bodies including the Expert Consumer Panel.

By any measure this represents a comprehensive attempt to gauge the sentiments of the key stakeholder groups. However, it appears that in the design of the quantitative survey for 1,000 respondents, ATCO has failed to adequately address the lack of consumer understanding on some key issues, and has largely ignored the feedback from their key stakeholders in the retailer and peak body groups.

The customer engagement process actually commenced with an alignment phase. This entailed a team review of previous research and understandings to either build on previous research findings or where necessary to expand on the focus of previous endeavours. At one level this is a logical process to ensure that all involved (e.g. ATCO and KANTAR operatives) were focused on the tasks to be undertaken.

It guided the development of a comprehensive consultative program, culminating in a quantitative survey of customers designed to quantify the consumer sentiments uncovered in the customer engagement process. The results of which were factored into the ATCO draft plan provided in April 2023 to key stakeholder groups for feedback.

At another level, by focusing on what had been, and seeking to extend those findings going forward, this process risked missing out on changes in societal sentiment regarding the wider energy mix. That is evident in the omission of any canvassing of the prospect of reducing GHG emissions by adjustments to the household energy mix in particular for the approximately 40% of WA households with solar PV systems (projected to increase beyond 50% within the AA6 period).

The customer engagement process involved a series of online focus groups, the content of which is unavailable for this review. We might comment however that fewer than half the participants had any awareness of ATCO or its role in the delivery of the natural gas supplies – the customer is only directly engaged with their gas retailer – predominantly ALINTA or Kleenheat.

The reporting of the early customer engagement processes shows a level of consumer interest in alternative energy sources that was not clearly addressed in the quantitative customer survey of November - December 2022.

The customer engagement process also revealed the extent to which customers believed they were ill-equipped to make considered judgements about efforts to reduce GHG emissions from the gas network. The quote below is from the KANTAR report on the sustainability thread in the early engagement process.

While unprompted, the majority of Residents need more information before they're fully confident in hydrogen / biogas blending. – While Residents are generally unfamiliar with natural gas alternatives such as biogas and hydrogen blending, most view them positively and support their further exploration.

And a comment from a customer reported in the same section:

I am unsure because I don't know if other gases are better or not. If I knew more, then I'd be confident in an answer.

The sentiments expressed in the customer engagement focus groups and in-depth interviews clearly show an awareness of the need for action on GHG reduction, but they also show that customers themselves do not believe they are adequately equipped to provide a confident informed response on these issues.

Given these findings from the qualitative exercise which was implemented in large measure to inform the design of the quantitative survey questionnaire, it is curious that no attempt was made in that quantitative ("measure") exercise to provide ANY technical information about the injections of non-fossil fuel, the risks of gas leaks etc.

3.2 ACCESS ARRANGEMENT INFORMATION

In reviewing section 4 (public) of the Access Arrangement Information document we noted that it gathers input from several stakeholder groups, most with an interest in maintaining at least some element of the status quo.

In this context it would be difficult to imagine current customers and stakeholder groups NOT supporting gas mains replacement, renewable gas, IT infrastructure, gas meter replacement and network expansion.

The observation that there is strong community support for gas from renewable resources is somewhat at odds with the (retailer driven) notion that ATCO should encourage greater demand for gas.

ATCO posed four possible scenarios for the future of gas, each of which involve an accelerated rate of depreciation of the network. Given the uncertainties of the energy transition over the forward AA6 period, ATCO considered the scenarios and proposed to accelerate $80 million of depreciation during AA6. It is significant that the KANTAR survey could not address this issue at all (it was conducted before the costs were calculated).

So the question of the extent to which the gas customer or ATCO should carry this cost of the accelerated depreciation of the network is not addressed at all in the engagements with consumers. There is simply no evidence that customers would be prepared to contribute to the accelerated depreciation at all. Given the very strong role that price has in determining customer attitudes towards ANY issue, it seems very unlikely that a question on this topic would have elicited a positive response.

While retailers were wary of the possibility of a material threat to the residential gas sector posed by the drive to net zero, they do not believe there will be a material change in demand within the AA6 period. They believe that ATCO has a responsibility to ensure that the delivery of gas into the future will meet the GHG reduction targets, while continuing to provide the means by which the retailers can continue with their current business model.

On the issue of **achieving net zero, resident customers** expressed a desire for ATCO to meet the net zero target, **provided it was affordable for them**. There is a desire to understand how that transition will be managed.

3.3 OTHER KEY STAKEHOLDER FEEDBACK

3.3.1 ALINTA GAS

Alinta is the largest retailer and has the greatest interest in maintaining the status quo as much as possible. Alinta provided comments to the ERA in response to its Issues Paper subsequent to ATCO's proposal and its views are of interest in how it viewed ATCO's customer engagement. Their comments suggest the H2 injection program is problematic and may not eventuate at all at scale. Their comments on the consumer survey in this regard were:

- *Customer responses were based on the delivery of renewable gas, which will not be achieved for many years and potentially never;*
- *Expenditure in AA6 is for preparatory work only (again, not delivery), for which there has been no customer research.*
- *The potential cost of appliance replacement, which may be required to accommodate renewable gases, does not appear to have been considered;*
- *The WTP of vulnerable customers, which presumably would be much lower, has not been considered*.

ALINTA is sceptical of the possibility of H2 becoming a major factor in decarbonisation:

"It is difficult to see how hydrogen blending will occur beyond a 10% blend in the gas distribution network. It seems that blending beyond this amount would require large scale appliance changes, with the cost of this borne by the distribution provider. Therefore it seems to us that moving to higher hydrogen blends at present is highly speculative".

ALINTA is also cognisant of the potential for legislative changes to materially affect the gas network outlook:

"Impending changes to legislative framework create substantial uncertainty, including challenges for the ERA in reviewing ATCO's proposal".

ALINTA has formed the view that gas demand will ease very slightly over the AA6 period; an observation that is at odds with the view of ATCO and other assessments. However their comments note that:

.."these predictions are based on highly variable economic, environmental, policy and geopolitical factors".

3.4 VOICE OF CONSUMER INSIGHTS

This quantitative exercise was intended to provide statistical reliability for the observations from the workshops. It involved a large sample (1000) of mains gas customers and appears to have been conducted at best industry standards. To that effect we can be very confident that the quoted results are indeed reflective of the way that the general gas consumer community would respond.

However, there are some issues with the questionnaire design that undermine our confidence that the findings are a true reflection of customer sentiment.

In particular, the very complex issues about the effectiveness of non-fossil fuel injection, the prospect for a requirement to modify or replace gas appliances at higher percentages of non-fossil fuels is not addressed at all.

3.4.1 STRONG SUPPORT FOR CONTINUED GAS ACCESS

Given that the sample was of current gas customers, it is hardly surprising that virtually all (97%) regarded access to gas as at least of some importance.

Similarly the survey reported high importance for ATCO to invest in:

- Gas Mains replacement (95%)
- Gas from renewable resources (94%)
- IT infrastructure (93%)
- Meter replacement (89%) and
- Network Expansion (88%).

All but one of the above investment areas are simply confirmation that they want to see their gas supply continue. This suggests that in the absence of any outside pressures, there would be little interest in terminating gas connections over the AA6 period.

Note however the 94% expression of the importance of gas from renewable resources. The suggestion is that there is a substantial theme of a desire for the energy system to be less based on fossil fuels. This may link in with the officially estimated 30%+ of WA households (a Roy Morgan Research report from 2022 suggested 42%) with solar PV systems. Indeed this is projected to grow to 50% over the next 5 years.

The consumer engagement process found strong support for renewable energy to be integrated into the gas mix. A 12% increase in costs to consumers for injection of 15% renewable gasses was calculated to produce the same level of satisfaction as the current scenario. In other words there is support for the renewable injections of up to 15%. However this finding is arrived at without any information about the effectiveness of the proposed strategy. Consumers could assume that this is the most effective means of reducing GHG emissions from the network. It was one of only two GHG reduction strategies presented to consumers. Moreover we note that the main ATCO emissions are from unaccounted gas loss – which is likely to be strongly linked to leaking pipeline infrastructure. This information is not provided to consumers, making it difficult for them to make a rational decision about which GHG reduction strategy they would be willing to support.

The price sensitivity of the gas supply is reflected in the rate at which preparedness to fund a change in the gas composition falls off very quickly after the initial 15% renewable energy proposal. **Whilst consumers want to see SOME movement to decrease emissions, they do not appear to be prepared to fund it at levels that would make a material difference.** They are very “light” green on this dimension, driven by a very high sensitivity to cost pressures. Though that reticence could

also be influenced by a concern that more than 15% non-fossil-fuel in the pipelines may affect the function or even suitability of their appliances; which begs the question of who should pay to replace / modify appliances should higher H2 levels come to pass. This issue of whether or not gas appliances would need to be modified at higher non-fossil fuel content is not considered or addressed at all in the ATCO customer engagement.

Query on Scale Interpretation

It is also worth noting that the scale shown to respondents when assessing the importance of areas for ATCO to invest in, only labelled the two extremes – code 1 = "Not at all important" and code 5 = "Extremely important". The **labels for codes 2,3 and 4 were added in the analysis phase.** Response codes shown to respondents:

Not at all important	1
	2
	3
	4
Extremely important	5

It is not unusual to only label the extremes of a rating scale, but PRG prefers the technique to only be applied to dichotomous (agree/ disagree, like /dislike, support/oppose, important/unimportant etc) rather than unidirectional scales. (zero importance / extremely important). Typically the analysis of the dichotomous scale treats the mid-point (3) as "neutral" and only takes the top two scores as being measures of agreement / support / importance etc.

We believe that in this instance the code 1 response would be akin to dismissing the activity as a legitimate factor to invest in at all; in which case code 2 would become the lowest score to indicate that the investment was acceptable but at a very low level of importance.

It is in this context that we note that the reported importance for investment in the various strategies was quoted as the accumulation of 4 of the 5 response options - from code 2 to code 5. "Somewhat important" up to "extremely important". Given that most of the elements could be associated with the continued supply of gas to a sample of gas users, it is not surprising that very few chose the "not important at all" response.

Not at all important	1
Somewhat important	2
Important	3
Quite important	4
Extremely important	5
Nett: Important	Accumulation of Codes 2 – 5

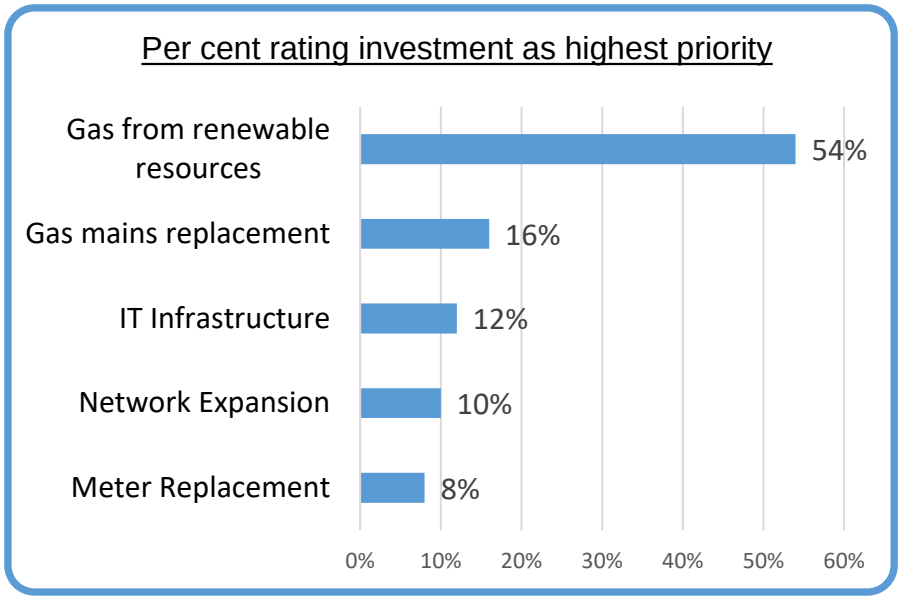
A more nuanced measure of the strength of the perceived importance may be based on the top three responses (from code 3 "Important" up to code 5 "Extremely important"), shown in the third column below.

Importance of Investment categories	Accumulation of top 4 out of 5 responses	Accumulation of top 3 out of 5 responses
Gas mains replacement	95%	85%
Gas from renewable resources	94%	89%
IT Infrastructure	93%	79%
Meter replacement	89%	73%
Network Expansion	88%	73%

The more nuanced analysis places the “renewables” factor as the most important and shows a greater difference between the “renewable” and other investment categories.

Indeed, investment in the “gas from renewable resources” component had 49% of respondents rating it as “extremely important”, compared to the second highest rated with gas meter replacement at 28%. Also the KANTAR’s survey measured consumer priority ranking for each investment strategy, “gas from renewable resources” was ranked as having the **highest priority** by 54% of respondents. Second, "gas mains replacement” with 16%.

The margin by which renewable resources emerged as the top priority is clearly shown in the figure below.



It is notable that the only mechanisms to reduce GHG emissions that were effectively canvassed were the injection of non-fossil fuels and the accelerated rate of pipeline repair. In our opinion, rather than a simple endorsement of the injection of non-fossil fuels into the system, the above should be seen as a de facto measure of the desire to reduce GHG emissions, by whatever means.

The key point in this analysis is that in the absence of any education about the effectiveness of the injection option, consumers were at liberty to assume that it was an effective strategy. Certainly the ALINTA and Expert Consumer Panel submissions to ATCO clearly question the viability of the injection strategy. Moreover, the Expert Consumer Panel, quotes the International Panel on Climate Change, that “hydrogen when released to atmosphere has a global warming potential (GWP) that is 5.8 times higher than CO2 over 100 years, and 33 times higher than CO2 over 20 years”. So the potential GHG damage from a leak of H2 that was injected into the gas network is a material factor that was not disclosed at all to the survey participants.

These issues were not addressed at all in the consumer survey. ATCO simply ignored these stakeholder inputs.

At the very least the non-fossil fuel injection strategy is contentious, yet the survey presents it to consumers in an information vacuum.

3.4.2 PRICE SENSITIVITY

Whilst the order of expressed importance of the investment strategies was clearly shown in the choice model exercise, the STRENGTH in those sentiments to move to renewable sources did not suggest preparedness to pay for a **material shift** in gas composition. KANTAR's survey resulted in a willingness to pay up to 12% more for gas that is a 15% blend with H2 or similar non fossil fuel. This value was calculated by assessing the level of support for the differing scenarios that equalled the current base case. There was a 40% increase in preference for gas compared to the current case, if there was a 15% injection of renewable gasses, indicating a desire to reduce the GHG footprint of gas usage. But higher levels of renewable gasses are progressively less attractive for each increase in renewable replacement.

The other important findings are that customers want the gas mains in good repair, both from safety and emissions reduction (through reduced leaks) perspectives. They support the pipeline replacement strategy via a 3% increase in costs to achieve an increase from 60km to 100 km replacement P.A.

BUT there is no indication of the % of customers who would accept each of these propositions.

The price sensitivity in decision-making is reflected in the proportional influence in decision-making. The distribution of the 100% of influence in customer decision-making in the choice modelling exercise is shown below;

- 40% Overall bill size
- 25% Gas from renewable resources
- 12% Network expansion
- 11% Mains replacement
- 9% meter replacement (smart meters)
- 4% IT Infrastructure.

(*minor rounding errors create a net of 101%)

"Overall bill size" is the most influential factor, having 1.6 times (40/25) the influence of the second most influential factor, "gas from renewable resources". The other factors play a marginal role in decision-making.

Given the significance of the overall bill size, it is notable that the customer survey analysis shows a lack of a clear assessment of the likely reaction to the proposed cost increases. As one of the stakeholder submissions noted,

"ATCO has proposed a significant increased charge to retailers of $78, or 39%, for an average residential customer at the start of AA6, from $199 in 2024 to $277 in 2025. This will flow through as an increase of 12% on an annual retail gas bill (of approximately $650) for customers."

But there was also separately a reported acceptance of a 3% increase in WTP for the increase in kms replacement from 60 to 100 kms pa.

There is no assessment of the % of customers who would find a 12% increase acceptable, nor any informed trade-off between the GHG reduction effectiveness of increased kms replacement Vs the non-fossil fuel injection.

Moreover, whilst there is a clear customer preference for reducing greenhouse gas emissions, the avenue to that objective is only presented in terms of tweaks to the gas supply - as an injection of non-fossil fuels, or additional kms of pipeline renewal. The prospect of other (non-gas) avenues, given the rate of technological change, is hardly explored at all.

Given the very high importance customers placed on reducing greenhouse gasses, there is a real risk that non-gas technologies could seriously impact the demand for gas going forward if consumers genuinely want to achieve the greatest reduction in greenhouse gasses at the lowest cost. There was little attempt to investigate customer interest in considering alternative technologies.

4.0 THE SURVEY LEARNINGS

4.1 QUESTIONNAIRE DESIGN

Our greatest critique of the KANTAR survey is that it has asked consumers for responses to questions on issues for which there is little information. Whilst some consumers may be well educated about the complexity of non-fossil fuel injection into the network, we believe (and the evidence from the early consumer engagement activities indicates) that in the main consumers would have no way of understanding the real benefits and risks (to the suitability of gas appliances for non-fossil fuel concentrations) of the injection strategy. They have a strong interest in reducing the GHG emissions, but that is tempered by a very strong resistance to cost increases. They would certainly choose the lowest cost or most cost-effective option to achieve the GHG reductions, but there is no information upon which to base any of these judgements.

Beyond the issue of posing questions without adequate explanation of the surrounding implications, and while we have some reservations over the addition of labels to the response ranges in the analysis phase, and certainly over the inclusion of the second lowest response "somewhat important" as an indicator of support, we believe that the questionnaire is well constructed overall. The survey also doesn't capture the reaction to specific cost increase proposals. E.G. On an average annual gas cost of $650 (average quarterly bill of $163) how much of an increase per quarter would you accept for:

Investment Strategy	Extent of extra quarterly cost that would be acceptable based on an average Quarterly bill of $163.						
	$0	up to $10	$10-$15	$15-$20	$20 - $25	>$25	D.k.
Injection of 15% non-fossil fuels to reduce greenhouse gasses	1	2	3	4	5	6	7
An increase in kms of old mains replacement to reduce leaks - Currently planned for 60kms P.A. which will reduce leaks by 19%. An increase to 100kms annually – will reduce leaks by 31%%	1	2	3	4	5	6	7
Both	1	2	3	4	5	6	7

(The above would need a brief description of the implications of each initiative).

We would like to build a question such as the above into the Task 2 survey questionnaire.

TASK 2 ESTIMATING FUTURE DEMAND.

The preference for gas as a fuel supply does not discern the importance of gas for various applications. E.G. there may be a strong preference for gas over electricity for cooktops, but a more neutral stance for other applications.

For task 2, we would like to see something along the lines of the following:

	Prefer Gas, even if a bit more $	Whichever is cheaper	Prefer Electric even if a bit more $	No preference
Cooktop	1	2	3	4
Oven	1	2	3	4
Hot water	1	2	3	4
Heating	1	(Reverse Cycle Air cond) 2	(Reverse Cycle Air cond) 3	4

The impact on future demand can be more materially affected by the potential for changes in the profile of appliances in the approximate 800,000 established households than the choices of new connections.

We note that the expert assessment is for a slight decline in demand over the AA6 period. There is a technology risk for demand estimates, in which a change in technology or a greater consumer awareness of the same, can materially alter the landscape in short order. But much depends on which of the postulated four future energy scenarios is closest to the actual future energy mix.

The probability of each of the four postulated ATCO scenarios for energy mix will be materially affected by government policy, and technological progress in non-gas energy solutions.

We would like to explore the possible pattern of HWS replacement. Gas HWS tanks last about 10 – 12 years (instantaneous can be about 20 yrs.). We should establish the age of the HWS across the network, noting the % with HWS older than 5 years, and ask what households intend to do to replace the HWS, comparing PV households with those without PV (PV households expected to grow from about 30% currently to 50% over the AA6 time frame).

The KANTAR questionnaire focusses solely on ways in which gas consumers may adjust their GHG footprint by supporting various gas modification strategies. The relatively new HWS technology of heat pumps offers a vastly different cost profile compared to the standard electric HWS, particularly for solar PV households.

We believe that the potential for the technology to change the balance of gas to electric amongst solar PV households should be explored. To that end, we could test awareness of heat pump technology for the HWS, and the notion of using the solar PV to heat water – effectively reducing the cost of hot water to zero. The HWS consumes around 40% of the gas supplied to a household with gas heating and cooktop appliances.

An explanation of the potential for a PV household to effectively have free hot water would then allow the potential for this disrupter be tested. This would show the POTENTIAL for a disruption to the current energy profiles of households.