Australian Gas Networks

Attachment 9.10 (2)

Renewable Gas Network Adaptation Plan – AGN Victoria and Albury

Final Plan 2023/24 – 2027/28

July 2022

Renewable Gas Network Adaptation Plan – AGN Victoria and Albury

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1. Program of works – 2023/24 to 2027/28

1.1. Program overview

AGN proposes to spend $9.5 million (total capital and operating expenditure) to ensure its gas distribution networks are ready for the introduction of renewable gas.

The capital and operating expenditure (capex and opex) program has been developed in accordance with the AGIG Network Adaptation Strategy – Renewable Gas AGIG-SP-0001, with the objective of adapting the AGN Victoria and Albury natural gas distribution network to transport renewable gas in a manner that is:

- a conservative and phased level of investment, consistent with achieving the lowest sustainable cost of transitioning to hydrogen and hydrogen blends;
- reflective of the locations that hydrogen will enter the network in the next five years;
- reducing the risk to an acceptable level; and
- aligned with the network vision of facilitating 10% renewable gas by 2030, and to facilitate the transport of fully decarbonised gas within our Victorian distribution networks (AGN and MGN) by no later than 2050, with 2040 identified as a stretch target.

Note hydrogen-ready replacements being conducted as part of ongoing asset replacement strategies such as the mains or meter replacement programs are not included in this Renewable Gas Network Adaptation Plan. This plan relates to proactive replacement of components outside of scheduled end-of-life replacement/upgrade.

Table 1-1 provides a breakdown of capex from 2023/24 to 2027/28 by program for the AGN Victoria and Albury network.

Table 1-1: AGN Victoria and Albury renewable gas network adaptation forecast capex $'000 real 2021

Title	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Hazardous area equipment	705	705	1410	1410	-	4,231
Replace incompatible parts	252	252	503	503	-	1,510
Weld procedures & hardness testing	798	758	558	458	458	3,030
Pipeline repair equipment	150	-	-	-	-	150
	1,905	1,715	2,471	2,371	458	8,921

Table 1-2 provides a breakdown of opex from 2023/24 to 2027/28 by program for the AGN Victoria and Albury network.

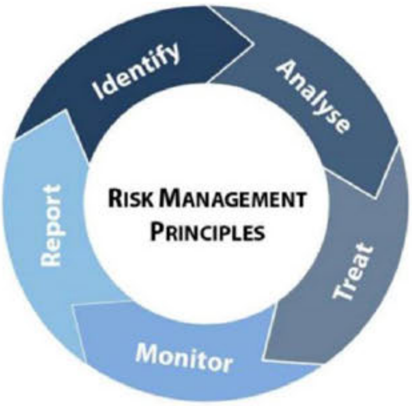
Table 1-2: AGN Victoria and Albury renewable gas network adaptation forecast opex $'000 real 2021

Title	2023/24	2024/25	2025/26	2026/27	2027/28	Total
TP compatibility assessment	118	-	-	-	-	118
Hazardous areas extents	30	30	-	-	-	60
Document updates	30	30	27	-	-	87
Further assessment or investigation required	61	62	123	123	-	369
	239	122	150	123	-	635

1.2. Risk assessment

Risk management is a constant cycle of identification, analysis, treatment, monitoring, reporting and then back to identification (as illustrated in Figure 1-1). When considering risk and determining the appropriate mitigation activities, we seek to balance the risk outcome with our delivery capabilities and cost implications. Consistent with stakeholder expectations, safety and reliability of supply are our highest priorities.

Figure 1-1: Risk management principles



Our risk assessment approach focuses on understanding the potential severity of failure events associated with each asset and the likelihood that the event will occur. Based on these two key inputs, the risk assessment and derived risk rating then guides the actions required to reduce or manage the risk to an acceptable level.

Our risk management framework is based on:

- AS/NZS ISO 31000 Risk Management – Principles and Guidelines,
- AS 2885 Pipelines-Gas and Liquid Petroleum; and
- AS/NZS 4645 Gas Distribution Network Management.

The Gas Act 1997 and Gas Regulations 2012, through their incorporation of AS/NZS 4645 and the Work Health and Safety Act 2012, place a regulatory obligation and requirement on us to reduce risks rated high or extreme to low or negligible as soon as possible (immediately if extreme). If it is not possible to reduce the risk to low or negligible, then we must reduce the risk to as low as reasonably practicable (ALARP).

When assessing risk for the purpose of investment decisions, rather than analysing all conceivable risks associated with an asset, we look at credible, primary risk events to test the level of investment required. Where an event has an overall risk rating of moderate or higher, we will undertake investment to reduce the risk.

Seven consequence categories are considered for each type of risk:

1. **Health & safety** – injuries or illness of a temporary or permanent nature, or death, to employees and contractors or members of the public
2. **Environment** (including heritage) – impact on the surroundings in which the asset operates, including natural, built and Aboriginal cultural heritage, soil, water, vegetation, fauna, air and their interrelationships
3. **Operational capability** – disruption in the daily operations and/or the provision of services/supply, impacting customers
4. **People** – impact on engagement, capability or size of our workforce
5. **Compliance** – the impact from non-compliance with operating licences, legal, regulatory, contractual obligations, debt financing covenants or reporting / disclosure requirements
6. **Reputation & customer** – impact on stakeholders' opinion of AGN, including personnel, customers, investors, security holders, regulators and the community
7. **Financial** – financial impact on AGN, measured on a cumulative basis

Note that risk is not the sole determinant of what investment is required in our network. Many other factors such as growth, cost, efficiency, sustainability and the future of the network are also considered when we develop engineering solutions. The risk management framework provides a valuable tool to manage our assets, and prioritise our works program, however, it is not designed to provide a binary (yes/no) trigger for investment.

The risk event being considered is that hydrogen is injected into the network without infrastructure adaptation, with two main consequences that would eventuate:

1. Loss of supply to >10,000 customer due to the failure of a high-pressure regulating site where the hydrogen has caused the elastomer and/or the metal to fail. This results in high risk levels in Operations, Reputation & Customer, and Finance
2. Potential loss of license due to breaching of the Safety Case, whereby all reasonable risks have not been managed. The results in a high risk under the Compliance category.

The moderate Health & Safety and People risk is due to potential for an explosion in a hazardous area caused by equipment not being upgraded for the purposes of operating in a hydrogen blend environment. This explosion may result in an employee receiving hospital treatment. The moderate risk is not considered ALARP.

Table 1-3: Risk rating – untreated risk

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Unlikely	Unlikely	Occasional	Unlikely	Occasional	Occasional	Occasional	High
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Moderate	Low	High	Moderate	High	High	High	

1.3. Customer and stakeholder engagement

AGIG is committed to operating the network in a manner that is consistent with the long-term interests of our customers. To facilitate this, AGIG conducts regular stakeholder engagement to understand and respond to the priorities of our customers and stakeholders. Feedback from stakeholders is built into our asset management considerations and is an important input when developing and reviewing our expenditure programs.

As discussed in the Network Adaptation Strategy, decarbonisation of the energy sector and a preference among stakeholders for renewable gas is the subject of ongoing discussion and research. For example, the Renewable Hydrogen Industry Development Plan 2021 sets a blueprint for how the Victorian Government supports the growth of the emerging renewable gas sector. Extracts from the report state:

"We have a vision for renewable hydrogen to be a part of our economy and the transition to a net zero emission future"

"Victoria has the most extensive gas main network in Australia and uses a significant amount of natural gas. Renewable hydrogen could become a low carbon substitute for natural gas, either through gas blending or complete replacement in the long term"

Further, in recent Victorian customer engagement workshops, key findings were:

- Clean energy and reducing carbon emissions is an imperative for the majority of customers.
- 87% of customers view climate change and reducing carbon emissions as important or very important.
- 89% of customers support AGN's proposed approach to preparing our networks for renewable gas.

Based on this feedback, it is clear our gas distribution networks will have an important role to play in Victoria's energy transition, and that customers still value gas services. We will therefore continue to pursue prudent and efficient ways to get our networks ready for renewable gas, and aim to do so without materially impacting customers' bills.

1.4. Program breakdown

This section provides a breakdown of our proactive, staggered approach to network adaptation, which we believe is the most efficient transition path to renewable gas transportation.

1.4.1. Hazardous area equipment

Compared to natural gas, hydrogen and hydrogen blends require a larger minimum hazardous area size in open spaces. Hydrogen will require a change to the equipment group, due to the reduced ignition energy compared to natural gas. This solution involves replacing Cat. II A & B rated equipment with Cat. IIC, hydrogen ready equipment.

AGN operates 300 network facilities with hazard areas (such as pressure reduction sites) of which 195 will be target for replacement. AGN also operates 400 metering facilities with hazardous areas (such as interval metering sites). Under our staggered implementation approach, 260 sites will be targeted for upgrade for compatibility with hydrogen during the next AA period.

1.4.2. Replace incompatible parts

Hydrogen can cause embrittlement of some metals, leading to a reduction in tolerance to crack-like defects and an acceleration of fatigue failure. We have identified that components with parts made from copper alloys, most aluminium alloys, and stable austenitic stainless steels are suitable for 10% and 100% hydrogen service. Other metals with poor performance such as cast irons, high strength carbon steels (e.g. chrome-moly), martensitic stainless steels and nickel alloys also may not be compatible with hydrogen.

Working with the manufacturers to eliminate as many components as possible, AGN has identified that there are only 232 incompatible parts within its network that require remediation to allow for the safe introduction of a hydrogen blend, detailed in the table below. Under the staggered approach, we will replace 151 incompatible parts in the next AA period.

Table 1-4: Identified hydrogen incompatible parts – Option 1

Make/Model	Units	Units to be replaced in next AA Period
Keystone AR2 butterfly valves	4	3
Crosby 951 relief valve/regulator	10	7
Mooney Flowgrid regulators	213	138
Fisher 951 partial relief valve	5	3
Total	**232**	**151**

1.4.3. Weld procedures and weld hardness testing

A compatibility review found that most of AGIG's pipelines (>1,050kPa) with design factors below .04 and Network steel piping (<1,050kPa) can safely be used to transport hydrogen blends or pure hydrogen. However, existing weld procedures will not be appropriate and must be re-qualified.

We must develop weld procedures for 21 steel pipelines identified in Table 1-5 below, to ensure the safe operation of our steel pipelines. We must also undertake hardness testing for a random sample of welds in each pipeline, to show compliance with the hardness limits of ASME B31.12.

The weld hardness testing project is relatively balanced across the AA period. There is a peak in activity in 2025 to provide early access to data and to help balance the work profile with the 2024 activity peak in weld procedures. The 2024 peak in weld procedures aligns with the HyP Murray Valley project. Following this the project is delivered evenly across the period to allow resources to be optimised with a steady workflow.

Table 1-5: Steel pipelines requiring new weld procedures and weld hardness testing

Pipeline/Section name	License number	Identified for AA period
PL11 Dandenong to Crib Point [1]	11	Yes
PL43 Longford to Sale [1]	43	-

Pipeline/Section name	License number	Identified for AA period
PL44 Sale to Maffra Pipeline	44	-
PL49 Dandenong to Frankston [1]	49	Yes
PL61 Hastings to Tyabb (Esso)	61	Yes
PL62 Tyabb to Mornington (plus loops) [1]	62	Yes
PL66 North Melbourne to Fairfield [1]	66	Yes
PL85 Bangholme (Melbourne Metro Board of Works)	85	Yes
PL102 Wodonga West to Wodonga	102	Yes
PL103 Shepparton (to Dookie Road)	103	-
PL115 Hastings (Lysaght)	115	Yes
PL137 Bittern to Dromana	137	Yes
PL139 Langwarrin to Frankston	139	Yes
PL167 Dromana to Rye	167	Yes
PL215/T82 Morwell to Tramway Rd [1]	215	-
PL215/T82 Morwell to Tramway Rd [1]	T82	-
PL201 Templestowe to Keon Park	201	Yes
PL208 North Melbourne to West Melbourne [1]	208	Yes
PL219 Wodonga City Gate to Vic/NSW Border	219	Yes
NSW501 Albury to Australian Newsprint Mills	NSW501	Yes
NSW502 Vic/NSW Border to Albury [1]	NSW502	Yes

1.4.4. Pipeline repair equipment

Further work is required to assess compatibility of transmission pipeline repairs undertaken with Plidco & Smith Clamps and purchase compatible equipment. This project will be delivered during the first two years of the AA period, as the information will assist in developing forward looking upgrade or replacement asset management plans.

1.4.5. Transmission pressure pipeline compatibility assessment

Most of the AGN Victoria and Albury transmission pressure pipelines have already been assessed for hydrogen compatibility as part of the Australian Hydrogen Centre (AHC technical assessment, or as part of the HyP Murray Valley Project. Several pipelines were excluded from these scopes due to their complexity, however, they still require suitable assessment prior to the introduction of hydrogen. For AGN Victoria and Albury this impacts five pipelines, which are identified in the table below.

Table 1-6: Transmission pressure pipelines requiring hydrogen compatibility assessments

Pipeline name / Section Name	Pipeline license	Identified for AA period
Dandenong to Crib Point & adjoining sections	VIC11	Yes
Longford to Sale	VIC43	Yes
Bittern to Dromana	VIC137	Yes
Langwarrin to Frankston	VIC139	Yes
Berri to Mildura Pipeline	VIC226	Yes

This project is being delivered during in the first two years of the next AA period, as the information will assist in developing forward looking upgrade or replacement asset management plans.

1.4.6. Hazardous areas extents

We must conduct a technical review of 150 Pressure Reduction Sites. This work will require a qualified engineer to review each site and provide recommendations to the business. This activity is prioritised for first two years of the next AA period, as the information will assist in developing forward looking upgrade or replacement asset management plans.

1.4.7. Document updates

We must ensure documentation complies with the introduction and operation of a hydrogen blend. For AGN Victoria and Albury, the following types of documentation have been identified:

- pipeline associated documentation, for example procedure 9066, pipeline defect assessment;
- an updated SMS for each affected pipeline;
- update procedures - AGN LMP for 100% H2 in alignment with the HyP Murray Valley hydrogen pipeline; and
- updates to the Geospatial Information System to indicate blended hydrogen areas.

The project shall be completed within first three years of the next AA period to allow safe operations from 2025 onwards, when hydrogen will be actively used within the AGN network.

1.4.8. Further assessment or investigation required

Further assessments are required to ensure the safe and progressive introduction and operation of a hydrogen blend into gas networks. For AGN the following areas have been identified as requiring further assessment:

- assess cast iron components currently in use >7kP for use with hydrogen;
- perform risk assessments on possible loss of isolation for all components containing nickel alloys, any untested aluminium alloy or elastomers;
- review capacity of 150 pressure regulating stations; and
- investigate mechanical joint compatibility and performance in the AGN network (<1050kPa).

This activity is phased to align with the 'replace incompatible parts' project to optimise the available workforce. The project increases over the period to balance the overall portfolio of works and to ensure that efficiencies and learnings are applied as the program progresses.

1.5. Options analysis

The following options have been identified to address the risk associated with the introduction of hydrogen into the network without network adaptation being undertaken.

- **Option 1 – Staggered approach** – Upgrade components in strategic locations of the AGN Victoria and Albury network ready for a 10% hydrogen blend by 2028, and continue ongoing research into the safe transition of increasing renewable gas volumes ($9.5 million)
- **Option 2 – Upgrade network by 2028** – Upgrade components all across the AGN Victoria and Albury network ready for a 10% hydrogen blend by 2028, and continue ongoing research into the safe transition of increasing renewable gas volumes ($12.6 million)
- **Option 3 – No network adaptation** – Inject hydrogen into the network without network adaptation investment. Continue ongoing research into the safe transition to renewable gas ($0.6 million)

A further option was also considered to make strategic locations of AGN's network 100% hydrogen blend ready by 2028. Although this option would best position AGN to facilitate transition to decarbonised energy in Victoria and help the Government achieve its emissions reduction targets, we considered there were too many unknowns in the cost estimation model to be able to develop a reasonable estimate.

We will continue to investigate the costs, benefits and technical implications of transitioning to 100% hydrogen, however, we feel it is more prudent and efficient to prepare the entire network for 100% renewable gas over a longer timeframe, and these initial projects represent a proactive and conservative approach at this stage in the transition journey.

Table 1-7: Option analysis – scope summary

Program	Option 1	Option 2	Option 3
Hazardous area equipment	195 of 300 hazardous facilities; 260 of 400 metering sites	300 of 300 hazardous facilities; 400 of 400 metering sites	N/A

Replace incompatible parts	151 of 232 identified incompatible parts	232 of 232 identified incompatible parts	N/A
Weld procedures and weld hardness testing	16 of the 21 identified steel pipelines	21 of the 21 identified steel pipelines	N/A
Further assessment or investigation	Program included	Program included	N/A
Transmission pipeline (TP) compatibility assessment	Program included in all options		
Hazardous areas extents	Program included in all options		
Document updates	Program included in all options		
Further assessment or investigation required	Program included in all options		
Capex	8,912	12,030	-
Opex	635	635	635
Totex	**9,547**	**12,665**	**635**

1.5.1. Option 1 – Staggered network upgrade

Under Option 1, rather than attempt to proactively replace all components, we will take a more strategic approach, focusing on those parts of the network most likely to have hydrogen introduced first. For example, the northern parts of the network around the Murray Valley would be targeted for being made hydrogen ready given the nearby HyP Murray Valley project. Isolated network sections located off the Northern Interconnect or the Longford to Dandenong pipeline would not be targeted, as these parts of our network are unlikely to see hydrogen within the next five years.

Option 1 therefore represents a more conservative work program than Option 2, with a reduction in the number of assets replaced, welds tested and hazardous areas assessed.

Cost assessment

Table 1-8 provides a breakdown of forecast capex for Option 1.

Table 1-8: Forecast capex – Option 1 $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Hazardous area equipment	705	705	1410	1410	-	4,231
Replace incompatible parts	252	252	503	503	-	1,510
Weld procedures & hardness testing	798	758	558	458	458	3,030

Further assessment or investigation	150	0	0	0	0	150
	1,905	**1,715**	**2,471**	**2,371**	**458**	**8,921**

Table 1-9 provides a breakdown of forecast opex for Option 1.

Table 1-9: Forecast opex – Option 1 $'000 real 2021

Option 1	2023/24	2024/25	2025/26	2026/27	2027/28	Total
TP compatibility assessment	118	-	-	-	-	118
Hazardous areas extents	30	30	-	-	-	60
Document updates	30	30	27	-	-	87
Further assessment or investigation	61	62	123	123	-	369
Total	**239**	**122**	**150**	**123**	**-**	**635**

Risk assessment

Under Option 1, the sections of the network that will receive hydrogen first will be made compatible, therefore the likelihood of the identified loss of supply and compliance risk events occurring reduces to rare. This results in an overall risk assessment of low.

Table 1-10: Risk assessment – Option 1

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Low
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Negligible	Negligible	Low	Negligible	Low	Low	Low	

Alignment with vision objectives

Table 1-11 shows how Option 1 aligns with our vision objectives.

Table 1-11: Alignment with vision – Option 1

Vision objective	Alignment
Delivering for Customers – Public Safety	Y
Delivering for Customers – Reliability	Y
Delivering for Customers – Customer Service	Y
A Good Employer – Health and Safety	Y
A Good Employer – Employee Engagement	-
A Good Employer – Skills Development	-
Sustainably Cost Efficient – Working within Industry Benchmarks	Y

Vision objective	Alignment
Sustainably Cost Efficient – Delivering Profitable Growth	-
Sustainably Cost Efficient – Environmentally and Socially Responsible	Y

Option 1 would align with our objectives of *Delivering for Customers* and *a Good Employer* as it enables the safe introduction of a hydrogen blend into the network without putting employees or the public at risk.

This option would also align with our objective to be S*ustainably Cost Efficient* as although the whole network must be adapted in the longer term, the priority is to focus on those areas expected to receive hydrogen in the current period. This makes for a modest, prudent and efficient work program. The project will also allow us to increase our understanding of hydrogen and renewable gas in the network, informing future plans and allowing us to identify operational efficiencies going forward.

1.5.2. Option 2 – Upgrade network by 2028

Under Option 2, we will identify all components that require proactive replacement in order to be compatible with a 10% hydrogen blend, and aim to replace them all during the next AA period (2023/24 to 2027/28). This includes replacing non-hydrogen ready equipment in hazardous areas, replacing incompatible parts (certain metallic valves and regulators), and testing weld hardness and procedures.

This would be an exhaustive program, designed to get the entire network ready for hydrogen[1] so that renewable gas can be introduced anywhere in the distribution system. Option 2 would also include opex to continue assessing hazardous area extents, updating key documentation to reflect renewable gas asset management, and assessing hydrogen compatibility with transmission pressure pipelines.

The program of works is forecast to be completed before 2028, to facilitate the phased introduction of a 10% hydrogen blend. We will prioritise areas such as the Murray Valley area, which will be one of the first parts of our network to receive a 10% (or more) hydrogen blend, for proactive asset replacement by 2025. We propose the program ramps up over the period as the resources increase in volume and productivity to deliver the project.

Cost assessment

Table 1-12 provides a breakdown of forecast capex for Option 2.

Table 1-12: Forecast capex – Option 2 $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Hazardous area equipment	950	950	1901	1901	0	5,702
Replace incompatible parts	340	340	678	678	0	2,036
Weld procedures & hardness testing	798	758	558	458	458	3,030

[1] Excluding assets scheduled for replacement as part of ongoing end-of-life replacement programs.

Further assessment or investigation	150	0	0	0	0	150
Total	**2329**	**1939**	**3227**	**3227**	**648**	**11,368**

Table 1-13 provides a breakdown of forecast opex for Option 2.

Table 1-13: Forecast opex – Option 2 $'000 real 2021

Option 2	2023/24	2024/25	2025/26	2026/27	2027/28	Total
TP compatibility assessment	118	-	-	-	-	118
Hazardous areas extents	30	30	-	-	-	60
Document updates	30	30	27	-	-	87
Further assessment or investigation	61	62	123	123	-	369
Total	**239**	**122**	**150**	**123**	**-**	**635**

Risk assessment

Under Option 2, all network components would be compatible with hydrogen, therefore the likelihood of the identified loss of supply and compliance risk events occurring reduces to rare. This results in an overall risk assessment of low.

Table 1-14: Risk assessment – Option 2

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Low
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Negligible	Negligible	Low	Negligible	Low	Low	Low	

Alignment with vision objectives

Table 1-15 shows how Option 2 aligns with our vision objectives.

Table 1-15: Alignment with vision – Option 2

Vision objective	Alignment
Delivering for Customers – Public Safety	Y
Delivering for Customers – Reliability	Y
Delivering for Customers – Customer Service	Y
A Good Employer – Health and Safety	Y
A Good Employer – Employee Engagement	-
A Good Employer – Skills Development	-
Sustainably Cost Efficient – Working within Industry Benchmarks	N

Vision objective	Alignment
Sustainably Cost Efficient – Delivering Profitable Growth	-
Sustainably Cost Efficient – Environmentally and Socially Responsible	Y

Option 2 would align with our objectives of *Delivering for Customers* and *a Good Employer* as it enables the safe introduction of a hydrogen blend into the network without put employees or the public at risk.

This option would not align with our objective to be S*ustainably Cost Efficient* as the solution, although required in the longer term, is not fully optimised. A hydrogen blend will be introduced throughout the entire network in the future, however, this is not likely to occur until after 2028 and therefore it is not necessary to proactively replace all assets within the next AA period.

1.5.3. Option 3 – No network adaptation

Option 3 involves the injection of hydrogen into the AGN network without undertaking proactive replacement to undertake compatibility risk. As discussed in the Network Adaptation Strategy, the vast majority of our network is already, in theory, compatible with a hydrogen blend of up to 10%. It is therefore reasonable to consider the possibility of introducing hydrogen without the proactive replacement, instead of waiting for all assets to reach end of life before replacing them with hydrogen compatible components. As and when network risks emerge, they would be managed reactively.

However, it is important to highlight the lack of practical experience and application of hydrogen blending in an ageing gas distribution network. There are unknowns with regard to the chemical and technical impact of hydrogen on our network. Once hydrogen impacts on one type of asset and results in operational failures, for example elastomers failing on pressure reduction sites, it is very likely that further failures will occur on all similar assets in a short period of time. This may result in significantly escalating reactive responses to incidents and loss of supply events.

Failed AGN infrastructure would be replaced with hydrogen ready assets.

This option would make the network non-compliant with Hazardous Area requirements.

Cost assessment

There are no upfront capital costs associated with this option. The network would be injected with a 10% blend without any proactive hydrogen ready asset replacement being conducted.

Work to research the safe transition to renewable gas would continue, resulting in opex costs of around $0.6 million as per Options 1 and 2.

We highlight that in the event of asset failure, the cost of emergency works and call out would be high, with reactive works typically costing 3-5 times more than proactive works. There would also be significant financial penalties associated with loss of supply incidents and non-compliances.

Risk assessment

The risk outcome under Option 3 would be the essentially same as the untreated risk, as no action would be taken to proactively replace non compatible assets and mitigate the current risk posed by hydrogen injection.

Table 1-16: Risk rating – Option 3

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Unlikely	Unlikely	Occasional	Unlikely	Occasional	Occasional	Occasional	High

Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Moderate	Low	High	Moderate	High	High	High	

Option 3 is not consistent with the requirements of our Safety Case, risk management framework, and does not meet the tests of a prudent asset manager/network business. Ultimately, the network business could lose its operating licence as the risks escalate over time.

Alignment with vision objectives

Table 1-17 shows how Option 3 aligns with our vision objectives.

Table 1-17: Alignment with vision – Option 3

Vision objective	Alignment
Delivering for Customers – Public Safety	N
Delivering for Customers – Reliability	N
Delivering for Customers – Customer Service	N
A Good Employer – Health and Safety	N
A Good Employer – Employee Engagement	-
A Good Employer – Skills Development	-
Sustainably Cost Efficient – Working within Industry Benchmarks	N
Sustainably Cost Efficient – Delivering Profitable Growth	-
Sustainably Cost Efficient – Environmentally and Socially Responsible	N

Option 3 would not align with any of our objectives. It would not deliver against the service, safety and decarbonisation expectations of our customers and stakeholders.

Introducing hydrogen without undertaking the necessary component upgrades exposes our employees and contractors to unnecessary hazards, placing them at risk of serious harm. It is therefore not consistent with being a good employer.

While the upfront capital costs would be lower than Option 1 and 2, the higher costs of reactive works and the potential for significant financial penalties means Option 3 is not sustainably cost efficient.

1.5.4. Summary of costs and benefits

Table 1-18 presents a summary of how each option compares in terms of the estimated cost, the residual risk rating, and alignment with our vision objectives.

Table 1-18: Comparison of options

Option	Estimated cost ($ million)	Treated residual risk rating	Alignment with vision objectives
Option 1	9.5	Low	Aligns with *Delivering for Customers* and *Sustainably Cost Efficient*
Option 2	12.6	Low	Aligns with *Delivering for Customers* but not *Sustainably Cost Efficient*

Option 3	0.6	High	Does not align with *Delivering for Customers, A Good Employer* or *Sustainably Cost Efficient*

1.5.5. Recommended option

Option 1 is the recommended option. This solution involves the adaptation of strategically targeted areas of the network, whilst simultaneously undertaking necessary works for future hydrogen blending.

1.6. Estimating efficient costs

The work programs that form the hydrogen network adaptation program were initially scoped and costed by external experts GPA Engineering as part of the AHC's wide ranging review into network compatibility with hydrogen. The expert report has been distilled down to applicable AGIG networks to develop network specific scopes and costs.

Further investigations have been undertaken with manufacturers to determine hydrogen compatibility of components initially identified as lacking information to support compatibility. This subsequent research has successfully identified that key infrastructure within the initial cost build up no longer requires further investment. For example, Axial Flow Regulators & Pietro Fiorentini regulators were found to be 10% hydrogen compliant, which reduced the forecast expenditure by $7.4 million.

Further refinement of the forecast expenditure was made by identifying and excluding costs for sections of the network that were unlikely to receive blended hydrogen in the upcoming regulatory period.

Through risk assessment processes, we have determined that many of the operational risks can be managed through additional monitoring practices and research projects, thereby reducing capital forecast investments to only those that are essential. The specific scope and volumes for each network business has been developed from the GPA reports, considered against the Network Adaptation Strategy, which has informed the specific projects.

Excluded from cost estimates are the minor incremental changes to procurement practices and design activities to accommodate future hydrogen blends in the network. These costs have been absorbed into forward looking unit rates specific to those assets and strategies.

To the extent possible, the costs derived for these programs have been estimated based on historical costs incurred in completing similar projects.

To achieve efficiency in design, engineering and project management, projects in the program are bundled together as a package for efficient use or resources. By way of example the incompatible parts project is phased to match the further investigation required project as engineering resources can complete the two in conjunction, with these efficiencies accounted for in the forecast.

Projects are phased across multiple years to achieve the optimal outcome for the business and customers in terms of asset utilisation, risk reduction, timing of the works and resource availability. Projects that are critical to developing knowledge and facilitating any hydrogen blend (regardless of percentage by volume) are prioritised in the earlier years of the period.

The unit rates used for all projects managed within this program of work include the internal labour, external labour, materials, design, engineering, construction, project management and commissioning costs forecast.

Historical projects in this strategy have typically achieved a labour to material split of 40:60 percent. This breakdown is then applied to the forecast below.

Table 1-19: Cost breakdown, AGN Victoria and Albury hydrogen adaptation $'000 real 2021

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Labour	858	735	1,049	998	183	3,822
Materials	1,287	1,102	1,573	1,497	275	5,734
Total	2,144	1,837	2,621	2,494	458	9,556

As with all capex programs, only capital actually incurred to adapt the network to renewable gas and hydrogen will be added to the regulated asset base (RAB) and recovered via regulated tariffs. We will endeavour to outperform the forecast where possible and ensure the incremental expenditure to get the network ready to deliver renewable gas reflects the lowest sustainable cost to consumers.

More detailed cost estimates are provided in Appendix A and Appendix B.

1.6.1. Consistency with the National Gas Rules

In developing these forecasts, we have had regard to Rule 79, Rule 74 and Rule 91 of the NGR. With regard to all projects, and as a prudent asset manager, we give careful consideration to whether capex is conforming from a number of perspectives before committing to capital investment.

NGR 79(1)

The proposed solution is prudent, efficient, consistent with accepted good industry practice and will achieve the lowest sustainable cost of delivering pipeline services:

- **Prudent** – The expenditure is necessary in order to ensure that the ongoing integrity of the network is maintained with the introduction of hydrogen and to reduce the risk of major gas escapes that could impact public safety and reliability of supply.

  Adapting our network in a way that mitigates foreseeable risks is consistent with our Safety Case and accepted industry practice. Hydrogen transportation is not new and the steps we are taking are known to address the risk associated with hydrogen in pipes. Several practicable options have been considered to address the risk. The proposed expenditure is therefore consistent with that which would be incurred by a prudent service provider.

- **Efficient** – The forecast expenditure is based on rates applied in similar projects and a detailed scope of work verified by an experienced third-party engineering consultant. Undertaking this project with a staged approach, focusing those parts of the network that will receive hydrogen first (rather than embarking on network-wide asset replacement), will help us inform the scope and cost of the forward works program as blends of hydrogen increase over time, while lessening revenue impact on customers in the next period.

- **Consistent with accepted and good industry practice** – We are constantly reviewing the network risks in line with the Safety Case and are taking steps to mitigate likely issues that will result from the introduction of hydrogen. Renewable gas and associated technologies are being pursued by stakeholders, and are part of the decarbonisation agenda being developed by the

Australian Commonwealth and State Governments. It is therefore good practice to ensure our network is ready to support this.

To achieve the lowest sustainable cost of delivering pipeline services – The proposed expenditure is necessary to facilitate the early stages of hydrogen introduction into the network. Failure to do so would result in additional expenditure being incurred to *reactively* augment the network over a short, unmanageable timeframe.

The project is therefore consistent with the objective of achieving the lowest sustainable cost of delivering services. The project will also enable us to inform and manage the future requirements of increasing hydrogen blends more efficiently. Fully understanding the effect of hydrogen blends on our assets, and taking a proactive approach, will allow us to operate the assets for as long as is safe and practicable, achieving the lowest sustainable cost of providing pipeline services.

NGR 79(2)

The proposed capex is justifiable under NGR 79(2)(c)(i) and 79(2)(c)(ii), as it is necessary to maintain the safety and integrity of services. Introduction of hydrogen into the distribution system without upgrading incompatible parts will likely resulting in asset failure, with the potential for significant safety and/or supply events.

NGR 74

The forecast costs have been arrived at on a reasonable basis by following realistic assumptions of costs, informed by independent engineering advice and experience in other jurisdictions. Rates are comparable with the market and the scope of the project is limited to only what is critical for the next access arrangement period, with a view to informing more accurate forecasts in future periods. We therefore consider the costs estimates represent the best forecast possible in the circumstances.

NGR 91

The proposed operating expenditure is required to undertake the necessary renewable gas research and studies to ensure the transition to renewable gas can occur in a safe and affordable manner. These are consistent with costs that would be incurred by a prudent service provider acting efficiently to achieve the lowest sustainable cost of service.

Appendix A Detailed capex estimates

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Appendix B Detailed opex estimates

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Appendix C Comparison of risk assessments for each option

Untreated risk	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Unlikely	Unlikely	Occasional	Unlikely	Occasional	Occasional	Occasional	High
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Moderate	Low	High	Moderate	High	High	High	

Option 1	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Low
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Negligible	Negligible	Low	Negligible	Low	Low	Low	

Option 2	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Rare	Rare	Rare	Rare	Rare	Rare	Rare	Low
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Negligible	Negligible	Low	Negligible	Low	Low	Low	

Option 3	Health & Safety	Environ-ment	Operations	People	Compliance	Rep & Customer	Finance	Risk
Likelihood	Unlikely	Unlikely	Occasional	Unlikely	Occasional	Occasional	Occasional	High
Consequence	Significant	Minor	Major	Significant	Major	Significant	Major	
Risk Level	Moderate	Low	High	Moderate	High	High	High	