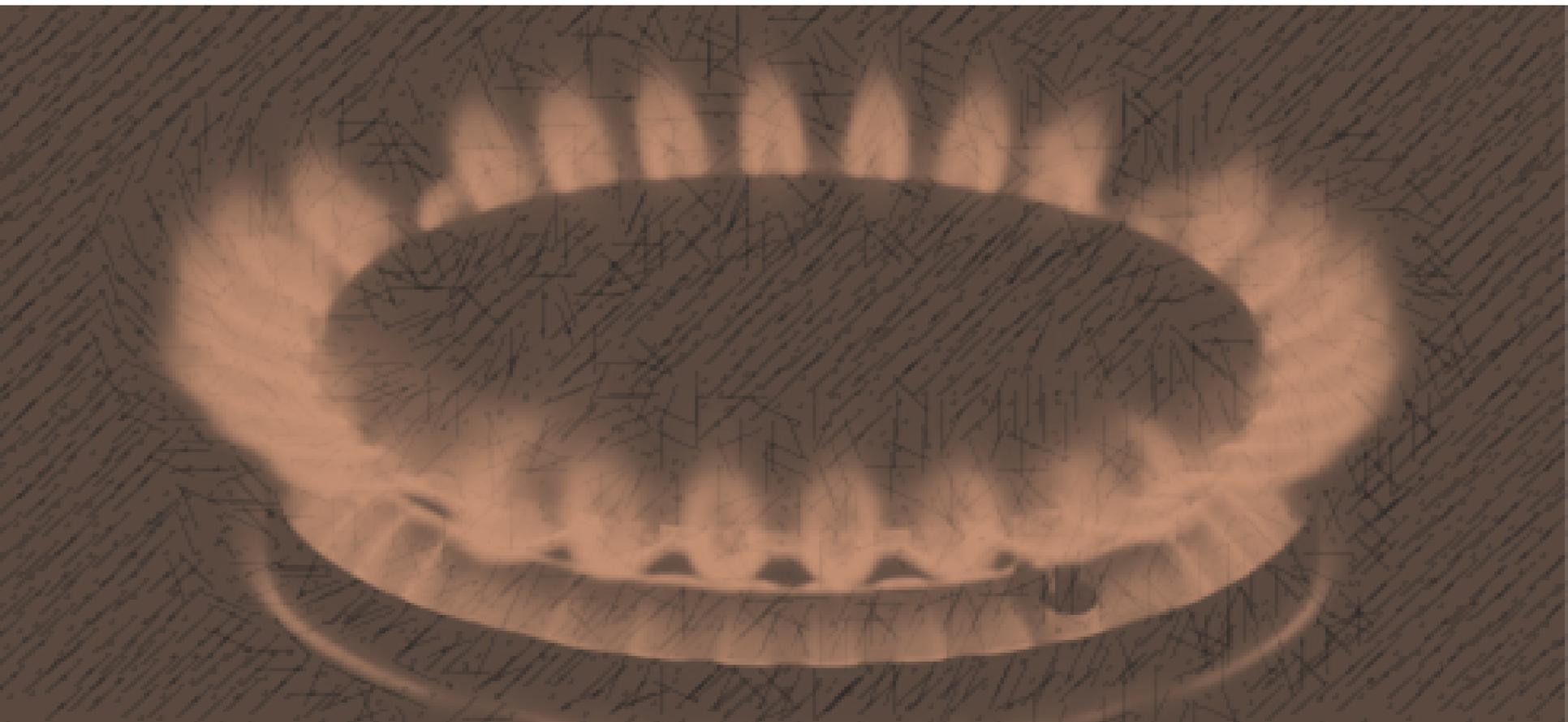




2019-2070 Scenario-based Outlook for JGN Gas Demand

January 2020



1. Executive Summary | Introduction and Scope



- Core has been engaged by Jemena Gas Networks (JGN) to undertake analysis of the outlook for gas demand within the JGN between 2020 and 2070, under a range of defined scenarios.
- Core has used a Confidential proprietary model to facilitate the scenario analysis. In broad terms the model is structured to receive inputs for future connection rates and future levels of demand per connection to derive total annual demand for Residential and Small Business customer segments and a broader analysis of potential demand for Tariff D customers, having regard to industrial capacity and gas share of energy mix.
- The remainder of this document is structured as follows:
 - Section 2 – Demand Scenario Summary
 - Section 3 – Supporting Analysis
 - Attachments

2. Executive Summary | Scenarios



- **Low Boundary**
 - Gas demand consistent with GAAR 20-25
 - 2050 net zero target achieved via complete electrification: bans on new gas connections, policy changes such as subsidies to remove gas appliances, rebates on electrical appliances (like announced in the ACT), hydrogen/biomethane not competitive, lower utilisation increases network charges. Cost of batteries, solar etc continue to fall.
 - NSW Government mandates progressively move toward no new connections under an emission reductions target from 2035 onward; gas appliances progressively phased out
 - 1.8% average reduction in Tariff D due to energy substitution and industry rationalisation/international competition
- **Low Gas**
 - Gas demand consistent with GAAR 20-25
 - Net zero target achieved: blend of hydrogen and biogas no conventional natural gas. Higher cost of gas, customer retention only where it is not cost effective to electrify (apartment buildings with sunk infrastructure or specific industrial customers). Lower new connections from 2035. Some demand loss from existing customers where they can easily switch - i.e. when renovating.
 - NSW Government mandates progressive move toward no new connections from 2035 (per above)
 - 1.7% average reduction in Tariff D
- **Mid Gas**
 - Net-zero target achieved: natural gas, biomethane and hydrogen. Possibly offsets for natural gas or cost effective biomethane and hydrogen. Gas prices higher than current levels. Potential for decarbonisation pathway in the longer term. Gas still competitive due to higher substitution cost of electrification. Not losing demand but limited new connections from 2035.
 - 1.4% average reduction in Tariff D
- **High Gas**
 - Net-zero target achieved: Technological breakthrough makes renewable gas cost competitive. Continued gas connections. No decline in usage.
 - Residential and small business lower than average recent trend
 - 1.3% average reduction in Tariff D

2. Executive Summary | Scenarios



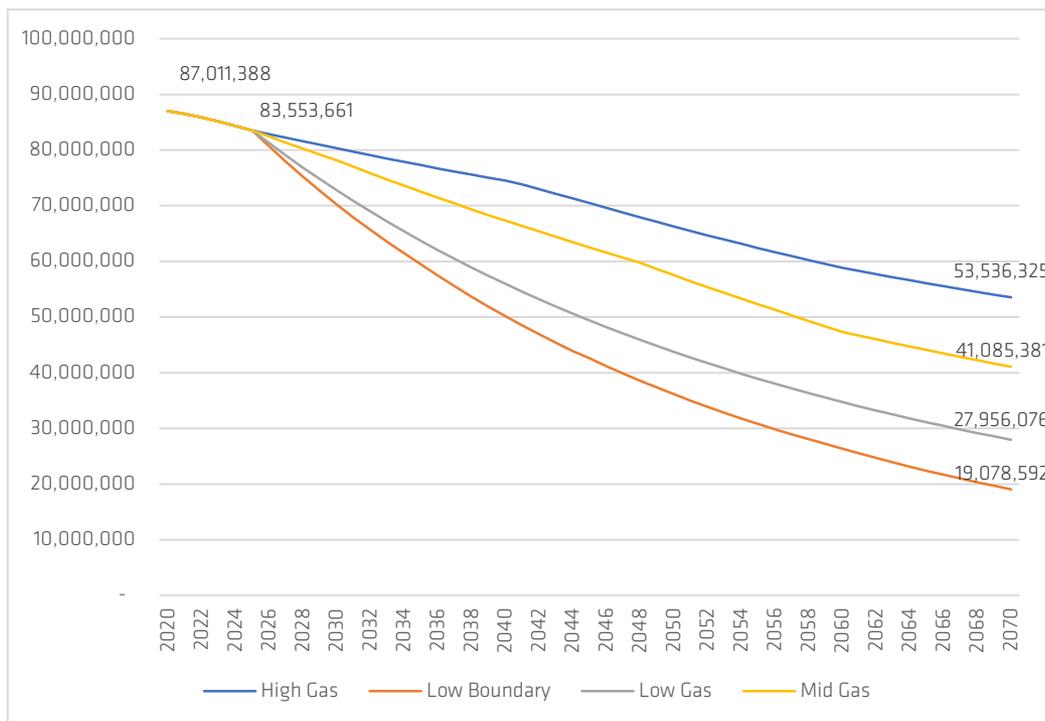
This Section summarises analysis which has been relied upon by CORE to derive scenarios of future JGN demand. It should be noted that there is not a direct relationship between the factors addressed and the scenarios presented above. Rather CORE has observed a wide range of potential outcomes and projected demand which meets the Scenario definition – as summarised on the above charts – noting that rates of growth may vary over time.

Scenario Driver	Low Boundary	Low Gas	Mid Gas	High Gas
Government Policy	NSW – net zero target 2050 achieved Fed – no fossil fuel post 2035	NSW – net zero target 2050 achieved Fed – no fossil fuel other than peak post 2035	NSW – net zero target 2050 achieved Fed – low fossil fuel other than post 2035	NSW – net zero target 2050 achieved Fed – low emission targets include gas
Economic Performance	Low	Low	Mid	High
Electricity Price	ES00 Central	ES00 Central	ES00 Central	ES00 Central
Gas Price	GS00 Fast	GS00 Fast	GS00 Neutral	GS00 Slow
Hydrogen cost	CORE slow learning	CORE slow learning	CORE Central	CORE fast learning

2. Executive Summary | Scenarios - Total JGN Demand



Total JGN Demand | GJ per annum

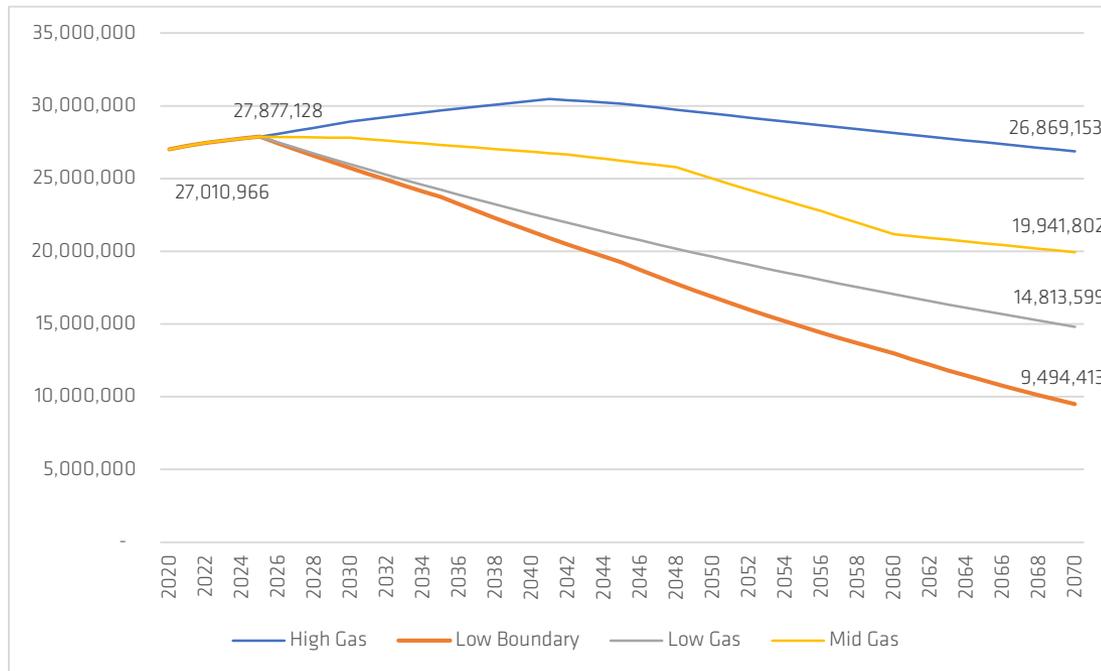


- Total demand is projected to fall under all scenarios:
 - High - 0.77% p.a.
 - Mid Gas -1.1% p.a.
 - Low Gas - 1.36% p.a.
 - Low Boundary - 1.56% p.a.
- The key driver in the residential and small business sectors is substitution away from gas in favour of electricity and other sources, via a change out of room heating, water heating and cooking appliances, and in the Tariff D sector by loss of manufacturing capacity and fuel switching.

2. Executive Summary | Scenarios - Residential Demand



Residential Demand | GJ per annum

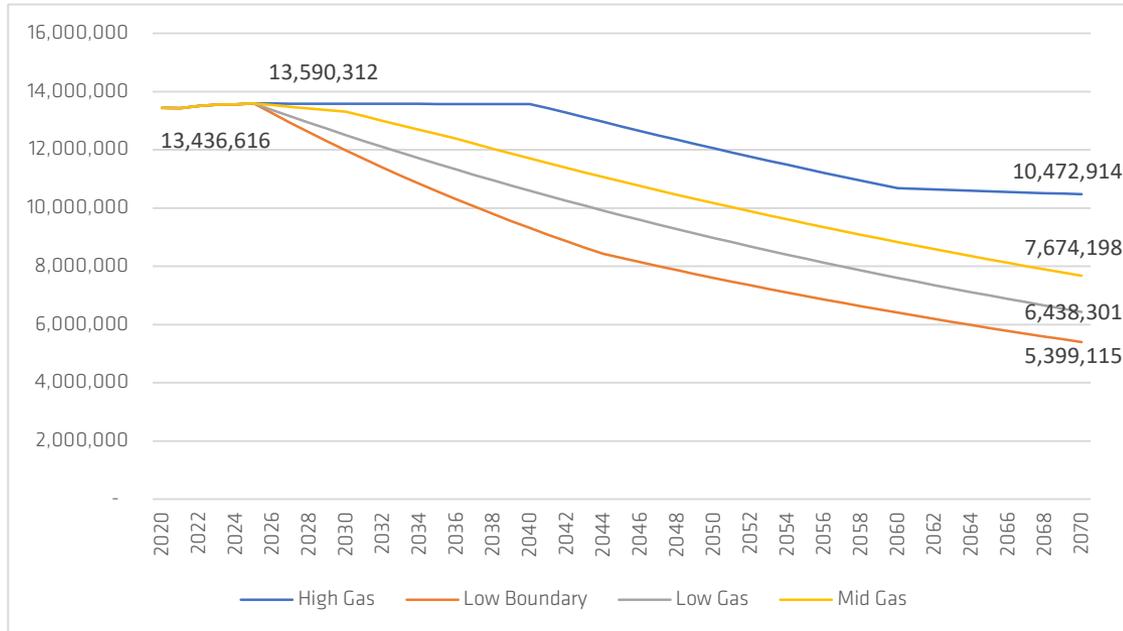


- Residential demand is projected to fall under all scenarios from 2041, with only the High scenario resulting in growth from 2025-2041. All other scenarios result in falling demand from 2025:
 - High - negligible fall on p.a. basis
 - Mid Gas - 0.41% p.a.
 - Low Gas - 0.90% p.a.
 - Low Boundary - 1.30% p.a.
- The key driver is substitution away from gas in favour of electricity and other sources, via a change out of room heating, water heating and cooking appliances
- The trend in change out of appliance is attributable to a combination of Government policy and price elasticity - as relative electricity prices, heat pump technology advances and incentives make electricity and other forms of energy more favourable than gas

2. Executive Summary | Small Business Demand



Small business | GJ per annum

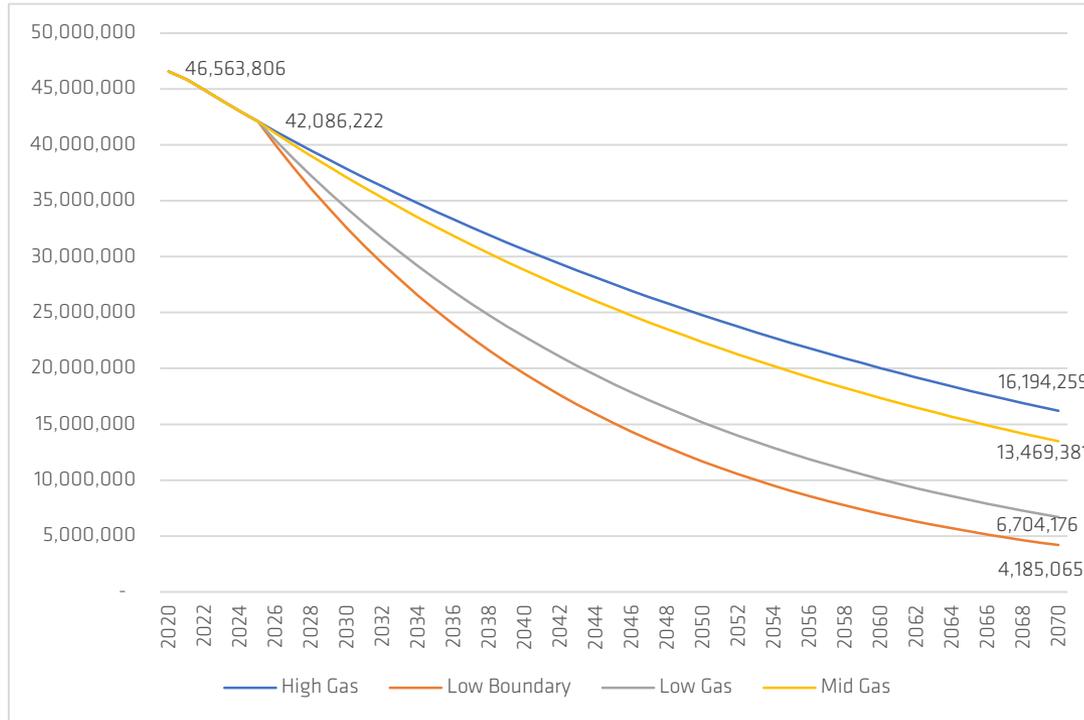


- Small business demand is projected to fall under all scenarios from 2041, with only the High scenario resulting in growth from 2025-2041. All other scenarios result in falling demand from 2025:
 - High - 0.44% p.a.
 - Mid Gas - 0.86% p.a.
 - Low Gas - 1.0% p.a.
 - Low Boundary - 1.20% p.a.
- The key driver is substitution away from gas in favour of electricity and other sources, via a change out of appliances
- The trend in change out of appliance is attributable to a combination of Government policy and price elasticity - as relative electricity prices, technology advances and incentives make electricity and other forms of energy more favourable than gas

2. Executive Summary | Scenarios - Tariff D Demand



Tariff D | GJ per annum



- Industrial, Tariff D demand is projected to fall under all scenarios:
 - High -1.3% p.a.
 - Mid Gas -1.4% p.a.
 - Low Gas -1.7% p.a.
 - Low Boundary -1.8% p.a.
- The key driver is industry rationalisation based on global competition and change in national industry mix, energy substitution and conservation

3. Executive Summary | Supporting Analysis



- Given the short timeframe and limited scope of this engagement, CORE has not developed detailed analysis of underlying factors which will drive each of the scenarios outlined above. However CORE has referenced a range of high-quality third-party analysis which support the potential material reduction of the future use of gas, in favour of electricity and renewable sources and these are include in the 'Support' sections below.
- Discretionary use of gas is influenced by economic and non-economic factors.
 - Economic factors are centred on the relative cost of gas to substitute energy sources such as electricity
 - Non-economic factors include the attractiveness of flame for cooking and, instant gas water heating access, a different 'feel' of gas room heating, etc.
- CORE is of the view that the relative cost of gas and electricity will bring about a marked reduction in gas use in the future
- In comparing the cost of energy use CORE has also considered the relative efficiency of alternative technologies
- Core's retail electricity price forecasts are influenced heavily by the CSIRO's forecasts to 2060 in their Australian National Outlook 2019, published in June 2019, which are directionally similar to AEMO's NEM residential price index published in the 2019 ES00.
- All forecasts point to a 10%-15% decrease from 2018 electricity prices into the early 2020s as new, cheap renewable generation enters the grid and then gradually increasing in the mid 2030's and beyond as the cheap coal generation is retired and more investment in grid firming is required due to the intermittent nature of renewable generation.
- Over the longer-term CORE considers it most likely that electricity will gain significant market share in both water heating and room/space heating sectors – due to the combined influence of the efficiency of 'heat pump' technology and relative price of delivered energy.



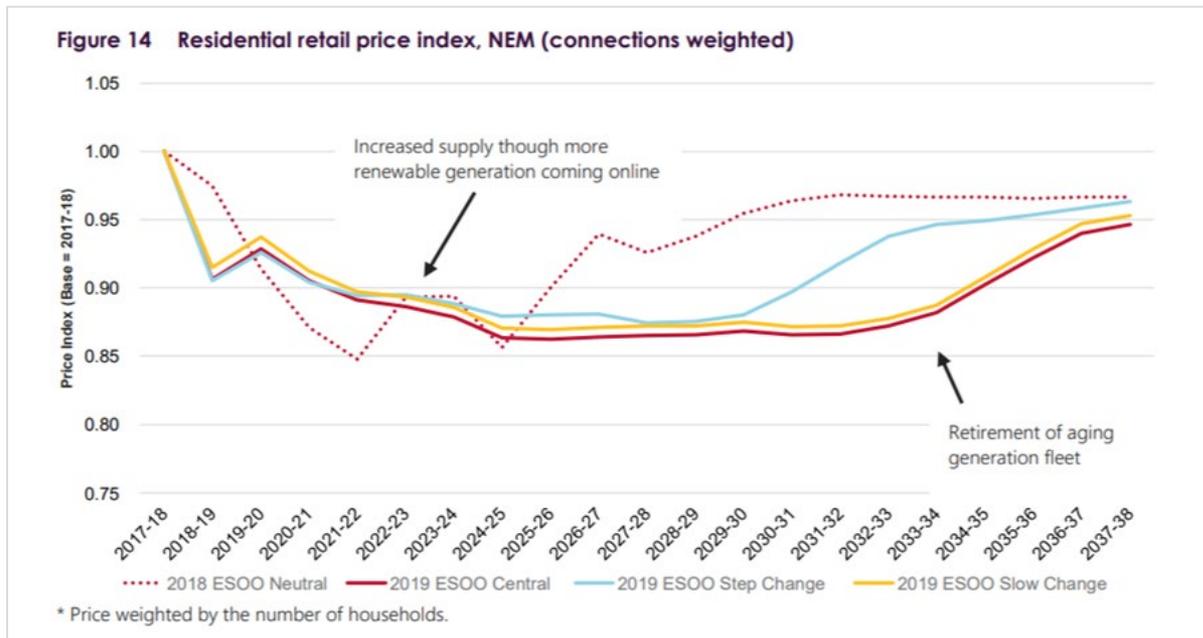
Attachments

This Section summarises inputs which have been relied upon by CORE to derive scenarios of future electricity and gas prices and hydrogen cost.

Attachment | Supporting Analysis – Electricity Price



- The following chart, from AEMO's 2019 NEM Electricity Statement of Opportunities (ESOO) illustrates a projected fall in the price of electricity under each of AEMO's defined scenarios.

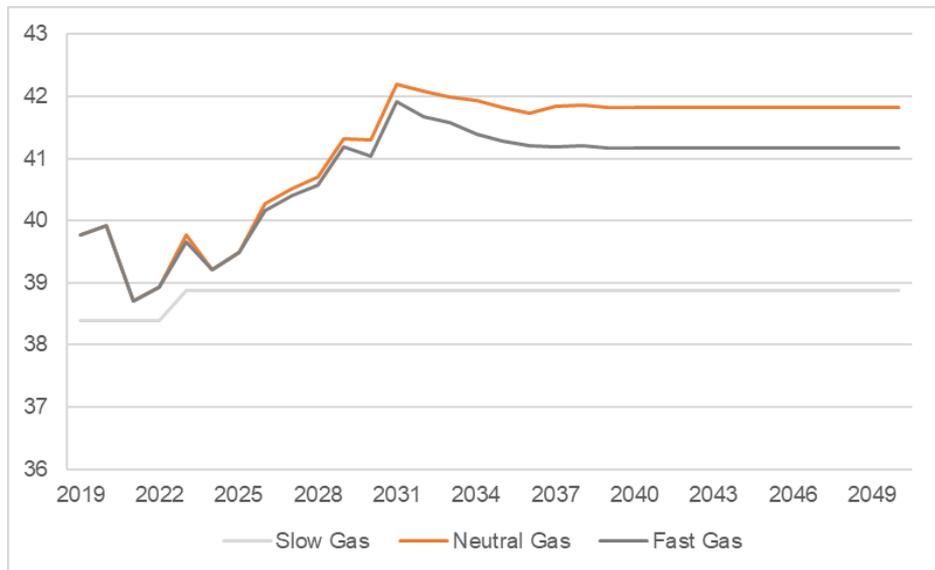


Attachment | Supporting Analysis – Gas Price



- Gas price for a network customer comprises wholesale gas + transmission + network + retail cost and margin + other.
- Core has made a series of ‘broad’ assumptions to arrive at a delivered price of gas.
- The result is a projected material increase in the price of gas under a range of Scenarios - consistent with the scenarios which have been used by AEMO for its GSOO

Projected delivered gas price (\$/GJ)



Attachment | Supporting Analysis – Hydrogen Cost



- To illustrate the potential impact of advances in hydrogen technology on the future cost of gas within a distribution system, CORE has developed a series of scenarios of hydrogen cost, based largely on CSIRO analysis. These scenarios assume variable degrees of learning or cost efficiency with time
- CORE's hydrogen forecasts (based largely on CSIRO) have been compared to Bloomberg New Energy Finance recent forecast.
- In our analysis, we have assumed a natural gas heating appliance has the identical efficiency of a hydrogen gas heating appliance. In practice, such appliances are not commercially available. In the future, hydrogen could be a direct substitute for gas appliances and generate heat through combustion or electrical appliances, generating electricity through fuel cell technology.

Projected delivered hydrogen cost (\$/GJ based on USD:AUD 0.70)

