Zincara

From strategy to action

Access Arrangement Review
Australian Gas Network (AGN)

Public

Prepared for

AUSTRALIAN ENERGY REGULATOR

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Zincara P/L

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1. EXECUTIVE SUMMARY

In June 2022, the Victorian gas distributors submitted its revised Access Arrangement (AA) for its gas distribution systems to the Australian Energy Regulator (AER). The submissions are to cover the period 1July 2023 to 30June 2028. The AER has engaged Zincara P/L to review some of the elements of the gas distributors' submission. Specifically, Zincara is assessing Australian Gas Network's (AGN) hydrogen proposal and its augmentation.

The tests used for Zincara's assessments are NGR Division 4 Section 79 and Division 7 Section 91. As the NGR is for natural gas, we have referred to the Australian Market Operation Commission (AEMC) report to extend the regulatory framework to cover hydrogen and renewable for guidance on the application of our assessment tests.

This report details Zincara's assessment for AGN's hydrogen proposal and its augmentation. In coming to our conclusions, we have taken into account the comments made by stakeholders in their submissions.

1.1 HYDROGEN

AGN proposes to introduce a 10% hydrogen and natural gas blend into its network by 2030 and operate a 100% hydrogen network by 2040. This is in line with the Victorian Government commitment to net zero greenhouse gas emission by 2050.

For the next AA period, AGN proposes to commence adapting its Victorian gas network to transport renewable gas. For capex, AGN proposes to carry out a range of activities from replacing network equipment (e.g. pressure reduction stations) which no longer meet the minimum hazardous clearance for hydrogen blend to replacing equipment which are not compatible with transporting hydrogen and requalifying welds in the transmission pipelines for hydrogen use.

In relation to operating expenditure, AGN proposes to carry out further assessment on its transmission pipelines for the suitability of transporting hydrogen, document updates and further investigations on the safe and progressive introduction of hydrogen.

AGN's proposed expenditure is shown in the table below.

Table 1-1: AGN expenditure for the introduction of hydrogen ($000 real 2021)

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Capital expenditure	$1,905	$1,715	$2,471	$2,371	$458	$8,920
Operating expenditure	$239	$122	$150	$123	-	$635

Source: AGN Final Plan_Attachment 9.10(2)_Renewable Gas network Adaptation Plan_Confidential

We concluded that the capex program is required for the introduction of 10% hydrogen. However, the lack of a detailed plan showing how the 10% hydrogen is to be rolled out means that there is no demonstrated imperative that the work needs to be commenced in the next AA period. We do not consider the capex to be prudent for the next AA period.

In relation to AGN's opex, we also concluded that the range of activities outlined above are required in preparation for the rollout of hydrogen. Like the capex, it is difficult to ascertain the timing of such projects given the lack of detailed rollout plan. We therefore do not consider the work to be prudent for the next AA period.

1.2 AUGMENTATION

AGN resubmitted its augmentation proposal after the release of the Victorian Government "Gas Substitution Roadmap" (GSR). AGN's augmentation plan had reduced from $73 million to $54 million, a reduction of $19 million. We consider that the revised program, has provided a reasonable assessment of potential GSR impacts, while at the same time being cognisant of the security of supply obligations under the Gas Distribution System Code.

The table below shows AGN's augmentation initial proposal and its revised proposal.

Table 1-2: Augmentation Project Expenditure ($000, real 2021)

Category	Initial	Revised	Variance
HP network augmentation	30,846	15,954	-14,892
Regulator capacity upgrades	14,135	10,394	-3,741
Dandenong Crib Point pipeline upgrade	28,220	28,220	0
Total Augmentation program	**73,201**	**54,568**	**-18,633**

(Source: Revised Capex Model)

HP Network Augmentation

For each proposed HP network augmentation, AGN has provided a detailed business case that included analysis of network flows and growth, network modelling and scoping design, solution options and cost estimates.

As a result of our analysis of AGN's methodology in assessing its networks and the quality of its business cases for prospective HP network augmentations we consider that the projects are prudent in managing integrity of supply to its customers. With respect to cost estimates, we consider that AGN's use of competitive tendering provides the most efficient costs in the circumstances. We therefore recommend approval of each of the HP augmentation projects included in AGN's revised program.

Regulator Capacity Upgrades

As with the network augmentation projects we consider that AGN's methodology in assessing its regulating stations and the quality of its business cases show that the projects are prudent. With respect to cost estimates, we consider that AGN's use of actual pricing from recent city gate projects provides the most efficient costs in the circumstances. We therefore recommend approval of each of the regulator capacity upgrade projects included in AGN's revised program.

Dandenong Crib Point Pipeline (DCP) Upgrade

The final stage of the DCP duplication was initially approved by the AER for the current period at a cost of $13.8 million, however AGN's recent business case submission has a revised cost of $28.2 million. The level of detail provided in support of the cost estimate and in subsequent information is extensive and the methodology applied would appear to be sound. We consider that the DCP project to provide security of supply to over 140,000 customers is prudent and the cost, based on the best information available, is efficient in the circumstances.

2. INTRODUCTION

2.1 BACKGROUND

In July 2022, Australian Gas Networks (AGN) submitted it revised Access Arrangement (AA) for its Victorian gas networks for the period 1 July 2023 to 30 June 2028 to the Australian Energy Regulator (AER). To assist in the capital expenditure review, the AER engaged Zincara P/L (Zincara) to advise on the two aspects of the capital expenditure: hydrogen and augmentation.

2.2 SCOPE

The focus of the review is to provide the AER with a view on whether the capex meets the requirements of the National Gas Rules (NGR) and in particular NGR Division 4 Section 79 for capex and Division 7 Section 91 for opex.

2.3 NATIONAL GAS RULES

The relevant part of NGR Division 4 Section 79 which has been applied is:

(1) Conforming capital expenditure is capital expenditure that conforms with the following criteria:

(a) the capital expenditure must be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services; and
(b) the capital expenditure must be justifiable on a ground stated in subrule (2); and
(c) the capital expenditure must be for expenditure that is properly allocated in accordance with the requirements of subrule (6).

The National Gas Rules Division 7 to determine operating expenditure. Section 91 (1) states:

"Operating expenditure must be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of delivering pipeline services."

2.4 DEFINITION FOR PRUDENCE AND EFFICIENCY

As the NGR does not define the prudence, efficiency and good industry practice, Zincara has adopted the following definitions:

"Prudence", means "*caution in managing one's activities to avoid undesirable consequences*[1]*".* Zincara has interpreted this to mean that for the project to be prudent, the

[1] Australian Concise Oxford Dictionary

decision is made on the basis that it is timely for the project to proceed to rectify ongoing safety and reliability issues.

'Efficiency' means *functioning or producing effectively and with the least waste of effort*[1]. This means that the choice of which option to adopt for the project must be made on the basis that the most effective solution has been adopted. The "least amount of effort" refers to the cost of the project and in that context the project must be carried out at market rates.

"Good industry Practice" means that the actions that a prudent operator would adopt in similar Australian conditions.

2.5 APPROACH

The key steps of our approach are:

- Review the relevant documents provided by AGN in its submission.
- Identify what are strategic objectives of the projects
- Determine whether the most efficient option had been adopted and the appropriateness of the timing of the project.
- Ensure that the estimated cost for the project meets the efficiency test.

Zincara's analysis is based on the AGN's submission and Zincara has assumed the data to be accurate. Zincara has not verified the accuracy or veracity of the data.

3. HYDROGEN

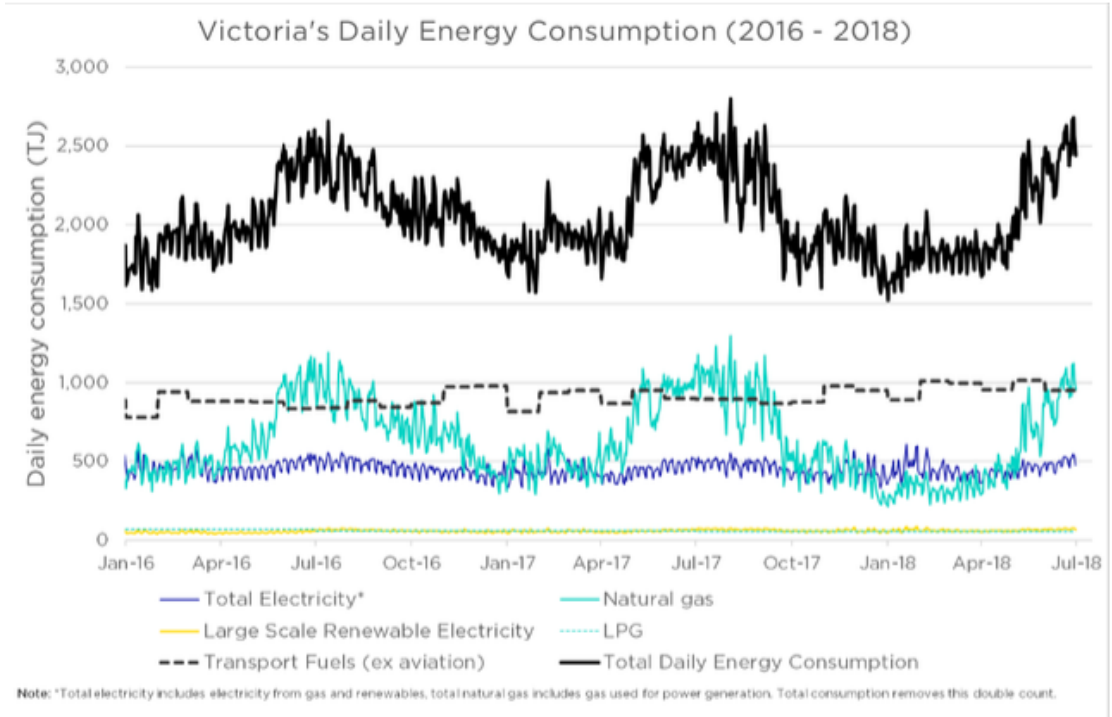
3.1 INTRODUCTION

AGN Victoria, AGN Albury and Multinet are part of Australian Gas Infrastructure Group (AGIG). In Victoria (including Albury Gas Company), AGIG's total networks[2] serve more than 1.5million customers and comprise of 21,667km of pipeline, services and meters. As such, AGIG has set out the same hydrogen rollout strategy for all three companies. For this report, we have presented the strategy as that of AGN which also includes AGN Albury.

AGN said that the Victorian Government has a timeline to reach net zero greenhouse gas emission by 2050. The Victorian Government has set emissions reduction targets of 28% to 33% by 2025 and 45% to 50% by 2030. AGN believes that renewable gas and gas networks have a role in Australian future energy mix and as such includes Victoria.

AGN advised that research across AGIG operations has shown that customers and the communities want gas in their homes as the preferred fuel for cooking, heating and for its reliability. The Victoria's energy consumption for the winter peak from 2016-2018 shows that gas provided double the energy provided by electricity.

Figure 3-:1 Victorian Daily Energy Consumption 2016-18



(Source: AGN Final Plan_Attachment 9.10(1) Figure 2.-1)

Given the energy transition and customer preference, AGN considers that it is important for its networks to be ready to transport renewable gas (e.g. hydrogen).

[2] AGN Final Plan_Attachment 9.10

3.2 STRATEGY

AGIG has commenced investigation towards a renewable gas future. It advised that it has successfully operated a hydrogen blended networks with hydrogen park in South Australia (HyP SA). It now proposes to expand the operation into Victoria with HyP Murray Valley towns to commence in 2024.

AGIG's key milestone is to accommodate a 10% hydrogen to natural gas blend by 2030 and operate a 100% hydrogen network by 2040. This is in line with the Victorian Government's commitment to net zero greenhouse gas emissions by 2050, with emissions reduction targets of 28% -33% by 2025 and 45% by 2030.

Its next phase is to facilitate 10% hydrogen gas blend by 2030 into its Victorian distribution networks (AGN and Multinet). This will involve targeting sections of its network to incrementally introduce hydrogen as a gas blend with the aim of offering 100% of renewable gas to new housing estate by 2025[3].

Work done on the suitability of the distribution systems to transport hydrogen has shown that in the main, the distribution system is substantially compatible for transporting a blend of natural gas with 10% hydrogen but further work needs to be done for transporting 100%. They include replacement of certain fittings and certain electrical equipment in hazardous locations.

For the 2023/24 to 2027/28 AA period, AGIG proposes to commence adapting both its AGN and Multinet networks to transport renewable gas. It considered three options for the introduction of 10% hydrogen blend into the network:

1. Staggered network upgrade focusing proactively on replacing the components in the network in the areas most likely to have hydrogen first.
2. Upgrade network by 2028 focusing on identifying all the components in the network and proactively replacing them in the 2023-28 AA period.
3. No network adaptation and only replacing components as network risks emerges.

For AGN, AGIG adopted option 1 which is to take a staggered approach to replacing its network. The proposed capital and operating costs for AGN network is $9.5mllion.

[3] AGN Final Plan_Attachment 9.10(1)_AGIG Network Adaptation Strategy -Renewable Gas_Public

3.3 CAPITAL AND OPERATING EXPENDITURE

The tables below show the breakdown of the capital and operating expenditure for AGN networks.

Table 3-1: AGN Forecast Capex for Hydrogen Adaptation Strategy ($000 Real 2021)

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Hazardous Area Equipment	705	705	1,410	1,410	-	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
Total	**$1,905**	**$1,715**	**$2,471**	**$2,371**	**$458**	**$8,920**

(Source: AGN Final Plan_Attachment 9.10(2)_Renewable Gas network Adaptation Plan_Confidential)

Table 3-2: AGN Forecast Opex for Hydrogen Adaptation Strategy ($000 Real 2021)

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

(Source: AGN Final Plan_Attachment 9.10(2)_Renewable Gas network Adaptation Plan_Confidential)

3.4 CAPITAL PROGRAM

3.4.1 Hazardous Area Equipment

Hydrogen and hydrogen blends require a large minimum hazardous area size in open spaces. Cat II A&B rated equipment will need to be replaced with Cat IIC. AGN operates 300 network facilities (e.g. pressure reduction station) of which 195 will be targeted for replacement. In addition, there are 400 metering sites (e.g. interval metering sites), 260 of which are targeted for replacement.

3.4.2 Replace Incompatible Parts

AGN said that it had been working with manufacturers to eliminate as many components as possible in its network that are suitable for the introduction of a hydrogen blend. However, AGN has identified 232 incompatible parts that require remediation. AGN proposes to replace 151 of these units.

3.4.3 Weld Procedures and Weld Hardness Testing

Even though a compatibility review showed that most of the pipelines (>1,050kpa) and network steel pipeline (<1,050kpa) can safely transport hydrogen blends or pure hydrogen, AGN has to develop weld procedures for 21 of its steel pipelines to ensure their safe operation. AGN is also required to carry out hardness testing of a number of sample welds for each pipeline to show compliance with the hardness limits of ASME B31.12[4].

Of its 21 transmission pipelines, AGN proposed to carry out the work on 16 of its pipelines.

3.4.4 Pipeline Repair Equipment

AGN indicated that further work is necessary to assess the compatibility of its transmission repair equipment in a hydrogen environment and purchase compatible equipment.

3.5 OPERATING PROGRAM

3.5.1 Transmission pressure pipeline compatibility assessment

AGN said that most of its pipelines have already been assessed for hydrogen compatibility. However, five of the pipelines were excluded due to their scope and complexity. AGN proposes to carry out the assessment of these pipelines in the next period.

3.5.2 Hazardous areas extents

This work is for an engineer to carry out a technical review of AGN's pressure reduction sites to assist in the development of future upgrade or replacement of their asset management plans.

3.5.3 Document updates

AGN said that it needed to upgrade its documentation to comply with the introduction and operation of a hydrogen blend for AGN and Albury. The range of work covers:

- pipeline associated documentation e.g. 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

[4] American Society for Mechanical Engineers B31.12 is the standard on hydrogen piping and pipelines. It covers joint (e.g. welding) connecting the piping associated with pressure vessels.

- updates to the Geospatial Information System to indicate blended hydrogen areas.

AGN proposes to complete the work within the first three years of next AA period.

3.5.4 Further assessment or investigation required

AGN propose to carry out further assessment to ensure the safe and progressive introduction and operation of a hydrogen blend into its networks. The range of work includes:

- 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).

3.6 ESTIMATED COSTS

AGN advised that the estimated costs were initially scoped and costed by GPA Engineering. AGN had carried out further investigations with manufacturers on the compatibility of their equipment for transporting hydrogen. AGN had been able to refine the costs further when certain equipment such as the Axial Flow Regulators and the Pietro Florentini regulators were found to be 10% hydrogen compliant.

In addition, AGN had also confined its costs to areas that are going to receiving gas in the ensuing regulatory period. Through its risk assessment processes, AGN had been able to reduce its capital forecast to the essential works only.

AGN also indicated that to the extent possible, it had estimated the projects using historical costs from similar completed projects. The unit rates that it had used included internal labour, external labour, materials, design, engineering, construction, project management and commissioning costs. A summary of the total costs which include both capex and opex is shown in the table below.

Table 3-3: Adaptation Projects Capex and Opex Costs ($'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**

(Source: AGN Final Plan_Attachment 9.10(2)_Renewable Gas network Adaptation Plan_Confidential)

3.7 AEMC REPORT

The tests that we have applied for our analysis is outlined in section **Error! Reference source not found.** National Gas Rules (NGR). However, it is noted that the National Gas Rules are for natural gas and not for natural gas substitution. As such, we have referred to report released by the Australian Energy Market Commission (AEMC) for guidance.

The AEMC stated[5] that the objective of the National Gas Law (NGL) is: *"to promote efficient investment in, and efficient operation and use of, natural gas services for the long term interests of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas"*. As the NGR is made under the NGL and this section is related to hydrogen, we are unable to apply the NGR as tests for our analysis.

However, the AEMC has recommended to Energy Ministers that changes be made to the national gas and retail regulatory frameworks to enable the natural gas sector to evolve using hydrogen and renewable gas to support Australia's emission reduction plans. In its final report (dated 8 September 2022), "Review into extending the regulatory frameworks to hydrogen and renewable gas", the AEMC sets out its recommendations and its draft rules to address the issues that could emerge in the National Gas Rules (NGR) and National Energy Retail Law (NERL) to cover gases and natural gas equivalents that are supplied to consumers.

The AEMC is seeking stakeholders' views on its recommended rule drafting by 13 October 2022.

The relevant section of the report is section 3.5 which covers voluntary transitions to another covered gas. Section 3.5.1 states

If a government does not mandate that a pipeline change to transporting another covered gas, but a service provider elects to do so, then, in the case of a scheme pipeline, the regulator would need to assess the proposal having regard to the expenditure criteria in Part 9 of the NGR. In keeping with these criteria, the regulator would need to consider whether:

- the proposed capital expenditure:
    - satisfies the prudent and efficient test
    - is justifiable on the grounds that either the overall economic value of the expenditure is positive, or the present value of the expected incremental revenue to be generated as a result of the expenditure exceeds the present value of the expenditure.

- the proposed operating expenditure satisfies the prudent and efficient test.

The above requirements are consistent with NGR 79 for capex and NGR 91 for opex.

The report also states that NGR 79(2)(c) also provides for capital expenditure to be justifiable if it is necessary to maintain and improve the safety of services, maintain the integrity of services, comply with a regulatory obligation or requirement, or maintain the service provider's capacity to meet levels of demand for services existing at the time of the capital expenditure. The AEMC has ruled that a voluntary transition to another gas is not expected to be justifiable on any of these grounds.

[5] AEMC website

We acknowledge that the draft rules in the AEMC report have not been accepted. However, as the above draft rules are similar to that of the NGR 79 and 91, we propose to use these rules as tests for our analysis, bearing in mind that the AEMC has ruled that the a voluntary transition to another gas is not expected to justify NGR 79 (c).

3.8 STAKEHOLDERS' SUBMISSIONS

There is a lack of support from the various stakeholders on AGN/MGN proposals to commence adapting their networks to transport 10% hydrogen by 2030. A summary of the comments are provided in the table below.

Table 3-4: Stakeholders' Submissions

Stakeholders	Summary of Responses
Energy Users Group of Australia	Consumers ask to pay for network hydrogen readiness under the guise of safety mains replacement.
Friends of the Earth Melbourne	100% hydrogen is more hype than reality.
Origin Energy	Expenditure to hydrogen readiness is appropriate only to the extent that legislation is introduced supporting the use of hydrogen blend.
Brotherhood of St Lawrence	The Gas Substitution Roadmap is strongly biased towards electrification and the hydrogen hero is unlikely to occur. Hydrogen likely to increase the challenge of electrification. Full cost of hydrogen blend not known. Assumed benefit of the proposal articulated in the National Hydrogen Strategy not demonstrated. Inconsistent with NGR objective or Rule 79. Conflicting priority for hydrogen with demand for industries and reticulation blending. 2040 for 100% hydrogen is a stretch target.
Consolidated submission from Victorian Community Organisations	Conflict with electrification of residential loads. Increase to network price should customers choose to leave the network. Premature in adapting network. No clear plan to transition from gas. Hydrogen development in its early stage and other mode of delivery may not require existing networks. Full cost of upgrades not known for hydrogen blends and 100% hydrogen.
TRAC Partners	NGR does not allow for expenditure to consumers when hydrogen not likely to be commercialised for 10-20 years. R&D expenditure not recoverable in a competitive market. Only expenditure related to commercial and industrial consumers should be allowed.
CCP	Distributors reported consumer strong support for hydrogen readiness expenditure in the stakeholders meetings but stakeholders demonstrated lack of support for AGN/MGN proposals.

(Source: Stakeholders' responses.)

3.9 CONCLUSION

In December 2018, the Council of Australian Government Energy Council[6] set a vision for clean, innovative, safe and competitive hydrogen by 2030. AGIG's key milestone to accommodate a 10% hydrogen to natural gas blend by 2030 and operate a 100% hydrogen network by 2040 is consistent with the overall vision.

In respect to the introduction of the hydrogen blend, our review concluded that AGN's work program shows that the activities are related to ensuring the equipment complies with the relevant safety standards. In addition, we also considered that the procurement of equipment suitable for the hydrogen environment is reasonable.

In relation to its capex cost estimates, AGN provided details in Appendix A of its Renewable Gas Network Adaptation Plan. AGN also advised[7] that its cost estimates are based on the unit cost estimates developed by its consultant, GPA, for the hazardous area equipment replacement. For other estimates, AGN used the current cost rate of pipeline excavation and coat repair for its weld procedures and the current procurement cost of repair equipment. An examination of the information provided has not revealed areas of concern and as such, we consider the costs to be reasonable.

However, we note that the 2030 is a target to have implemented 10% hydrogen. There is no detailed plan to show that how the hydrogen blend is to be rolled out. There is therefore no demonstrated imperative that the adaptation of the network needs to commence in the next AA period or that they need to be carried out before the commencement of the introduction of the hydrogen blend.

AGIG has indicated[8] that in South Australia its first renewable hydrogen blending project – HyP SA is already operational. The project is a 1.25MW electrolyser producing renewable hydrogen for blending with natural gas (up to 5%) and supply to more than 700 existing homes in metropolitan Adelaide. AGIG proposed another hydrogen park for the Victorian Murray Valley towns to commence operation in 2024. Supplying 10% hydrogen to around 40,000 customers is at a different scale to then commence supplying 10% hydrogen to a network with more than 740,000 customers[9]. This further reinforces the need for a plan to demonstrate how the hydrogen blend is to be rolled out and where the hydrogen is to be produced.

In addition, the Gas Substitution Roadmap (GSR) priorities are on electrification and freeing up natural gas for industrial users. Whilst the GSR supports the introduction of hydrogen and biomethane, there is no timeline or details on the rollout of hydrogen blend. This adds to the confusion of what needs to be carried out in the next AA period for the introduction of the hydrogen blend.

It is also noted that stakeholders (discussed in section 3.8) do not support any expenditure in the next AA period for the introduction of a hydrogen blend.

Given the above, we are unable to recommend the capital expenditure as prudent for the next AA period.

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[6] Australian National Hydrogen Strategy.
[7] IR023
[8] AGN Final Plan_Attachment 9.10(1)_AGIG Network Adaptation Strategy -Renewable Gas_Public
[9] AGN Final Plan July 2022 pg 18

On the matter of how this capital expenditure meets the AEMC final report "Review into extending the regulatory frameworks to hydrogen and renewable gas", AGIG has written[10] to the AEMC on the final report. However, it is worth noting that in the report, when a service provider proposes to transport an alternative gas to natural gas, Section 3.5.1 of the report says that the proposal can only be justified when the overall economic value of the expenditure is positive. In this case, Multinet or AGIG have not provided a business case demonstrating this requirement.

In relation to AGN's opex, we consider that the range of activities outlined above are required in preparation for the rollout of hydrogen. Like the capex, it is difficult to ascertain the timing of such projects given the lack of detailed rollout plan.

For the reasons outlined in the discussion on the capex, we are unable to recommend the expenditure as prudent for the next AA period.

[10] IR023

4. AUGMENTATION

4.1 INTRODUCTION

Subsequent to Australian Gas Networks (AGN) initial submission of its proposed augmentation program to the AER for the next regulatory period (2023/24 to 2027/28), they have undertaken an assessment of the Victorian Government's "Gas Substitution Roadmap (GSR)" to determine potential impacts. As a result of their assessment and further modelling AGN has submitted to the AER "Attachment 9.11A: Addendum to Augmentation business cases". The following table summarises the initial and revised augmentation proposals:

Table 4-1: Augmentation projects ($'000 real 2021)

HP augmentation projects	Customers	Initial	Revised	Variance
Cranbourne	52,000	9,368	6,101	-3,267
Echuca	9,000	768	0	-768
Thomastown	69,000	7,659	6,852	-807
Wallan	5,300	1,288	473	-815
Traralgon	< 10,000	2,220	0	-2,220
Wodonga	1,200	560	560	0
Berwick	21,000	1,141	1,141	0
Eltham	<10,000	1,014	827	-187
Howlong	1,100	2,832	0	-2,832
Pakenham[(1)]	*Moved to Regulator capacity upgrades*			
Somerville	6,000	3,996	0	-3,996
Total HP augmentation projects		**30,846**	**15,954**	**-14,892**
Regulator capacity upgrades				
City gate heater upgrades		2,202	1,247	-955
City gate upgrades	24,000	4,179	1,393	-2,786
Sale city gate augmentation	9,460	1,311	1,311	0
Pakenham new gate station[(1)]	22,300	6,443	6,443	0
Total Regulator capacity upgrades		**14,135**	**10,394**	**-3,741**
Pipeline upgrade				
Dandenong Crib Point pipeline	140,000	28,220	28,220	0
Total Augmentation capex		**73,201**	**54,568**	**-18,633**

(Source: Capex model: capex category summary – initial and revised; and augmentation business cases – initial and revised)

Note[(1)]: Pakenham: in the initial submission this augmentation was "Pakenham HP network augmentation". The revised capex model shows the project as "New gate station Pakenham". It is still shown in the business cases under its initial title (refer section 2.1 Addendum to Augmentation business cases". The above capex category totals reflect the revised proposals.

The GSR will impact the growth in AGN's networks over the next AA period by introducing new incentives for electrification, removing incentives for gas appliances and a 7-star standard

for new homes. AGN's revised growth forecast indicates that these measures will see much lower growth in new residential connections, higher rates of existing customer disconnections, and declining average consumption. Overall AGN forecasts a 25% reduction in new residential connections and a 1.8% reduction in average annual load, compared to its Final Plan.

AGN's revised growth forecasts have been applied to the network models and as a result a number of proposed augmentations will not see peak demand fringe pressures decline to minimum levels during the next AA period. These augmentations have been deferred beyond the timeframe of the next AA period. It is noted that the options analysis is not impacted by the changed growth forecasts.

4.2 HP AUGMENTATION PROJECTS

Given the similarity of these projects, we have reviewed the methodology used to identify and assess the projects. We have then reviewed each project business case to consider any specifics that warrant individual assessment.

The purpose of these six projects is essentially the same. They are designed to address the risk of growth-driven pressure drop and capacity shortage. The two key drivers of the need for network augmentation are:

- Peak hourly gas demand
- New connections

The Gas Distribution System Code specifies minimum delivery pressures for gas distribution networks in Victoria. For high pressure networks this is 140 kPa. If gas pressures fall below the minimum HP supply threshold, the downstream gas supply to customers may be interrupted and/or gas appliances may become inoperable. This causes reliability issues and in extreme cases, safety risks.

Modelling summarised in the various business cases show that for the forecast growth rates, the minimum pressure during peak periods will drop below 140 kPa within the next five years.

4.2.1 Network flows and growth

Apart from Wodonga the revised suite of augmentation projects for HP networks cluster around metropolitan growth areas where residential and commercial dwellings are being constructed, and new subdivisions are expanding into greenfield areas. With strong growth over the last five to ten years these networks are currently operating at or near minimum allowable pressures and as a result GSR impacts have tended to defer timing of the projects within the next AA period rather than removing the need for augmentation.

4.2.2 Network planning and design

The network requires augmentation under two principal circumstances:

- the minimum pressure in a network falls, or is forecast to fall, below the recommended minimum typically at fringe locations of the network, during design load conditions; or
- there is insufficient redundancy within the network, which adversely affects the security of supply to a large number of customers.

4.2.2.1 Modelling

AGN uses the industry standard hydraulic computer modelling software, Synergi, to evaluate various load scenarios and augmentation options. Capacity shortfalls are identified, and solutions modelled to confirm augmentation requirements.

In its modelling AGN applies peak load using a one-in-two probability winter's day. Tariff D customer load is normalised based on consumption during daily peak hour period throughout winter. AGN validates the network models against actual field data to ensure accurate network models are used in its forecasts.

AGN[11] says "*The first considered solution by our hydraulic asset management engineers is always to rebalance the network through the manipulation of HP regulating equipment to improve the flow dynamics in the network. This may include the changing of network input pressures at multiple locations, or the increasing of supply pressures. However, once the network is operating towards its maximum allowable operating pressure (MAOP), this no longer becomes a viable long-term solution and incremental increase in pressure can no longer be undertaken. At this point addition infrastructure is required. Once pressure alterations and numerous network flow balancing options have been exhausted, further hydraulic modelling is completed to determine various pipeline and regulating equipment combinations and solutions that could mitigate the low pressure risks*".

4.2.2.2 Project scoping

Once the various capacity, replacement and security of supply issues are reviewed and options considered they are transferred to business cases for formal executive review and consideration. AGN says it reviews projects annually to confirm their timing and scope.

[11] Augmentation business cases – V.03.CD HP projects: section 2.1.4

4.2.3 Risk assessment.

AGN[12] notes that "*the identified risk relating to an increasing number of customer connections and associated load growth is as follows: Load growth without network reinforcement or augmentation will cause delivery pressures to drop, leading to substandard supply or loss of supply to customers. This may also lead to customers' gas appliances becoming inoperable or damaged in certain circumstances*".

The typical untreated risk rating for a pressure drop impacting >10,000 customers is High. For customer numbers less than 10,000 but greater than 1,000 the rating is Moderate. In both these instances AGN will recommend action be taken to address the untreated supply risk within the next five years. Projects will be prioritised by risk rating. Any project currently considered a moderate (not ALARP) risk, must be completed prior to the risk escalating to high due to the increased likelihood of a major supply disruption.

4.2.4 Options assessment

AGN[13] says "*Mitigating the risk of pressure drop caused by load growth, typically requires one or more of the following actions:*

- *installing additional HP polyethylene pipelines to increase the supply of gas to the affected distribution network;*
- *upgrading or installing new regulating equipment; and*
- *reinforcing, upsizing or reconfiguring parts of the distribution network*".

These potential risk mitigations are considered for each of the HP augmentation projects and are used to develop credible asset management solutions. For each of the HP augmentation projects required over the next five years, as a minimum, a primary solution (Option 1) and a secondary solution (Option 2) has been developed, as well as considering the impact of maintaining the status quo (taking no new action to address the risk – Option 3). The options are assessed according to:

- cost;
- risk reduction;
- consistency with vision objectives; and
- satisfaction of the tests specified under the National Gas Rules (NGR).

For each of the projects, the residual risk rating after implementing either the primary or secondary engineering solutions results in a low-risk rating. The recommended solution typically delivers the required risk reduction for a lower cost.

[12] Augmentation business cases – V.03.CD HP projects: section 3.1
[13] Augmentation business cases – V.03.CD HP projects: section 4

4.2.5 Cost Estimation Method

AGN's[14] cost estimation for augmentation projects "*are based on individual bottom-up builds for each project. This allows each estimate to cater for the unique variables that the project may bring, including the degree of urbanisation, ground conditions and complex junctions and timing.*

For installation of a new city gate, external estimating experts are used to compile the estimate. In the case of refurbishment and/or upgrade of an existing city gate, internal cost estimation and expertise is used. In both cases, senior engineers and internal subject matter experts use experience, historical precedent and prevailing economic conditions to provide a top-down challenge to the bottom-up estimate.

The work is delivered by a combination of internal project management and governance practices, as well as the use of contractors with the appropriate capability and skill sets that are procured through market testing tender processes.

AGN has a panel of market tested contractors to install the HP mains and to install pressure regulating equipment, who are experienced in delivering the activities and provide the required quality at the most efficient cost. The contractor panel is reviewed every year for changes, as well as a full re-tender completed every 3 to 5 years. The rates utilised in costing these activities are based on current vendor and contractor rates in 2019 and historical costing. For specialist services, the cost estimate is derived from reviewing the cost for similar projects.

This approach enables us to produce robust cost estimates that are based on an appropriate mix of historical costs, current market pricing and expert external estimation".

The following table provides a summary of proposed HP network augmentation project costs, by year, during the next regulatory period.

Table 4-2: Summary of HP augmentation project costs ($000 real 2021)

HP network	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Cranbourne	-	-	359	-	5,742	6,101
Thomastown	5,890	-	-	-	962	6,852
Wallan	-	473	-	-	-	473
Wodonga	-	560	-	-	-	560
Berwick	-	1,141	-	-	-	1,141
Eltham	-	-	-	-	827	827
Total	**5,890**	**2,174**	**359**	**0**	**7,531**	**15,954**

(Source: Addendum to Augmentation Business Cases – HP projects; revised Capex Model)

[14] Augmentation business cases – V.03.CD HP projects: section 5

4.2.6 Cranbourne HP network

The Cranbourne high pressure (HP) network supplies gas to the broader Cranbourne area located on the south-eastern fringe of Melbourne, including the suburbs of Cranbourne, Clyde, and Langwarrin, covering some 52,000 customers.

The areas covered by this network are among the fastest growing in Victoria and at least six major projects have been undertaken during the current AA period to service the new residential developments. However, further augmentation will be required during the next AA period as the growth continues.

Over the last ten years the average connection rate has been 2,690 per year, and this has accelerated more recently with the average over the last five years average being 3,150 new connections per year. GSR impacts of AGN's growth forecast sees a reduction of 1.8 % annual load for existing customers compared to the Final Plan. For new areas a 25% reduction in new residential connections compared to the Final Plan. As a result, modelling shows the pressure at the network fringe will drop below 140 kPa by winter 2026 without augmentation, a deferral of one year compared to their Final Plan submission.

AGN's revised recommended option is for augmentation in three stages during the next AA period:

- First stage to be delivered during 2025/26 (one year later than initial plan) involves 370 m of DN180 PE HP trunk and a 180 m section of DN125 PE HP main.
- Second stage to be delivered in 2027/28 (two years later than initial plan) involves a new field regulator and installing 750 m of DN280 PE HP main.
- Fourth stage to be delivered in 2027/28 (one year later than initial plan) involves installing 1,700 m of DN180 PE HP main.
- Stages three and five of the initial plan will not be required during the next AA period.

The revised augmentation will cost $6.101 million a reduction of $3.267 million compared to the Final Plan.

4.2.7 Thomastown HP network

The Thomastown HP network supplies gas to approximately 69,000 customers across a large area including the suburbs of Preston, Reservoir, Thomastown, Lalor, Epping, and Wollert.

Over the past five years, the number of customer connections in the network has grown by an average of 1,710 new connections per year, with 1,096 of those in the Epping North and Wollert areas. AGN's revised forecast shows reductions similar to Cranbourne and modelling reaffirms that augmentation will be required in 2023/24 to avoid drop in fringe pressure below 140 kPa. However, only the first two stages of augmentation will be required during the next AA period, with the third stage being deferred.

AGN's recommended augmentation is to install a new city gate and 1 kilometre of 300 mm steel main during 2023/24, with a second stage installing 650 m of DN180 PE HP trunk main in 2027/28.

The revised augmentation during the next AA period will cost $6.852 million, a reduction of $0.807million compared to the Final Plan.

4.2.8 Wallan HP network

The Wallan HP network supplies gas to over 5,300 customers and is an island network supplied by a single source located on the eastern side of Wallan, east of Hume Freeway. The network extends across the Hume Freeway to the west, and feeds into the northern and western sides of Wallan.

The rate of historical growth in residential connections has increased from 260 per year over the ten year period, to 345 per year over the last three years. In this current AA period (2018 to 2022), there have been three augmentations to maintain supply to the current customer base and support the expanding network growth areas. With existing and planned developments in Wallan, AGN has estimated growth will continue but at reduced levels (reduction rates similar to Cranbourne).

Revised network modelling indicates that pressures in the western extremities will fall below 140 kPa before winter 2025, one year later than the Final Plan.

AGN's recommended augmentation is to install 290 m of DN180 PE HP trunk main during 2024/25. Stages two and three, included in the Final Plan, are no longer required during the next AA period. The total project cost is $0.473 million, a reduction of $0.815 million.

4.2.9 Wodonga HP network

The HP network in the Wodonga network supplies more than 17,500 customers.

The southern suburbs of Wodonga, from Wodonga South to Leneva, is a major residential growth area. Over the past five years, the number of customer connections in the entire Wodonga network has grown by an average of 350 new residential connections per year, while the southern suburbs have grown around 150 per year. AGN expects growth to continue at reduced rates over the next access arrangement period.

Network modelling indicates that pressures in the network will fall below 140 kPa during winter 2025 without augmentation, one year later than the Final Plan.

AGN's recommended augmentation is to install 600 m of PE main during 2024/25.

The cost of this augmentation is $0.560 million, which is no change from the initial plan.

4.2.10 Berwick HP network

The Berwick HP network supplies gas to 21,000 customers in the suburbs of Berwick, Clyde North and Minta Farm.

While Berwick is well established with a nominal growth rate, the network's southern fringe areas of Clyde North and Minta Farm are greenfield and relatively new developments, with growth rates in excess of 300 connections per year.

Revised modelling indicates that pressures in the network will fall below 140 kPa during winter 2025 without augmentation, a deferral of one year.

AGN's recommended option is to transfer the Clyde North load from the Berwick city gate to the Huckerby Drive city gate which is part of the Cranbourne HP network. It involves a three stage program of works, to be completed by June 2025, laying 800 m of 180PE, 502 m of 125 PE and isolating (cut-off) the Clyde North section of network from the Berwick HP network.

The augmentation program cost is $1.141 million, which is no change from the initial plan.

4.2.11 Eltham HP network

The Eltham HP network supplies gas to 34,700 customers. Over the past five years customer growth has averaged 202 connections per year. Plenty, Montmorency and Lower Plenty are the areas most susceptible to pressure drop. Revised modelling indicates that pressures in the network will fall below 140 kPa by winter 2028 in Lower Plenty, without augmentation, a deferral of four years compared to the initial plan.

AGN's revised augmentation to be completed during 2027/28, involves laying 575 m of PE HP mains. Further stages in the initial plan will no longer be required during the next AA period.

The cost of this augmentation is $0.827 million, a reduction of $0.187 million.

4.2.12 Summary of HP augmentation projects

Each of AGN's HP augmentation projects are subject to similar approach summarised as follows:

- Network flows and growth: Development of forecast growth includes assessment of historical growth typically over five or ten years along with review of forecast growth data from a range of sources including Councils, developers and respective associations. In most cases the networks requiring augmentation are associated with significant greenfields developments.

- Network planning and design: AGN says that it reviews modelling on an annual basis and also validates these with actual field data. The models adjust for 1-in-2 peak loads (for HP networks). Where networks indicate that pressure is forecast to decline to around 140

kPa during the next AA period, then these networks are assessed for augmentation. Project scope is developed with a primary and secondary options as well as a status quo option. An untreated risk is assigned to each network project.

- Cost estimation: AGN uses a bottom up build of the cost estimate, considering the degree of urbanisation, ground conditions, any complex functions and project timing. AGN has a panel of market tested contractors which are reviewed annually and subject to competitive re-tendering each 3 to 5 years.

We have reviewed the methodology used and consider that it reflects good industry practice and will enable AGN to remain compliant with its obligations to maintain minimum network pressures under Schedule 1 of the Gas Distribution Code.

For each of the HP network augmentations, AGN has prepared business cases that include details following the methodology summarised above. The information is comprehensive.

Subsequent to submission of its initial Final Plan augmentation business cases, AGN has undertaken an assessment of the impact of the Victorian government's "Gas Substitution Roadmap (GSR)" which was published just after AGN's access arrangement submissions to the AER and which they did not have time to consider.

As a result of its assessment, AGN has submitted an "Addendum to augmentation business cases" as well as other associated documentation including a revised Capex Model. The revised growth forecasts indicates that there will be much lower growth in new residential connections, higher rates of existing customer disconnections, and declining average consumption. Overall AGN has forecast a 25% reduction in new residential connections and a 1.8% reduction in average annual load, compared to AGN's Final Plan.

AGN's revised network models indicate that a number of proposed augmentations in its Final Plan can now be deferred. For the HP networks, Wodonga is the only regional area still requiring augmentation with the other proposed augmentations associated with growth areas across AGN's metropolitan area. It is noted that the options analysis is not impacted by the changed growth forecasts.

The revised suite of HP networks augmentations recommended for the next AA period shows a revised capex of $15.954 million a reduction of $14.892 million (noting that the revised capex model shows the Pakenham augmentation correctly within the "Regulator capacity upgrades" section).

In most cases the revised forecast growth has resulted in deferral of augmentation and some no longer required in the next AA period. During our initial review of augmentation business cases we had considered the potential for deferral if growth forecasts were not realised due to recent government policies. We consider that AGN's revised submissions address these concerns.

As a result of our assessment of the AGN's methodology in assessing its networks and the quality of its business cases for prospective HP network augmentations we consider that the projects are prudent in managing integrity of supply to its customers. With respect to cost estimates, we consider that AGN's use of competitive tendering provides the most efficient costs in the circumstances. We therefore recommend approval of the HP network

augmentation projects as outlined in the revised capex model and Addendum to augmentation business cases.

4.3 REGULATOR CAPACITY UPGRADES

Table 4-3: Summary of Regulator capacity upgrade costs ($000 real 2021)

Regulator	2023/24	2024/25	2025/26	2026/27	2027/28	Total
City gate heater upgrades	844	403	-	-	-	1,247
City gate upgrades	1,026	367	-	-	-	1,393
Sale city gate augmentation	-	437	437	437	-	1,311
Pakenham city gate	-	-	-	-	6,443	6,443
Total Regulator capacity upgrades	**1,870**	**1,207**	**437**	**437**	**6,443**	**10,394**

(Source: revised Capex model)

Note: the revised capex model shows Pakenham – new gate station within this category of capex, compared to HP network augmentation category. For consistency we have aligned timing and cost to that shown in the capex model.

4.3.1 City Gate Heater upgrades

City gates are the transfer point of gas supply from high-flow transmission pipelines to the distribution network, stepping down supply pressures. The drop in pressure and flow as it passes through the gate station causes natural gas to cool (the Joule-Thompson effect). If the gas gets too cold, it can damage equipment downstream or even the regulator at the gate station itself. Delivery of low temperature gas also impacts the accuracy of customer metering, and therefore billing. It can also affect the accuracy of Unaccounted For Gas (UAFG) estimates.

AGN has 39 gate stations that use heaters to maintain the gas temperature above its safe operation limit (SOL). In its Final Plan AGN had identified that Laurimar Park (9,215 customers) and Wallan (5,335 customers) city gates are experiencing load growth to the extent that the heaters are reaching their maximum capacity and require heater upgrade during the next AA period. However, as a result of its revised growth forecasts, following review of potential GSR impacts, the Wallan heater is no longer expected to reach capacity during the next AA period and will not need to be replaced.

With respect to Laurimar Park, AGN says that there is no impact by the revised growth forecasts as it is already at capacity and has experienced numerous excursions below -5 ^{0}C in 2021.

Laurimar Park city gate facilities were built in 1998. The heater has a heating capacity of 50 kW which at design conditions (inlet pressure 7,400 kPa, outlet pressure of 450 kPa and SOL outlet temperature of -10 ℃) gives capacity of around 3,000 m^3/hr.

With gas flows now approaching 10,500 m^3/hr the heater is not maintaining design outlet temperatures and it is continuing to trend close to the SOL of the facilities and downstream distribution network.

During 2021 winter AGN were frequently recording pressures above 5,500 kPa, at which point capacity of the city gate is only 8,000 m^3/hr to ensure temperatures remain above SOL. While AGN has forecast connection rates to be below the five and ten year averages, the throughput is still increasing impacting on the technical limits of the heaters. There have been regular instances of the temperature falling below -5 ℃ with one instance during winter 2021 of -7.25 ℃

Combining inlet pressures, flows and temperatures, AGN says that it wouldn't be able to supply sufficient gas into the network without operating under the SOL.

AGN proposes to replace the existing 50 kW bath heater with a 250 kW heater, which it says will enable the facility to maintain temperatures of 5 ℃ for another 15 years. It proposes to deliver this project during 2023/24 and 2024/25.

The revised program for city gate heater upgrades now only includes Laurimar Park at a cost of $1.247 million. With Wallan city gate heater upgrade not required during the next AA period, the reduction in capex for this category is $0.955 million.

4.3.2 City Gate upgrades

There are 145 city gates in the AGN Victoria and Albury networks, which connect the distribution networks to transmission pipelines.

Each city gate has a maximum (and minimum) capacity, within which the amount of gas entering the distribution system and downstream assets can be adjusted. The ability to vary the volume of gas entering the distribution system enables downstream supply pressures to be maintained.

In its initial submission AGN hade identified three city gates, supplying around 24,000 customers, that require upgrade in the next five years to keep pace with growth and mitigate declining supply pressures:

- Tramway Rd Morwell (7,000 customers);
- Lyndhurst (5,000 customers); and
- Hume St Wodonga (12,000 customers)

However, as a result of its revised growth forecasts AGN's modelling indicates that augmentation for Morwell and Lyndhurst would no longer be required in the next AA period. However, as Hume St Wodonga is currently over capacity and is less impacted by the GSR, this augmentation is still required.

Hume St Wodonga supplies gas to 12,000 customers and has an inlet MAOP of 1,050 kPa. Historical growth in connections over the ten years has been averaging 382 per year. AGN has

indicated that with its revised growth forecast new connections will continue increasing until 2024 before plateauing.

Monitoring of the city gate has shown that it is operating over capacity during peak periods of 2020 and 2021. As such an upgrade of the city gate is now required.

AGN has considered three options for augmentation of the city gate, of which the preferred option to upgrade the existing city gate is the least cost. The station will require larger pipework and new regulators to be installed while maintaining supply to the downstream network. As a majority of the station pipework will need to be replaced, a temporary supply is required.

The Hume Street gate station has been prioritised for the first year of the period, given this site is already operating over capacity. The expenditure profile reflects the construction timeframes and enables the asset to become operational before the risk of poor pressure or equipment damage occurs.

Information from recent city gate construction activity has been used as the basis of these estimates. The level of detail in the cost estimate is comprehensive.

The cost of the city gate upgrade is $1.393 million. With two city gates not requiring upgrade during the next AA period, there is a reduction in this category of $2.786 million.

4.3.3 Sale City Gate augmentation

With respect to the revised growth forecasts arising from its review of GSR impacts, AGN[15] notes that "*There are no amendments to this augmentation as it is not driven by growth, and therefore not impacted by the GSR. This augmentation is driven by AEMO's request to reduce the minimum inlet pressure conditions and for AGN to meet its regulatory obligations associated with gas delivery in Victoria*".

The Sale City Gate serves 9,460 customers in Sale and Maffra.

AEMO has reaffirmed, latest correspondence dated September 2021, a need to reduce the Sale minimum operating pressure from 4,800 kPa to 4,500 kPa thereby requiring some augmentation to manage the changing inlet conditions in the Victorian Transmission System.

The original AEMO request for a reduced inlet pressure was identified in 2016. A capital project to facilitate this pressure change was approved by the AER for the current access arrangement (AA) period, at a forecast cost of $5.8 million ($2016).

During the AA current period AEMO and AGN created an administrative process (workaround) to mitigate some of the inherent risk of this delivery pressure, which has allowed the capital works to be deferred. However, two incidents occurred in 2021, which have been investigated and documented by AEMO, that instigated a review of arrangements.

[15] Addendum to augmentation business cases: Sale city gate augmentation: section 2.14

The current workaround is no longer considered a credible solution to manage the risk of lower inlet pressures, and AGN says that the capital works can no longer be deferred.

However, AEMO has rescoped the project compared to the original 2016 solution and proposes a capital project that achieves the same outcome for a significantly lower cost.

The proposed augmentation works involve an entire gate station rebuild, installing larger pipework and new valves and regulators to supply the downstream network. Because there is currently no bypass at Sale City Gate, they will need to build a new regulating station in parallel to the existing station, so as not to disrupt supply to customers. The existing regulator station will then be removed from the site once the new station has been commissioned.

The previous augmentation proposal also included a duplication of 4.7 kilometres of the Sale City Gate to Sale pipeline. The new proposal does not require this pipeline duplication, with a new City Gate having larger pipework and regulators being installed to replace the existing station.

A detailed cost estimate is provided in the business case and shows cost of $1.311 million. There is no change compared to the Final Plan.

4.3.4 Pakenham new city gate

Note: This augmentation project was titled "Pakenham HP network augmentation" in the Final Plan and the revised plan. However, the revised Capex Model shows it as "New gate station Pakenham", which appears more appropriate as the recommended work is to install a new city gate.

The Pakenham HP network supplies gas to 23,300 customers including eight tariff D customers.

Over the past five years growth has averaged 1,080 connections per year. While growth in the existing Pakenham area is expected to decline over the next few years, urban development is planned within the eastern region.

The Koo Wee Rup Rd regulator is the main feed into the southern and eastern Pakenham area and is located within the southern region of Pakenham. This regulator is currently operating close to the maximum capacity of 13,600 scm/hr (12,200 scm/hr in 2021).

Revised modelling indicates that fringe pressures will fall below 140 kPa before winter 2028 without augmentation, a deferral of two years. In addition, the Koo Wee Rup Rd regulator will exceed its capacity by winter 2028. This would have the effect of lowering its outlet pressure and exacerbating the low-pressure issues at the fringes, increasing the number of customers experiencing poor supply.

AGN's recommended option is still to install a new city gate before winter 2028, within close proximity to the urban development within eastern Pakenham. This will provide sufficient supply to the new Pakenham urban development plan, and also mitigate network pressures and address the capacity issues present within the Koo Wee Rup Rd regulator.

Note that the revised business case shows the cost of this project spread over two years ($1.189 million) 2026/27 to ($5.154 million) 2027/28, while the revised Capex Model shows the full cost in 2027/28. For consistency we have reflected to costs as shown in the revised Capex Model.

The cost of the new city gate installation is $6.443 million, no change from the initial plan.

4.3.5 Summary of regulator upgrades

Heater upgrades. AGN's revised modelling of forecast load growth indicates that the heater at Laurimar Park will be at capacity during the next AA period. At Laurimar Park temperatures below -5 ^{0}C have been recorded on a number of occasions during winter of 2021, with one instance of -7.5^{0}C. As a result the requirement for augmentation is not impacted by revised growth forecast arising from GSR review. With ongoing load growth a heater upgrade is required, which AGN has scheduled for 2023/24. Based on our review of the business case we consider that it is prudent to recommend the upgrade of the Laurimar Park city gate heater to maintain the integrity of supply. With respect to costs, AGN say that they are based on rates of similar projects. We therefor consider that this augmentation is prudent and efficient in the circumstances.

City gate upgrades. In its initial submission AGN had identified three city gates (Morwell, Lyndhurst, and Wodonga) where modelling indicated they were nearing or at capacity during the next AA period. AGN's revised growth forecast modelling showed that Morwell and Lyndhurst city gates would not require upgrade during the next AA period. The Wodonga city gate peak flow monitoring has shown that it is operating over capacity during peak periods of 2020 and 2021. Based on the available information we consider it would be prudent to upgrade this city gate as recommended by AGN, in order to maintain integrity of the networks. The forecast expenditure is based on rates related to similar projects and the level of component detail in the cost estimates are such that we consider the expenditure to be efficient.

Sale city gate upgrade. AEMO has reaffirmed its need to reduce the minimum operating pressure for this city gate from 4,800 kPa to 4,500 kPa to manage the changing inlet conditions in the Victorian Transmission System. This project was initially approved by the AER for this current AA period, at a cost of $5.8 million. However, during the current period AEMO and AGN created an administrative process (workaround) to mitigate some of the inherent risk of this delivery pressure, which has allowed the capital works to be deferred. However, some incidents in 2021 have required a review of the process and AEMO has now reaffirmed the need to reduce the pressures. The recommended augmentation involves replacing the existing city gate with a new city gate having larger pipework and new valves and regulators to supply the downstream network. This solution will avoid the need for duplication of supply main resulting in a much lower cost of $1.3 million. Given AEMO's requirement for a lower minimum pressure we consider that the recommended augmentation is prudent and, with a much lower cost than previously approved by the AER, and cost estimates based on other recent city gate installations we consider the costs to be efficient. We agree with AGN that this augmentation is not impacted by its review of GSR impacts.

Pakenham new city gate. Over the past five years growth has averaged 1,080 connections per year. While growth in the existing Pakenham area is expected to decline over the next few years, urban development is planned within the eastern region. Revised modelling indicates that fringe pressures will fall below 140 kPa before winter 2028 without augmentation, a deferral of two years. In addition, the Koo Wee Rup Rd regulator which is the main feed into the southern and eastern Pakenham area is currently operating close to the maximum capacity further impacting fringe pressures. AGN's recommended option is still to install a new city gate before winter 2028, within close proximity to the urban development within eastern Pakenham at a cost of $6.443 million, no change from the initial plan. Based on our analysis of the initial and revised business cases we consider this augmentation project to be prudent and with costs based on recent city gate installations we consider the costs to be efficient in the circumstances. We therefore recommend approval of this new city gate.

4.4 DANDENONG CRIB POINT PIPELINE DUPLICATION

The Dandenong to Crib Point (DCP) transmission pressure (TP) pipeline is the primary supply to high pressure networks in the Mornington Peninsula, supplying gas to over 140,000 consumers.

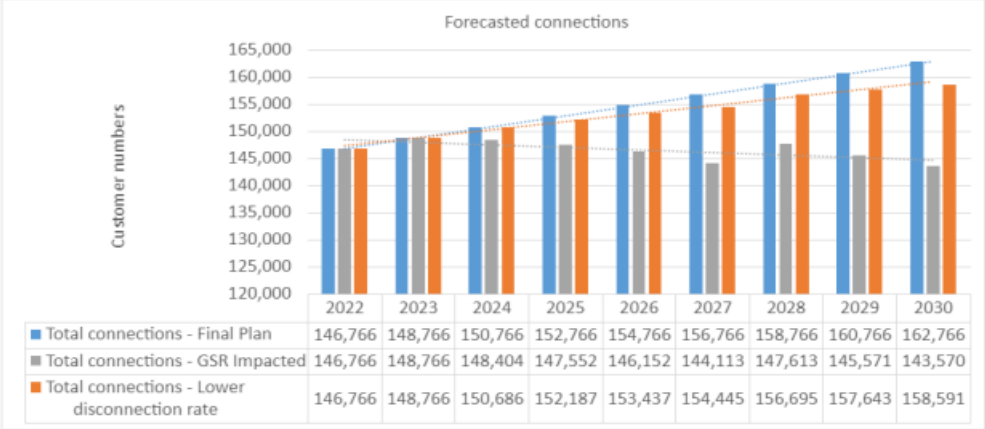
Over the past thirteen years, AGN has been delivering the DCP duplication project, in which they are taking a staged approach to duplicating the pipeline in order to provide increased supply to the area.

The final stage of the DCP duplication – Abbotts Road to the DCP – was originally planned (and approved by the AER) for construction in readiness for winter 2021. However, network flows were less than forecast during the current period and as a result this final stage of the project has been able to be deferred to the next regulatory period with modelling indicating that minimum pressure thresholds would not occur until around winter 2025.

4.4.1 Growth forecast

The vast majority of customers in the Cranbourne, Frankston and Mornington regions are supplied from the DCP. Since 2014, new customer connections have been averaging 2,000 per year for the networks supplied by the pipeline. Revised growth forecasts arising for AGN's assessments of GSR impacts are shown in the following figure:

Figure 4-:1Mornington Peninsula GSR impact on forecast connections



	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total connections - Final Plan	146,766	148,766	150,766	152,766	154,766	156,766	158,766	160,766	162,766
Total connections - GSR Impacted	146,766	148,766	148,404	147,552	146,152	144,113	147,613	145,571	143,570
Total connections - Lower disconnection rate	146,766	148,766	150,686	152,187	153,437	154,445	156,695	157,643	158,591

(Source: Addendum to augmentation business cases: DCP pipeline duplication: Figure 2:21)

In the revised forecast the total number of connections peak in 2023/24, ahead of potentially declining. However, AGN has forecast a lower disconnection rate across the areas covered by the pipeline, with the overall result that the total number of connections would continue to rise over the period, albeit at a reduced rate.

4.4.2 Pressure modelling and risk assessment

AGN's initial modelling shows that the most critical location in the pipeline is at the Bayview Road HP regulator (Rosebud) located at the southern extremity of the network which will decrease below the minimum threshold by 2025. This regulator requires a minimum delivery pressure of 1200 kPa, as it supplies into a HP2 trunk main at 1000 kPa. Over the last few years, the fringe pressure has been declining at a rate of over 50 kPa per year and is currently around 1300 kPa.

As a result of its GSR impacts review, AGN[16] says "*this project is sensitive to the levels of load reduction for existing customers exceeding new connection load growth (which is modelled to occur around 2024 under the GSR impacted scenario)".* From a load perspective, this indicates that fringe pressures may hover around the minimum levels based on a range of assumptions, which include:

- Peak load based on 1 in 20 winter (typical for transmission pressure pipelines): For the DCP this reflects an actual 1:20 network demand observed in 2007 and adjusted using the actual 2015 demand to provide a better estimate of actual morning and evening peak usage.
- Load growth or decline: The GSR has only recently been published and it is very uncertain as to how closely actual connections, disconnections and loads will reflect AGN's revised forecasts.
- Tariff D operations: Modelling does not assume any additional tariff D loads as these are addressed on an as needs basis.

With no other viable and lower cost alternatives to ensure supply in the Mornington Peninsula area, there are effectively two options for the next AA period:

[16] GSR response Addendum business cases: DCP duplication: section 2.15.2

(i) Maintain status quo, take no action;
(ii) Complete the final stage of the DCP duplication

Maintain status quo:

- Capex reduction during the next AA period, will be $28.2 million, less expenditure incurred to date which AGN says relates to engineering and pipe material purchased for the final stage.
- If actual growth, disconnections, and peak loads match, or are below, AGN's revised forecasts then supply should be expected to be maintained above minimum fringe pressures.
- If actual peak loads are higher than the revised forecasts then there will be a high likelihood of poor supply or loss of supply events. The size of these events can vary significantly both in terms of number of customers impacted and duration of the event. With over 140,000 customers supplied from the DCP there is the risk of these events being large and complex.
- If loads are continuing to trend upwards warranting the augmentation project, there is the potential for multiple supply interruptions, as the lead time for the project is two to three years.
- Customers around the fringe areas of the network will be at greater risk of being impacted by supply interruption events compared with those closer to the Dandenong City Gate.

Complete the final stage of DCP augmentation:

- Capital expenditure of $28.2 million
- If actual loads decrease and fringe pressures increase then expenditure will not have been prudent or efficient and the network will have excess capacity into the future.
- If actual loads increase in line with, or greater than the revised forecast then the full DCP duplication project will be prudent and will enable the networks to operate safely.

The DCP duplication has been a long term augmentation project, and completion of the final stage requires a lead time of 2 to 3 years. With the DCP supplying over 140,000 customers, potential fringe pressures finely balanced, and the range of assumptions not providing a clear direction, we agree with AGN's assessment of the potential risks, including compliance requirements, and consider it prudent to proceed with the project as proposed in AGN's initial plan. This recommendation will enhance security of supply and provide a secondary feed to the Mornington Peninsula.

4.4.3 Augmentation options

The business case has assessed three options:

- Option 1 – continue duplicating the DCP pipeline ($28.2 M)
- Option 2 – install new city gate and connect to existing Longford pipeline ($32.0 M)
- Option 3 – Maintain status quo, take no action (Nil)

AGN's recommendation is option 1 with a scope of work that includes:

- construction of 3,300 metres of DN450 steel TP pipeline;
- tie in into the existing and original DCG;
- tie in into the duplicate and recent pipeline DN450 pipeline in Abbotts Road; and
- installation of pig launching facilities for future inline inspections.

This project is proposed to commence in 2023/24 and be completed prior to winter 2025. In its Addendum of augmentation business cases, AGN notes that, with such a long lead time, engineering works have commenced and pipe material has been purchased.

4.4.4 Project cost estimate

Costs of the DCP duplication final stage are summarised in the following table.

Table 4-4: Dandenong Crib Point pipeline duplication cost ($000 real 2021)

Project	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Abbotts duplication	14,110	14,110	-	-	-	**28,220**

(Source: Augmentation Business Cases: Dandenong Crib Point Pipeline business case)

The estimate is based on an external quote from APA Transmission and has been validated and challenged by AGN internal engineering and management to ensure it reflects market conditions. The cost estimate is based on a detailed bottom-up build of cost. The business case[17] has included an extensive detailed costing, with a level of detail far greater than the current AA period business case. A summary of the project categories is summarised in the following table:

Table 4-5: Dandenong Crib Point cost ($000 real 2021)

Category	Cost
Project Management	xxxx
Land & approvals	xxxx
Design	xxxx
Procurement	xxxx
Construction	xxxx
Commissioning & handover	xxxx 4
Project total	**28,220**

(Source: Business Case: Dandenong Crib Point: Appendix B)

The cost of this final stage is however double the cost of that approved by the AER for construction during the current AA period ($13.8 million ($2016, real)).

AGN's explanation as to the doubling of the cost estimate says[18] *"The initial costing estimates used for the current access arrangement period business case have been revised as the level of project detail has significantly increased, highlighting the challenges of building the transmission pipeline through urbanised areas. The costs have been revisited by independent experts with the additional context of urbanisation levels, ground conditions, complex junctions and timing. The new city gate has been estimated by external estimating experts to*

[17] DCP business case: appendix B
[18] DCP business case: section 4.7.2.

ensure robust costing. In both cases, senior engineers have used experience, historical precedent, and prevailing economic conditions to provide a top-down challenge to the bottom-up estimate".

4.4.4.1 Further project cost details

Given the doubling of cost since the last AER approval, we sought further explanation to reconcile the differences in the estimates. AGN's response to AER's information request (IR010) indicated that there are two drivers of the difference in cost estimates between December 2016 and July 2022:

- Front-end Engineering Design (FEED) study undertaken in 2018;
- Considerable change in the construction landscape.

The 2016 project cost estimate was based on a build-up of materials, labour and project timing but before a FEED study had been undertaken. In 2018, a FEED study was undertaken highlighting narrow easements with landowners encroaching on either side requiring additional Geotech and Horizontal Directional Drilling (HDD).

During the six-year delay period, the construction landscape has changed with the availability of labour and increase in construction and material costs having significant impact on cost. The revised cost estimate also has regard for new EPA requirements, introduced in 2021, for soil testing and removal.

AGN's response included comments regarding each category of the project estimate, summarised as follows:

- Project management: increased by xxxx. The project will now be managed as a standalone project, given the complexity with encroachment, narrow easements, additional HDD and additional insurances associated with this large project;
- Access and approvals: increased by xxxx and includes easement compensation of xxxx for business disruption during construction;
- Design: increased by xxxx for increased scope, Geotech and hydrogen readiness assessment;
- Procurement : increased by xxxx, due to higher line pipe, additional hot formed bends and rock jacket requirements associated with HDD;
- Construction: increased by xxxx. Significant increase in labour rates based on recent actual pricing, additional HDD requirements, soil testing requirements and reinstatement;
- Commissioning and handover: no change.

The details provided in the business case together with the additional information provided in the response indicate that AGN has developed the best estimate possible and we therefore consider the cost estimate to be reasonable in the circumstances.

4.4.5 Summary of Dandenong to Crib Point pipeline duplication

This augmentation project represents the final stage of the duplication of the DCP which has been undertaken over a number of AA periods. This stage was previously approved by the AER as part of AGN's 2018 – 2022 AA proposals, at a cost of $13.8 million ($ million 2016 direct). However, network flows were marginally less than forecast during the current period and as a result this final stage of the project has been able to be deferred to the next regulatory period with modelling indicating that minimum pressure thresholds would not occur until around winter 2025.

Revised customer growth and disconnection forecasts arising for AGN's assessment of the impact of the GSR indicates that there will continue to be net growth in connections over the forecast period. However, the revised load forecast scenario indicates that load reduction for existing customers may exceed new connection load growth around 2024.

With over 140,000 customers across the Mornington Peninsula potentially impacted by a low pressure event, this pipeline has the highest risk consequence of the augmentation program. While the project is sensitive to the levels of load from existing and new customers, AGN[19] says that "*the risk of not completing the duplication by the required timeframe is too great should load destruction happen any slower than modelled in our GSR response*". The project has a long lead time to complete and the project is already underway to meet pressure constraints ahead of winter 2025.

Based on our review of the project and analysis of the various assumptions and risks we consider that the augmentation remains prudent. With respect to the cost, AGN has provided a detailed breakdown of cost components in its business case, its estimation methodology appears reasonable and they have also challenge tested the costs. The additional information provided in its IR010 response provided further details of costs. On the basis of the information provided we consider that the costs are reasonable in the circumstances.

4.5 STAKEHOLDER SUBMISSIONS

Submissions received from various stakeholders have expressed concerns regarding growth forecasts influencing the requirements for augmentation of the networks. They recommended that forecasts and expenditure be tested to verify that they are the "best estimates arrived at on a reasonable basis".

AGN is required to ensure security of supply by maintaining minimum network pressures in accordance with the Gas Distribution System Code. AGN's methodology includes a modelling assessment of when minimum pressures are likely to be experienced in the various networks and to explore alternate options to maintain supply before resorting to augmentation.

It is recognised that there is uncertainty as to future gas demand and AGN has submitted revised forecasts following its assessment of potential impacts associated with the Gas Substitution Roadmap (GSR). As a result, a number of augmentation projects have been deferred beyond the next AA period and the scope of others has resulted in reduced expenditure during the next AA period.

In nearly all cases, the revised program of projects relate to areas associated with recent high growth resulting in declining fringe pressures which are at or approaching minimum levels.

[19] Addendum to augmentation business cases: DCP section 2.15

Risks associated with poor supply or complete outages across part or all of these networks need to be managed and augmentations are typically a last resort activity in terms of good industry practice. It is also recognised that timeframes for completion of these projects are such that they can not address immediate supply shortfalls if they occur. Our review of each of the projects considers whether they are prudent and efficient in the circumstances. In this regard we consider AGN's revised growth and demand forecasts would appear to be reasonable, while at the same time being cognisant of risks to security of supply. Our conclusions and recommendations are summarised below.

4.6 CONCLUSION - AUGMENTATION

The following table shows AGN's proposed augmentation program along with revisions made as a result of its assessment of the Victorian Government's "Gas Substitution Roadmap (GSR)":

Table 4-6: Augmentation projects expenditure ($'000 real 2021)

Category	Initial	Revised	Variance
HP network augmentation	30,846	15,954	-14,892
Regulator capacity upgrades	14,135	10,394	-3,741
Dandenong Crib Point pipeline upgrade	28,220	28,220	0
Total Augmentation program	**73,201**	**54,568**	**-18,633**

(Source: Revised Capex Model)

HP augmentation

AGN's initial program included eleven networks requiring augmentation during the next AA period. Following its GSR review, four networks were deemed not to be required during the next AA period, four networks had their augmentations partly deferred and only two network augmentations remain unchanged. One HP network augmentation has been recategorised as a regulator capacity upgrade project, to align with AGN's revised capex model.

The revised growth forecasts indicated that there will be much lower growth in new residential connections, higher rates of existing customer disconnections, and declining average consumption. Overall AGN has forecast a 25% reduction in new residential connections and a 1.8% reduction in average annual load, compared to its Final Plan.

Apart from the regional Wodonga network, the remaining HP network augmentation projects are associated with growth areas across AGN's metropolitan area.

For each proposed augmentation, AGN has provided a detailed business case that included analysis of network flows and growth, network modelling and scoping design, and cost estimates.

We consider that the revised augmentation projects have addressed our concerns relating to growth forecasts and project timing, as the Final Plan had not been subject to assessment of GSR impacts.

As a result of our analysis of AGN's methodology in assessing its networks and the quality of its business cases for prospective HP network augmentations we consider that the projects

are prudent in managing integrity of supply to its customers. With respect to cost estimates, we consider that AGN's use of competitive tendering provides the most efficient costs in the circumstances. We therefore recommend approval of each of the HP augmentation projects included in AGN's revised program.

Regulator capacity upgrades

The revised capex model includes four augmentation project categories (including Pakenham, which was initially shown as a HP network augmentation). While AGN recommended all of these projects in its revised augmentation program, the city gate heater upgrade was reduced from two sites to one (Laurimar Park), and the city gate upgrade program reduced from three sites to one (Wodonga). The Sale city gate, being driven by AEMO requirement and Pakenham new city gate remain unchanged.

AGN has provided detailed business cases, included revised updates for each project. Cost estimates have been mainly based on recent city gate projects.

With respect to Sale city gate, AEMO has reaffirmed its requirement to reduce the minimum operating pressure for this city gate in order to manage the Victorian Transmission System. This project had previously been approved for the current AA period, but AEMO and AGN were able to apply workaround processes. However, the pressure change is now required, meaning that an augmentation is required during the next AA period. However, a new solution has been developed that does not require pipeline duplication and as a result the cost has been significantly reduced from $5.8 million to $1.3 million.

The Pakenham augmentation requires a new city gate (hence the recategorisation) and the revised growth forecasts has seen the timing of this project deferred by two years, but still within the next AA period.

As with the network augmentation projects we consider that AGN's methodology in assessing its regulating stations and the quality of its business cases show that the projects are prudent. With respect to cost estimates, we consider that AGN's use of actual pricing from recent city gate projects provides the most efficient costs in the circumstances. We therefore recommend approval of each of the regulator capacity upgrade projects included in AGN's revised program.

Dandenong Crib Point pipeline duplication

The proposed project is the final stage of a progressive duplication of the pipeline that supplies over 140,000 customers across the Mornington Peninsula area. While the initial plan showed significant ongoing growth the revised forecasts indicate a reduced net growth (new connections minus disconnections) and gas loads that are approaching a balance in the next few years.

The range of assumptions used in developing the forecasts indicate that the fringe pressures are sensitive to any variations, such that any change from these assumptions will result in the fringe pressure falling below minimum level, or conversely enabling the DCP to continue supply without incident.

Given the large number of customers supplied by the pipeline, any increased load from customer growth or weather events presents the risk of very sizable supply interruptions with large number of customers impacted and potentially for extended periods of time. On the balance of risks we consider it prudent to complete the DCP duplication project during the next AA period.

The final stage of the DCP duplication was initially approved by the AER for the current period at a cost of $13.8 million, however AGN's recent business case submission has a revised cost of $28.2 million. The level of detail provided in support of the cost estimate is extensive and the methodology applied would appear to be sound. Further details provided in response to AER's information request has shown that the cost estimate is reasonable in the circumstances. Therefore, we consider that the project is prudent and based on the best estimates in the circumstances.