ATTACHMENT 5.1
BENCHMARKING PARTIAL PRODUCTIVITY PERFORMANCE

ATCO 2020-24 PLAN

EIM # 97150851

PUBLIC
31 August 2018

Benchmarking Operating and Capital Costs of ATCO Gas' Western Australian Network Using Partial Productivity Indicators

Report prepared for

ATCO Gas Australia

16 July 2018

Michael Cunningham

Economic Insights Pty Ltd
10 By Street, Eden,
NSW 2551, Australia
Ph +61 2 6496 4005
WEB www.economicinsights.com.au
ABN 52 060 723 631

CONTENTS

EXECUTIVE SUMMARY

This report discusses the efficiency performance of ATCO Gas Australia's Western Australian operations ('ATCO') over the period 1999–2017 within a group of 13 Australian and two New Zealand gas distribution businesses (GDBs). The report has been prepared for ATCO as an input to the forthcoming review by the Economic Regulatory Authority of its access arrangement for the period 2020 to 2024.

A set of partial performance indicators is presented to compare the opex and capital input efficiency of the thirteen businesses against one another. The Australian and New Zealand GDBs included in the study are: ActewAGL (ACT); AGN Albury (NSW); AGN Queensland; AGN South Australia; AGN Victoria; AGN Wagga (NSW); Allgas Energy (Queensland); ATCO Gas Australia (Western Australia); AusNet Services (Victoria); Jemena Gas Networks (NSW); Multinet (Victoria); Powerco (New Zealand); and Vector (New Zealand). The partial performance indicators presented are:

- Opex per customer relative to customer density
- Opex per mains km relative to customer density
- Asset cost per customer relative to customer density
- Asset cost per mains km relative to customer density
- Total cost per customer relative to customer density
- Total cost per mains km relative to customer density.

While these indicators have the advantage of simplicity, care is needed in interpretation, as individual partial performance indicators may give a misleading impression of overall efficiency. Generally, if a GDB is ranked highly for most indicators this may be taken to suggest that it is performing at levels consistent with industry best practice. If performance on these measures is mixed or unfavourable, more analysis may be warranted. It is also desirable to examine more holistic measures of efficiency, such as total factor productivity (TFP) analysis, or methods of measuring efficiency, which can control for differences in scale and other operating environment differences.

The data used in this study has been predominantly sourced from documents in the public domain. These data have been supplemented in some places with information provided by several major Australian GDBs in response to common detailed data surveys.

Key findings

ATCO's operating environment characteristics can be summarised as follows:

- After Jemena in NSW (the largest GDB in the sample), ATCO is the second largest in terms of customer numbers and network length, but is fifth largest in terms of gas deliveries. In terms of network length and customer size, ATCO is closely comparable in size to the Victorian GDBs, but in terms of gas deliveries it is more closely comparable in size to AGN SA.
- ATCO's customer density is similar to Jemena, AGN SA and AGN Albury. It somewhat lower than the three Victorian GDBs. The other GDBs in the sample,

which tend to be smaller in size, also have lower customer densities.

- ATCO's energy density per customer is the lowest in the sample. In terms of energy density the most comparable GDBs are AGN SA, ActewAGL, AGN Qld and Jemena.
- ATCO has relatively low energy deliveries per km or 'network utilisation'. The GDBs with comparable levels of network utilisation are ActewAGL, AGN Wagga, Powerco, AGN Qld and Vector (after its relatively recent divestment).

ATCO's opex per customer is the lowest in the sample, and its asset cost per customer is amongst the lowest in the sample. ATCO's total cost per customer is the lowest in the sample. Comparisons of cost per customer suggest that ATCO compares well amongst its peers with higher customer density and is amongst the most efficient of the GDBs in the sample.

The partial indicators analysis presented in this report does not enable influences such as scale economies or different mixes of inputs to be controlled for in a rigorous fashion. This means that care needs to be taken when drawing inferences. Based on these indicators and recognising the nature of their networks, ATCO has performed at better than average levels, achieving comparatively low levels of opex per customer, asset cost per customer and hence total cost per customer.

1 INTRODUCTION

1.1 Terms of reference

ATCO Gas Australia ('ATCO') commissioned Economic Insights Pty Ltd ('Economic Insights') to provide advice on productivity measurement and benchmarking of its Western Australian gas distribution network operations. The advice provided in this report presents partial indicator comparisons between a set of 11 Australian and two New Zealand GDBs using primarily public domain data. These partial performance indicators are analogous to those published by the Australian Energy Regulator for electricity distribution businesses (AER 2014). This report updates similar studies carried out for AGN SA in 2015 and three Victorian GDBs (AGN Vic, AusNet and Multinet) in 2016 for their respective access arrangement reviews (Economic Insights 2015, 2016).

1.2 Outline of the Report

Section 2 presents data on the business operating environment characteristics that influence the observed performance of GDBs. Section 3 provides a summary comparison of partial performance indicators relating to costs per customer. Appendix A briefly describes the operations of the 11 Australian GDBs and two New Zealand GDBs included in this study, and Appendix B describes the database used in the study.

1.3 Economic Insights' experience and consultants' qualifications

Economic Insights has been operating in Australia for over 20 years as an economic consulting firm specialising in infrastructure regulation. Economic Insights provides strategic policy advice and rigorous quantitative research to industry and government. Economic Insights' experience and expertise covers a wide range of economic and industry analysis topics including:

- infrastructure regulation;
- productivity measurement;
- benchmarking of firm and industry performance;
- infrastructure pricing issues; and
- analysis of competitive neutrality issues.

2 OPERATING ENVIRONMENT INDICATORS

This section describes the key characteristics for the 13 GDBs included in this study, covering the years 1999 to 2017. A summary overview of each of the GDBs included in this study is available at Appendix A. The performance indicators discussed below are summarised in Tables 2.1, 2.2 and 2.3 at the end of this section.

The dataset on which this analysis is based is described in Appendix B. Data for the full 19-year period from 1999 to 2017 are available for six of the Australian GDBs. Data for ATCO is available from 2000; Allgas and AGN Queensland from 2001; Powerco from 2004; and Vector from 2005. Data for Allgas, AGN Queensland and ActewAGL is available up to 2016; and AGN Wagga to 2015. Availability of data for New Zealand GDBs has been affected by merger and restructuring activity. Furthermore, the comparability of data for Vector in 2016 and 2017 against earlier years is affected by its divestiture of gas pipelines outside Auckland in November 2015.

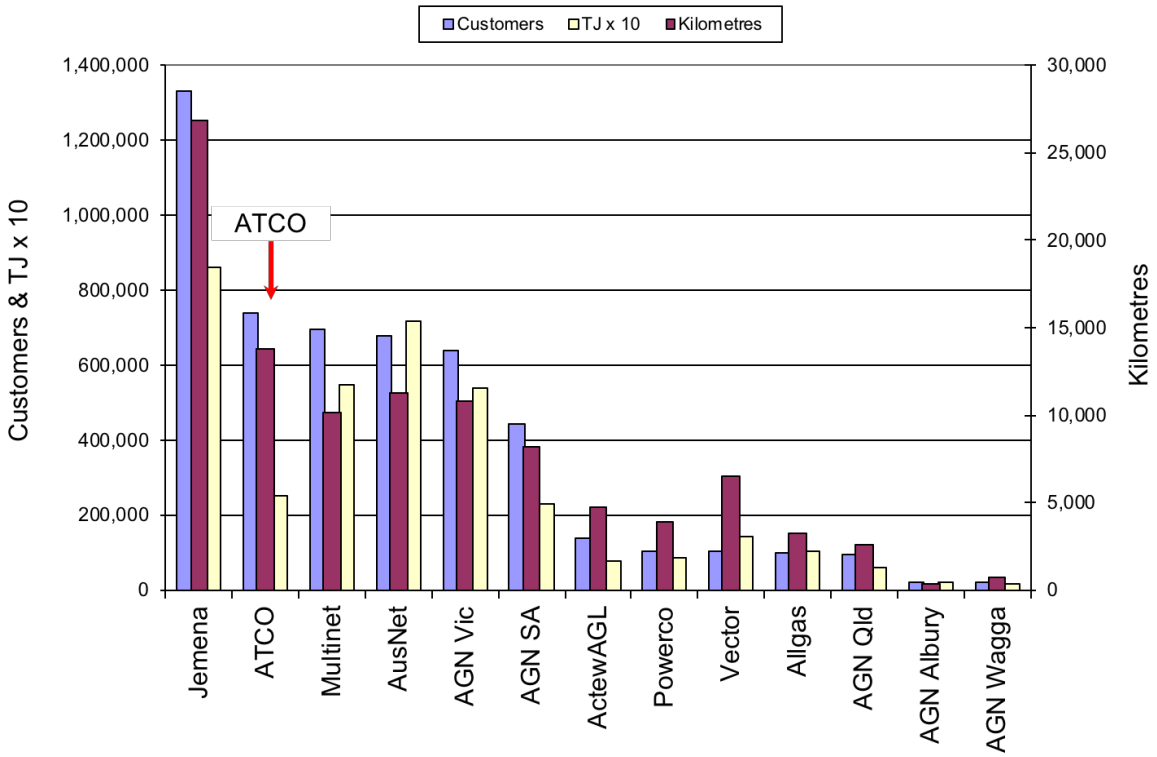
The 13 Australasian distribution businesses operate in varying environments often with substantial differences in network size, amount of throughput, demand growth, number and type of customers, and the mix of rural, urban and central business district (CBD) customers. The operating environment indicators presented in this section are:

- Energy delivered in terajoules (TJ), number of customers and network kilometres (km) (Figure 2.1)
- Customer density—customers per km of mains (Figure 2.2)
- Energy density—TJ per customer (Figure 2.3)
- Network utilisation—TJ per km (Figure 2.4).

Figure 2.1 shows, for each GDB in the sample, customer numbers, gas energy throughput (TJ) and mains length (km) in 2017 (or the latest year available). GDBs are ranked in terms of number of customers and the position of ATCO is highlighted. In terms of customer numbers, and in terms of network length, ATCO is the second largest GDB in the sample. By these measures it is a little larger than each of the Victorian GDBs (AGN Vic, AusNet and Multinet). However, in terms of gas throughput, ATCO is the fifth largest. By this measure it is only slightly larger than AGN SA.

Among the other GDBs, Jemena in NSW is by far the largest. Other larger GDBs include the three Victorian networks, ATCO and AGN SA. Vector is the larger of the two New Zealand GDBs included. The remaining five Australian GDBs in the sample are relatively small (i.e. ActewAGL, Allgas, AGN Queensland, AGN Albury and AGN Wagga Wagga).

Figure 2.1: Key features of the operating environment, 2017*



* AGN Qld, Allgas and ActewAGL data is for 2016. AGN Wagga data is for 2015.

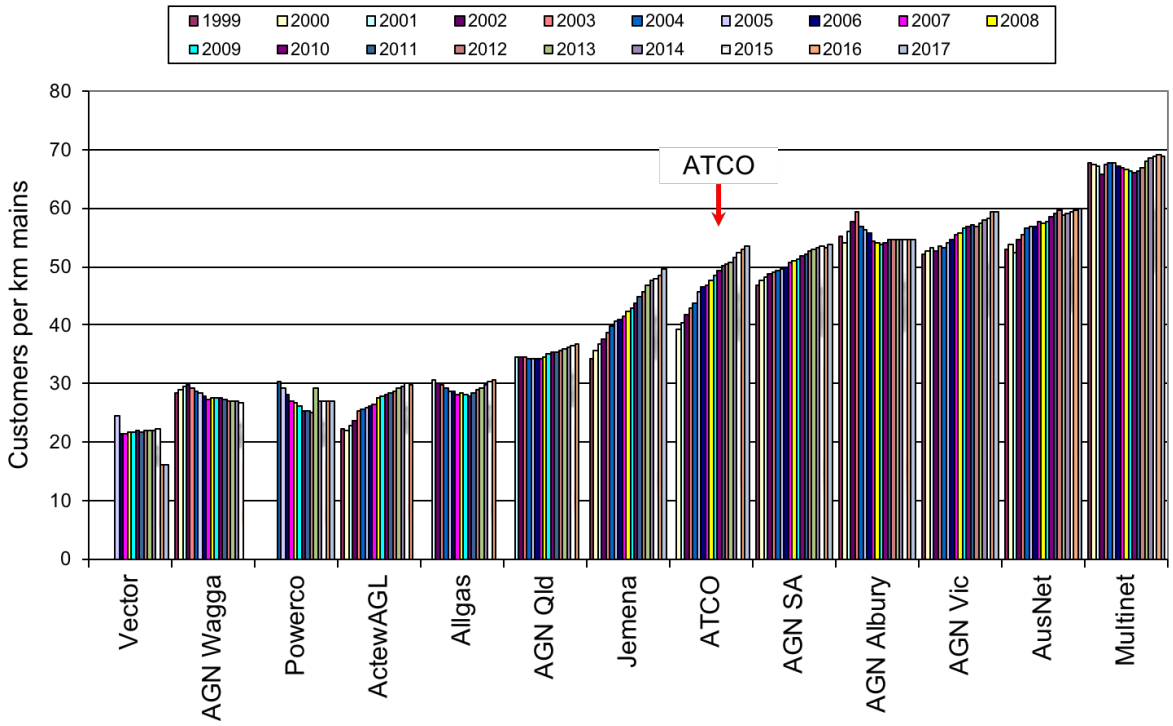
Source: Economic Insights gas utility database

Two of the key operating environment characteristics influencing energy distribution business productivity levels and costs are customer density, measured by the number of customers per km of mains, and energy density measured by energy throughput (i.e. TJ) per customer. A GDB with lower customer density requires more pipeline length to reach its customers than a GDB with higher customer density and the same consumption per customer. This would make the lower density distributor appear less efficient unless the differing densities are allowed for. Being able to deliver more energy to each customer means that a GDB requires less capital and non-capital inputs to deliver a given volume of gas as input requirements are more influenced by customer numbers than energy quantities.

These two density measures for all companies in the sample for all available years are presented in Figures 2.2 and 2.3. When the foregoing two measures are multiplied together, the result is the ratio of energy throughput per km, or 'network utilisation'. This measure is presented in Figure 2.4.

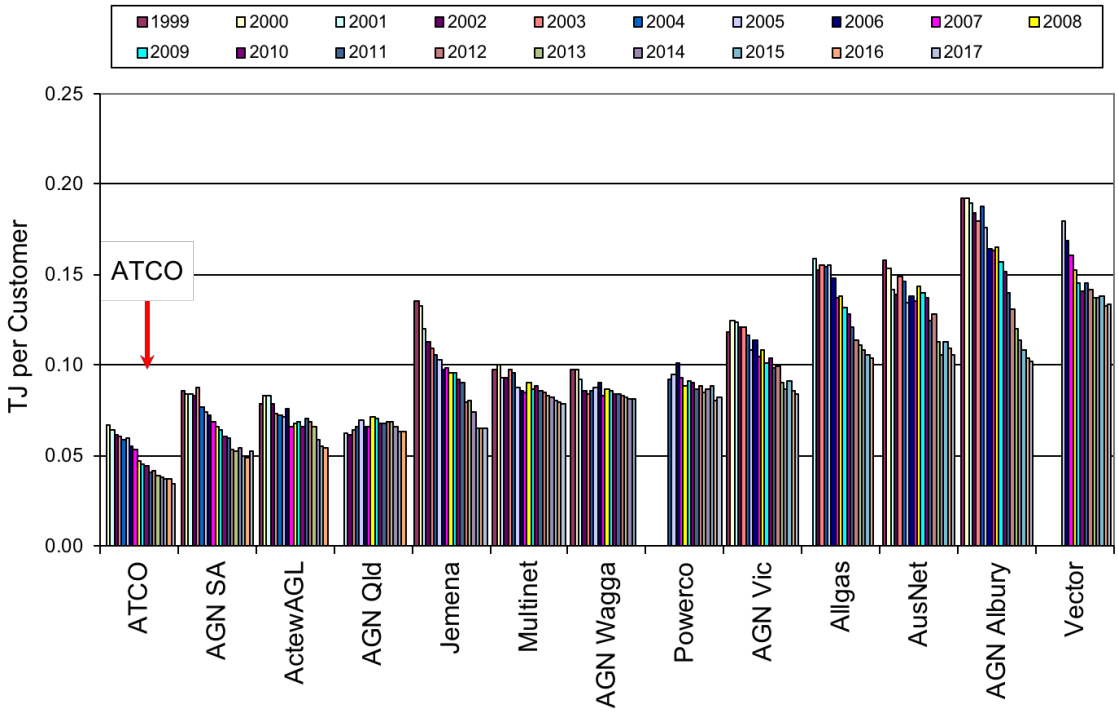
The three Victorian GDBs have the highest customer densities in the sample in 2017 (or latest year available). AGN Vic, AusNet and Multinet had 59.4, 59.9 and 68.9 customers per km respectively. ATCO has the sixth highest customer density in the sample (53.4 customers per km), broadly comparable to those of AGN SA and Jemena (53.7 and 49.6 customers per km respectively). The two New Zealand businesses and most of the smaller Australian GDBs (excepting AGN Albury) have comparatively low customer densities.

Figure 2.2: Customer density, 1999–2017



Source: Economic Insights gas utility database

Figure 2.3: Energy density, 1999–2017



Source: Economic Insights gas utility database

ATCO's and Jemena's customer densities have increased quite strongly over the sample period. AGN Vic, AusNet and AGN SA have had ongoing, but more moderate, increases in customer density, whereas Multinet has not had any significant increase in customer density (having relatively little scope for network expansion within its franchise area, which is largely confined to mature urban area of Melbourne and does not include any of the higher growth urban fringe areas). The two New Zealand businesses and most of the smaller Australian GDBs (excepting ActewAGL) have had relatively static network densities over the sample period.

ATCO had the lowest energy density of all the GDBs in the sample, an average of 34 gigajoules (GJ) per customer in 2017, for all customer types.[1] By comparison, AGN Vic, AusNet and Multinet had energy densities of 84, 106 and 79 GJ per customer respectively, and Jemena and AGN SA had energy densities of 65 and 52 GJ per customer (all in the same year). There is considerable diversity in the energy densities of the smaller Australian and New Zealand GDBs, reflecting wide variation in climates and the competitiveness of alternative fuels.

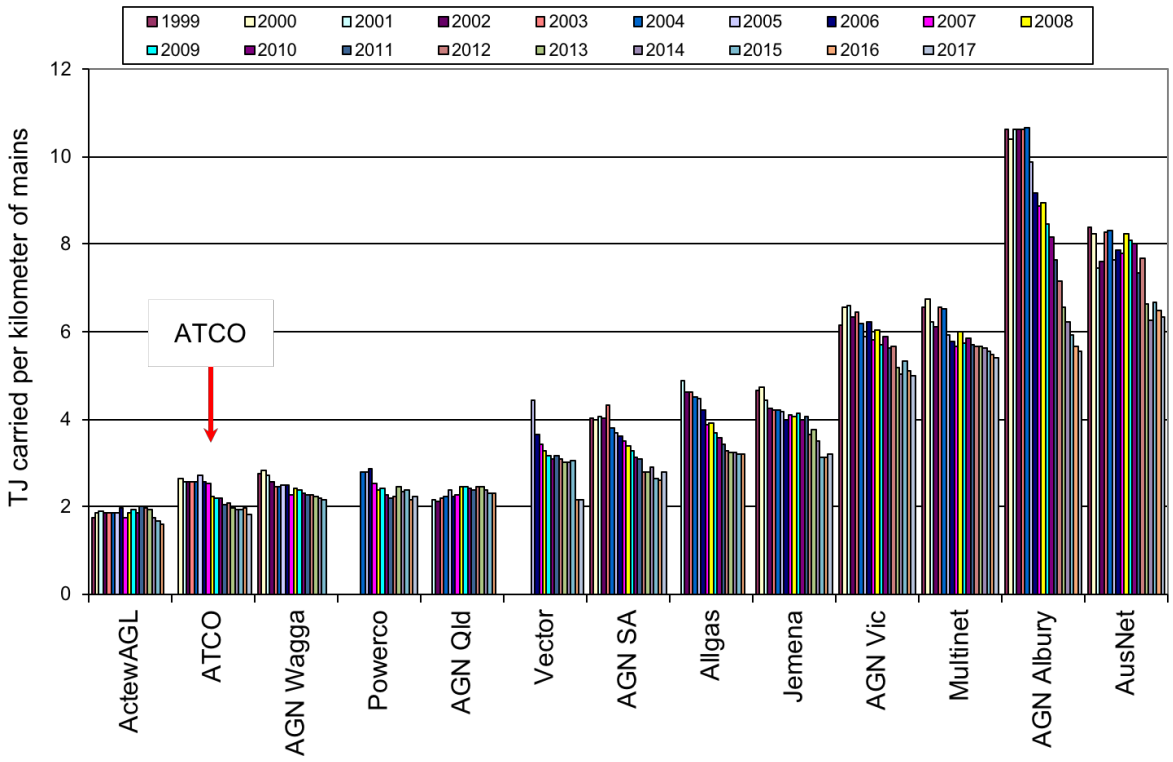
Energy use per customer has generally declined over the period from 1999 to 2017. For example, for ATCO it has virtually halved from 67 GJ per customer in 2000 to 34 GJ per customer in 2017 (a 48 per cent cumulative decrease). Jemena's energy density has slightly more than halved over the available sample period, from 135 GJ per customer in 1999, to 65 GJ per customer in 2017 (a 52 per cent cumulative decrease). AGN SA's energy density has also seen a substantial decline, from 85 GJ per customer in 1999, to 52 GJ per customer in 2017 (a 39 per cent cumulative decrease), and AusNet has seen a decline from 158 GJ per customer to 106 GJ per customer (a 33 per cent decrease) over the same period. These trends reflect a combination of decreased gas demand by energy-intensive industries, residential energy efficiency improvements, and greater competition in the domestic heating market from electric split systems (e.g. split system air-conditioning and heating).

The combined effect of customer density and energy density is the energy delivered per km of mains or 'network utilisation', shown in Figure 2.4. ATCO had the second lowest level of network utilisation in the sample in 2017, at 1.8 TJ per km, primarily because of its low energy density. For comparison, the Victorian GDBs had much higher levels of network utilisation, namely 5.0 TJ/km for AGN Vic, 6.3 TJ/km for AusNet and 5.4 TJ/km for Multinet. Jemena in NSW and AGN SA had more intermediate levels of network utilisation, at 3.2 and 2.8 TJ/km respectively. The New Zealand and smaller Australian GDBs (excepting AGN Albury) generally had low levels of network utilisation, broadly similar to ATCO's.

For most GDBs, network utilisation has declined over the sample period, reflecting the fact that declines in energy density per customer have typically outpaced increases in customer density per km. ATCO's network utilisation decreased from 2.6 TJ/km in 2000 to 1.8 TJ /km in 2017 (a cumulative decrease of 30 per cent). For comparison, Jemena's network utilisation decreased from 4.6 to 3.2 TJ/km between 1999 and 2017 and AGN SA's decreased from 4.0 to 2.8 TJ/km over the same period (an overall decrease of 30 per cent in both cases). The cumulative declines in network utilisation of the Victorian GDBs were not quite as large, ranging from 18 per cent for Multinet to 25 per cent for AusNet.

[1] A GJ is one thousandth of a TJ (i.e. 1,000 GJ = 1 TJ).

Figure 2.4: Network Utilisation (Energy per kilometre), 1999–2017



Source: Economic Insights gas utility database

Table 2.1 shows averages for each of the operating environment indicators presented in Figures 2.1 to 2.4, for each GDB over the five-year period 2017 (or the latest year). It also shows a number of additional partial performance indicators including:

- Opex per customer, per TJ and per mains km
- Capex per customer, per TJ and per mains km
- Assets per customer, per TJ and per mains km
- Asset cost per customer, and
- Total cost per customer.

Table 2.2 shows the average growth rates of each of these partial performance indicators for each GDB over the whole sample period available for that GDB. Table 2.3 shows the average growth rates of each partial performance indicator for each GDB over the last five years of the data sample.

The performance of businesses in relation to the partial indicators presented in section 3 can be influenced by the customer mixes of GDBs. Table 2.4 shows information on the customer mixes of the GDBs, in terms of 'volumetric' and 'demand' customers, and for each customer type shows the TJ per customer and TJ per km of mains. This information may assist to interpret outcomes reported in section 3.

Table 2.1: Operating and performance indicators, Australian and New Zealand GDBs, average*

Company	Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	2013-17	2,355	21,510	394	55	5.99	0.110	831	91	4,964
AGN Vic	2013-17	54,166	617,920	10,557	59	5.13	0.088	1,023	90	5,246
Multinet	2013-17	55,625	690,509	10,045	69	5.54	0.081	1,065	86	5,896
AusNet	2013-17	71,056	651,538	10,971	59	6.48	0.109	672	73	4,353
AGN SA	2013-17	22,003	428,672	8,039	53	2.74	0.051	2,327	119	6,361
AGN Qld	2012-16	6,055	92,100	2,548	36	2.38	0.066	3,686	242	8,757
Allgas Qld	2012-16	10,110	93,397	3,133	30	3.23	0.108	1,751	190	5,649
AGN Wagga	2011-15	1,609	19,554	723	27	2.23	0.082	1,443	119	3,214
JGN	2013-17	86,907	1,250,021	25,981	48	3.35	0.070	1,498	104	5,011
ActewAGL	2012-16	8,046	133,442	4,523	29	1.78	0.061	2,907	175	5,151
ATCO WA	2013-17	26,001	706,278	13,521	52	1.92	0.037	1,798	66	3,457
Pwrco NZ	2013-17	8,796	104,156	3,793	27	2.32	0.084	1,619	137	3,750
Vector NZ	2013-17	18,670	136,993	6,906	20	2.68	0.136	732	99	1,961
Average		28,569	380,468	7,780	43	3.52	0.083	1,642	122	4,906

Company	Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	2013-17	338	37	2,023	16,111	1,756	95,886	158	249
AGN Vic	2013-17	1,771	156	9,098	22,627	1,982	116,027	206	296
Multinet	2013-17	1,033	83	5,710	18,280	1,472	101,195	149	234
AusNet	2013-17	1,014	110	6,561	18,300	1,995	118,468	196	269
AGN SA	2013-17	4,375	224	11,935	53,758	2,753	146,842	313	433
AGN Qld	2012-16	4,751	314	11,320	61,296	4,025	145,532	399	641
Allgas Qld	2012-16	2,563	278	8,269	45,677	4,947	147,381	499	689
AGN Wagga	2011-15	2,609	215	5,817	41,221	3,391	91,773	389	507
JGN	2013-17	1,977	135	6,494	31,045	2,149	103,352	298	402
ActewAGL	2012-16	2,441	144	4,258	37,774	2,269	66,893	266	441
ATCO WA	2013-17	2,554	94	4,912	36,394	1,338	69,902	151	217
Pwrco NZ	2013-17	1,241	105	2,857	36,840	3,108	85,433	298	435
Vector NZ	2013-17	1,095	149	2,887	17,955	2,445	49,546	367	467
Average		2,135	157	6,319	33,637	2,587	102,941	279	426

Note: * Average for period indicated. TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 dollars.

Table 2.2: Operating and performance indicators, average annual growth rate since earliest year

Company	Year/ Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	1999-2017	-1.5	2.1	2.2	-0.1	-3.5	-3.5	2.9	-0.7	-0.7
AGN Vic	1999-2017	0.6	2.5	1.8	0.7	-1.1	-1.8	-0.7	-2.5	-1.8
Multinet	1999-2017	-0.3	0.9	0.8	0.1	-1.1	-1.2	0.6	-0.6	-0.5
AusNet	1999-2017	0.4	2.7	2.0	0.7	-1.5	-2.2	-1.1	-3.2	-2.6
AGN SA	1999-2017	-1.0	1.8	1.0	0.8	-2.0	-2.7	1.4	-1.4	-0.6
AGN Qld	2001-2016	2.1	2.0	1.6	0.4	0.5	0.1	0.3	0.4	0.8
Allgas Qld	2001-2016	0.5	3.4	3.4	0.0	-2.8	-2.8	3.3	0.4	0.4
AGN Wagga	1999-2015	0.8	2.0	2.4	-0.4	-1.5	-1.1	-0.6	-1.8	-2.1
JGN	1999-2017	-0.9	3.2	1.1	2.1	-2.0	-4.0	0.0	-4.0	-2.0
ActewAGL	1999-2016	1.4	3.7	1.9	1.7	-0.5	-2.2	1.2	-1.0	0.7
ATCO WA	2000-2017	-0.6	3.4	1.6	1.8	-2.1	-3.9	-0.3	-4.2	-2.4
Pwrco NZ	2004-2017	-0.9	-0.1	0.8	-0.9	-1.7	-0.8	-1.0	-1.8	-2.7
Vector NZ	2005-2017	-4.3	-1.9	1.6	-3.4	-5.8	-2.5	-4.2	-6.6	-9.8
Average		-0.3	2.0	1.7	0.3	-1.9	-2.2	0.1	-2.1	-1.8

Company	Year/ Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	1999-2017	-0.4	-3.8	-3.9	2.9	-0.7	-0.7	-2.7	-2.0
AGN Vic	1999-2017	3.9	2.0	2.7	1.7	-0.1	0.6	0.7	-0.4
Multinet	1999-2017	4.0	2.8	2.9	0.1	-1.0	-1.0	-1.1	-0.9
AusNet	1999-2017	2.9	0.7	1.3	1.6	-0.6	0.0	-0.2	-1.2
AGN SA	1999-2017	7.8	4.9	5.7	3.2	0.4	1.1	0.4	-0.2
AGN Qld	2001-2016	3.6	3.7	4.1	1.5	1.6	2.0	3.5	2.2
Allgas Qld	2001-2016	4.5	1.5	1.6	3.7	0.8	0.8	1.9	1.5
AGN Wagga	1999-2015	2.1	0.9	0.5	2.6	1.4	1.0	0.6	0.0
JGN	1999-2017	2.4	-1.7	0.3	2.2	-1.9	0.1	-1.8	-2.5
ActewAGL	1999-2016	8.6	6.2	8.1	0.2	-2.0	-0.3	-1.0	-1.0
ATCO WA	2000-2017	5.6	1.5	3.4	2.3	-1.6	0.1	-2.0	-2.8
Pwrco NZ	2004-2017	6.3	5.4	6.6	-1.6	-2.4	-3.2	-1.9	-1.9
Vector NZ	2005-2017	8.4	6.4	3.5	-15.7	-17.8	-20.6	-1.3	-2.8
Average		4.6	2.3	2.8	0.4	-1.8	-1.5	0.2	0.5

Note: TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 dollars.

Table 2.3: Average annual indicator growth rate, latest 5 years

Company	Year/ Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	2013-2017	-3.4	1.6	1.6	0.0	-5.0	-4.9	4.0	-1.1	-1.2
AGN Vic	2013-2017	-1.2	2.2	1.3	0.9	-2.4	-3.3	0.8	-2.5	-1.7
Multinet	2013-2017	-0.7	0.8	0.2	0.6	-1.0	-1.5	-2.6	-4.1	-3.6
AusNet	2013-2017	-1.7	2.1	2.1	0.0	-3.7	-3.8	1.1	-2.7	-2.7
AGN SA	2013-2017	1.0	1.5	1.1	0.4	-0.1	-0.4	-0.6	-1.1	-0.7
AGN Qld	2012-2016	1.1	2.5	1.7	0.8	-0.6	-1.4	3.4	1.9	2.7
Allgas Qld	2012-2016	0.2	3.4	1.7	1.7	-1.5	-3.1	3.4	0.3	1.9
AGN Wagga	2011-2015	0.7	1.5	2.0	-0.5	-1.3	-0.8	0.8	0.0	-0.5
JGN	2013-2017	-1.0	3.1	1.4	1.7	-2.4	-4.1	2.0	-2.1	-0.5
ActewAGL	2012-2016	-2.2	3.1	2.1	0.9	-4.2	-5.1	4.5	-0.9	0.0
ATCO WA	2013-2017	-1.3	2.5	1.3	1.1	-2.6	-3.6	1.3	-2.3	-1.3
Pwrco NZ	2013-2017	-0.9	0.6	-0.8	1.4	0.0	-1.4	0.9	-0.6	0.9
Vector NZ	2013-2017	-8.3	-7.2	-1.4	-5.9	-7.0	-1.2	-2.4	-3.5	-9.3
Average		-1.4	1.4	1.1	0.2	-2.4	-2.7	1.3	-1.5	-1.2

Company	Year/ Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	2013-2017	3.4	-1.7	-1.8	7.9	5.8	2.5	-4.6	-3.3
AGN Vic	2013-2017	1.0	-2.3	-1.4	5.4	1.4	2.9	4.0	1.9
Multinet	2013-2017	10.9	9.2	9.8	1.4	-35.5	0.4	-1.1	-2.2
AusNet	2013-2017	2.3	-1.6	-1.5	3.8	-2.1	-0.1	-3.6	-3.4
AGN SA	2013-2017	11.7	11.2	11.6	3.7	0.0	3.7	1.4	0.6
AGN Qld	2012-2016	9.0	7.5	8.4	4.2	2.6	3.6	7.0	5.1
Allgas Qld	2012-2016	0.8	-2.3	-0.7	3.0	2.0	1.5	7.2	5.2
AGN Wagga	2011-2015	3.8	2.9	2.5	2.3	-0.2	1.0	5.0	3.7
JGN	2013-2017	0.9	-3.2	-1.5	3.7	-0.1	1.2	0.3	-0.4
ActewAGL	2012-2016	24.2	17.8	18.9	5.0	3.3	0.6	2.6	1.1
ATCO WA	2013-2017	18.4	14.1	15.3	5.8	2.8	3.1	-4.3	-3.7
Pwrco NZ	2013-2017	5.3	3.8	5.2	1.4	-0.2	1.4	-1.2	-1.0
Vector NZ	2013-2017	7.2	6.0	-0.3	-35.5	1.5	-40.1	-2.1	-2.5
Average		7.6	4.7	5.0	0.9	-1.5	-1.4	-3.3	-3.0

Note: TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 dollars.

Table 2.4: Market decomposition, Australian and New Zealand GDBs, average*

Company	Period	TJ Tariff V	TJ Tariff D	TJ Tariff V %	TJ/km Tariff V	TJ/km Tariff D	Cust. Tariff V	Cust. Tariff D	TJ/cust Tariff V	TJ/cust Tariff D
AGN Albury	2013-17	1,069	1,287	45.4	2.71	3.27	21,501	9	0.050	139.840
AGN Vic	2013-17	35,153	19,014	64.9	3.33	1.80	617,667	253	0.057	75.151
Multinet	2013-17	43,785	11,840	78.7	4.36	1.18	690,243	266	0.063	44.566
AusNet	2013-17	36,588	34,467	51.5	3.33	3.14	651,268	270	0.056	127.676
AGN SA	2013-17	10,182	11,821	46.3	1.27	1.47	428,544	128	0.024	92.385
AGN Qld	2012-16	2,082	3,973	34.4	0.82	1.56	92,027	73	0.023	54.428
Allgas Qld	2012-16	3,110	7,000	30.8	0.99	2.23	93,293	104	0.033	67.308
AGN Wagga	2011-15	928	681	57.7	1.28	0.94	19,539	15	0.048	45.376
JGN	2013-17	36,140	50,767	41.6	1.39	1.95	1,249,607	415	0.029	122.388
ActewAGL	2012-16	6,852	1,194	85.2	1.51	0.26	133,403	39	0.051	30.620
ATCO WA	2013-17	14,933	11,068	57.4	1.10	0.82	706,203	74	0.021	149.169
Pwrco NZ	2013-17	4,557	4,238	51.8	1.20	1.12	103,925	231	0.044	18.331
Vector NZ	2013-17	9,858	8,813	52.8	1.43	1.28	136,912	80	0.072	109.883
Average		15,787	12,782	55.3	2.03	1.64	380,318	151	0.044	82.856

Note: 'Tariff V' refers to volumetric customers (i.e. residential and small/medium commercial and industrial users); 'Tariff D refers to demand customers (i.e. large industrial users).

3 PARTIAL PERFORMANCE INDICATORS

The AER has said the following in relation to electricity distribution, which applies equally to gas distribution:

> *We consider that the most significant output of distributors is customer numbers. The number of customers on a distributor's network will drive the demand on that network. Also, the comparison of inputs per customer is an intuitive measure that reflects the relative efficiency of distributors (AER 2014, p.23).*

This section presents information on the inputs per customer of GDBs compared to their network customer densities. Information on GDB inputs per mains km are also compared to their customer densities. By expressing inputs in per customer or per km values and plotting them against customer density, we seek to control for differences in the size and customer densities of GDBs.

The inputs we present information on include real opex, real asset costs, and total costs (the sum of real opex and real asset costs). All of the input, output and customer density measures presented in this section are averages over the five-year period ending 2017, or the latest five years available. The partial performance indicators we present are:

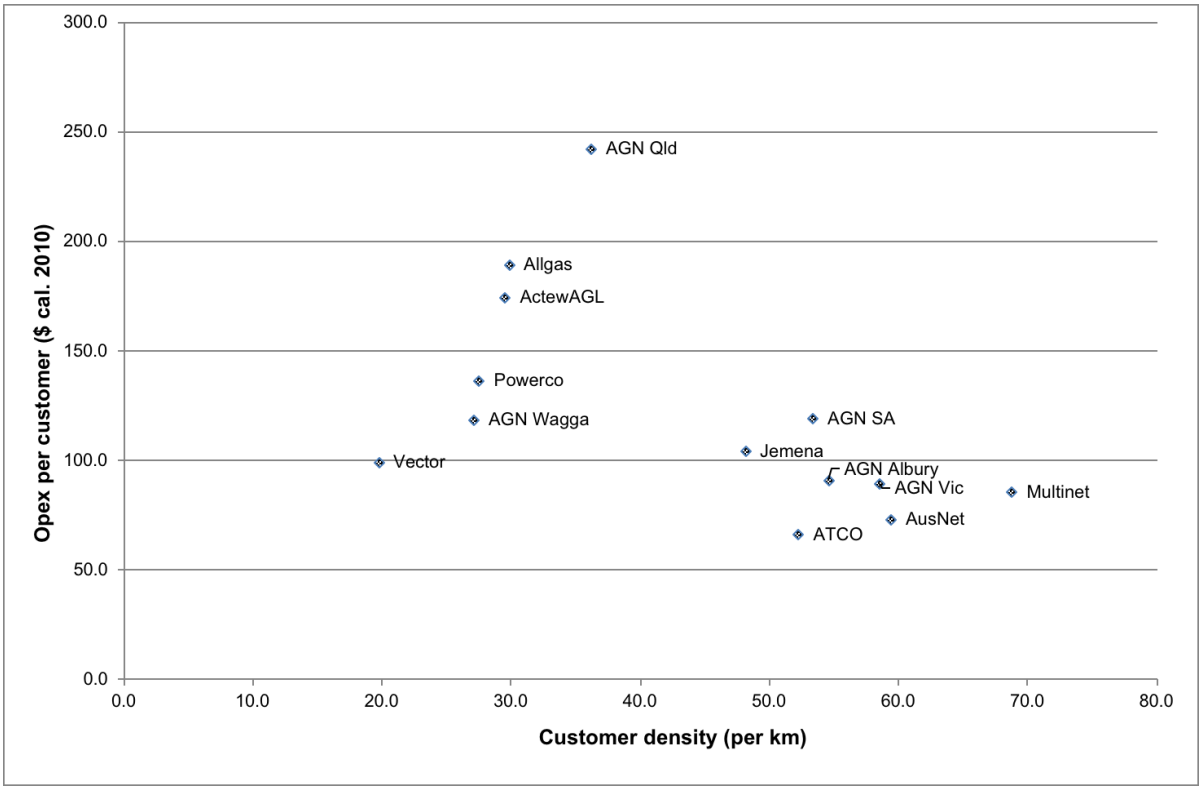
- Opex per customer relative to customer density (Figure 3.1)
- Opex per mains km relative to customer density (Figure 3.2)
- Asset cost per customer relative to customer density (Figure 3.3)
- Asset cost per mains km relative to customer density (Figure 3.4)
- Total cost per customer relative to customer density (Figure 3.5), and
- Total cost per mains km relative to customer density (Figure 3.6).

3.1 Opex per customer

Figure 3.1 plots real opex per customer (in $2010) against customer density. GDBs with lower customer density, such as Vector, Powerco, AGN Wagga, Allgas, ActewAGL and AGN Qld, usually have higher opex per customer (although with considerable variation). For example, opex per customer for AGN Qld, Allgas and ActewAGL averaged $242, $190 and $175 respectively for the latest five-year period (see Table 2.1). Opex per customer for Vector, AGN Wagga and Powerco was not as high, but overall, for the six GDBs with lowest customer density, the average opex per customer of was $160 for the latest five-year period.

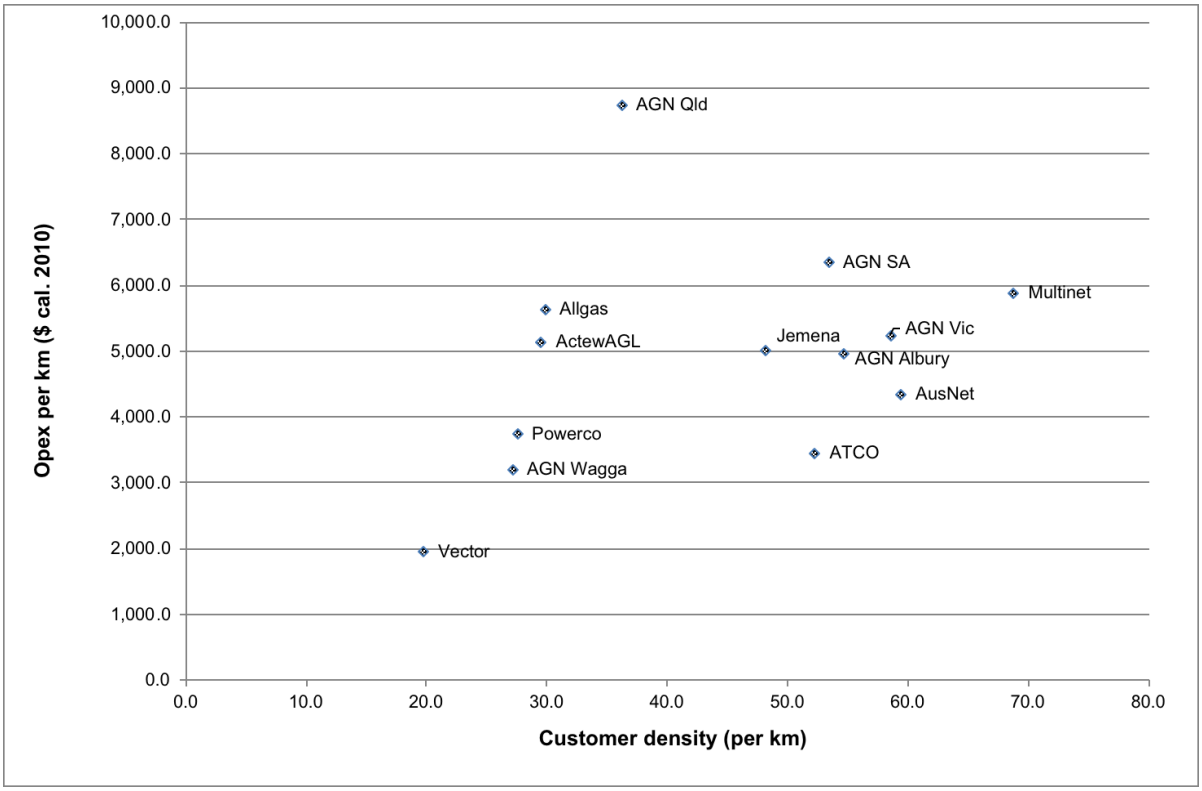
GDBs with higher customer density— such as Jemena, AGN SA, ATCO, AGN Vic, AusNet, Multinet and AGN Albury—tend to have lower opex per customer. For example, the average opex per customer of AGN Vic, Multinet and AusNet over the period 2013 to 2017 was $90, $86 and $73, respectively. Average opex per customer of Jemena and AGN SA over the latest five-year period was $104 and $119, respectively. ATCO's average opex per customer was relatively low compared to the other GDBs with higher customer density, averaging $66 over the period from 2013 to 2017. The average opex per customer of the seven GDBs with highest customer density was $90 over the latest five years.

Figure 3.1: Opex per customer relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database.

Figure 3.2: Opex per mains km relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database.

Figure 3.2 plots real opex per mains km against customer density. Among the seven GDBs with higher customer density, the average opex per km was $5041 over the five years to 2017. ATCO's opex per km was $3,457 over the same period, which is the lowest among the GDBs with higher customer density. There is very wide variation in opex per km among the GDBs with relatively low customer density. The average opex per km for the six GDBs with relatively low customer density was $4,747 over the last five years, which is slightly lower than for the GDBs with higher customer density. Although opex per km appears to increase with customer density, there is too much variation between the GDBs to be able to draw that conclusion.

ATCO's average opex per customer is below the average for GDBs with relatively high customer density and has the lowest opex per customer. Similarly, ATCO's average opex per km is again below the average for GDBs with relatively high customer density, and is the lowest for this group. These observations suggest that ATCO has among the highest opex efficiency of the GDBs in the sample (i.e. efficiency in the use of 'opex' or non-capital inputs). A comparison of this kind does not control for other drivers of opex costs that may be relevant, and only qualified conclusions can be drawn from it.

3.2 Capital assets cost per customer

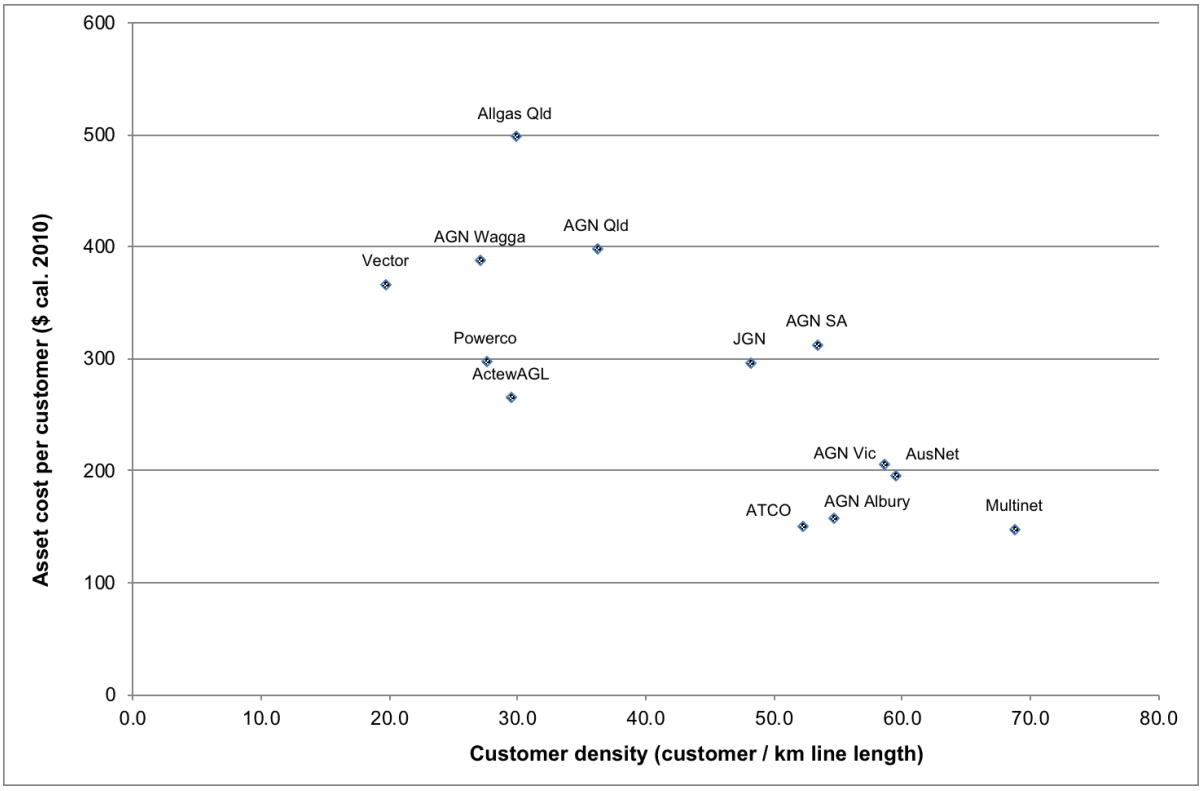
The efficiency of the use of capital inputs is indicated by asset cost per customer, which is based on actual returns to capital rather than a measure based on the opportunity cost of capital and depreciation cost, as used by the AER, because insufficient information is available from public sources to derive a measure based on the latter approach (AER 2013).

Figure 3.3 plots the average asset cost per customer (in $2010) against average customer density in the period 2013 to 2017, where asset cost is measured by the actual return to capital including depreciation. The chart shows that GDBs with lower customer density tend to have higher asset cost per customer than the GDBs with higher customer density. ATCO's asset cost per customer was $151 in this period. This can be compared to the asset costs per customer of the three Victorian GDBs, which were $149 for Multinet, $196 for AusNet and $206 for AGN Vic; and to AGN Albury, which was $158. The average asset costs per customer of Jemena and AGN SA were substantially higher at $298 and $313 respectively. The average asset cost per customer for the six GDBs with comparatively low customer density was $370 over the latest five-year period.

Table 3.4 shows average asset cost per km of mains for the period 2013 to 2017 for each GDB, plotted against customer density. There is no apparent relationship between assets cost per km and customer density. ATCO's average asset cost per km was $7,853 over the latest five years, which closely compares to several smaller or lower customer density GDBs such as Vector, Powerco, ActewAGL, AGN Albury and AGN Wagga. It is considerably lower than the asset costs per km of the larger GDBs in the sample such as Multinet ($10,211), AusNet ($11,619), AGN Vic ($12,088), Jemena ($14,301) and AGN SA ($14,436).

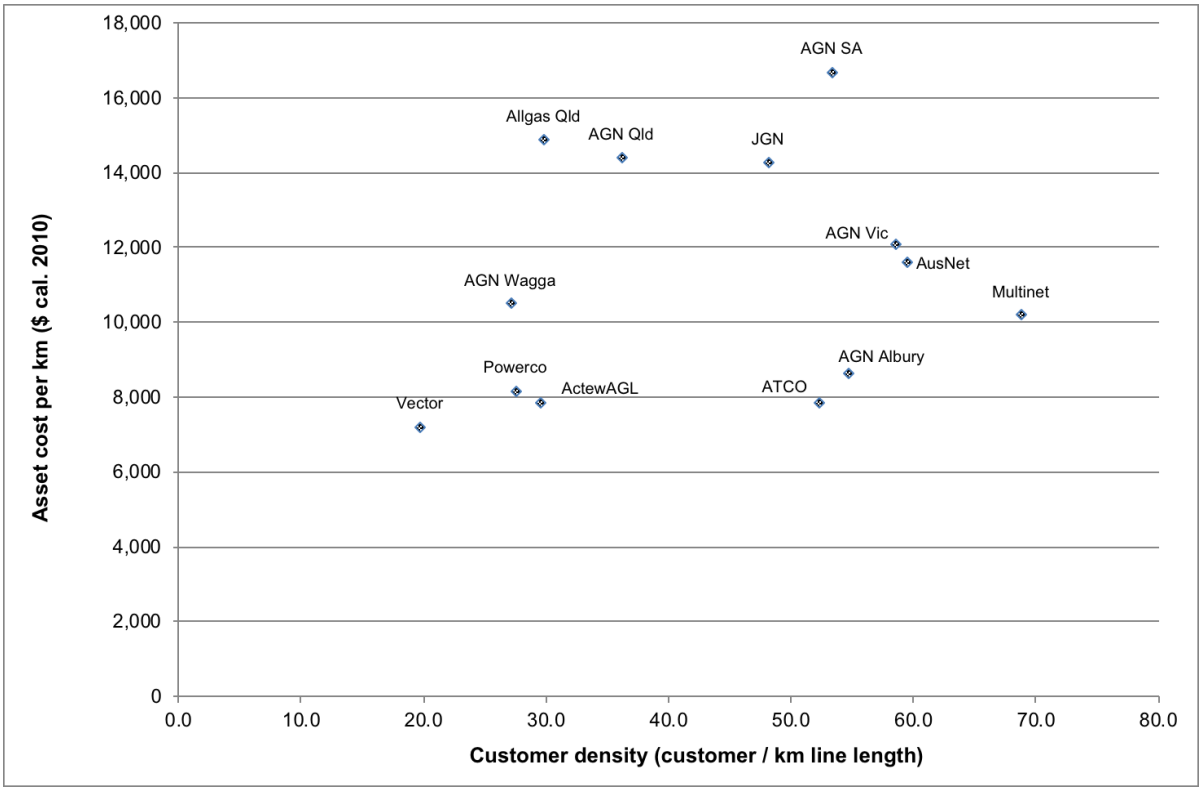
These comparisons are influenced among other things by asset age, original network asset valuations, and various factors not controlled-for which influence the quantity of assets per customer, and hence asset cost per customer. Thus, only qualified conclusions can be drawn from this chart. It suggests that ATCO is one of the most efficient GDBs in the sample in terms of asset use.

Figure 3.3: Asset cost per customer relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database. Asset cost is defined as real revenue minus real opex.

Figure 3.4: Asset cost per mains km relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database. Asset cost is defined as real revenue minus real opex.

3.3 Overall cost efficiency

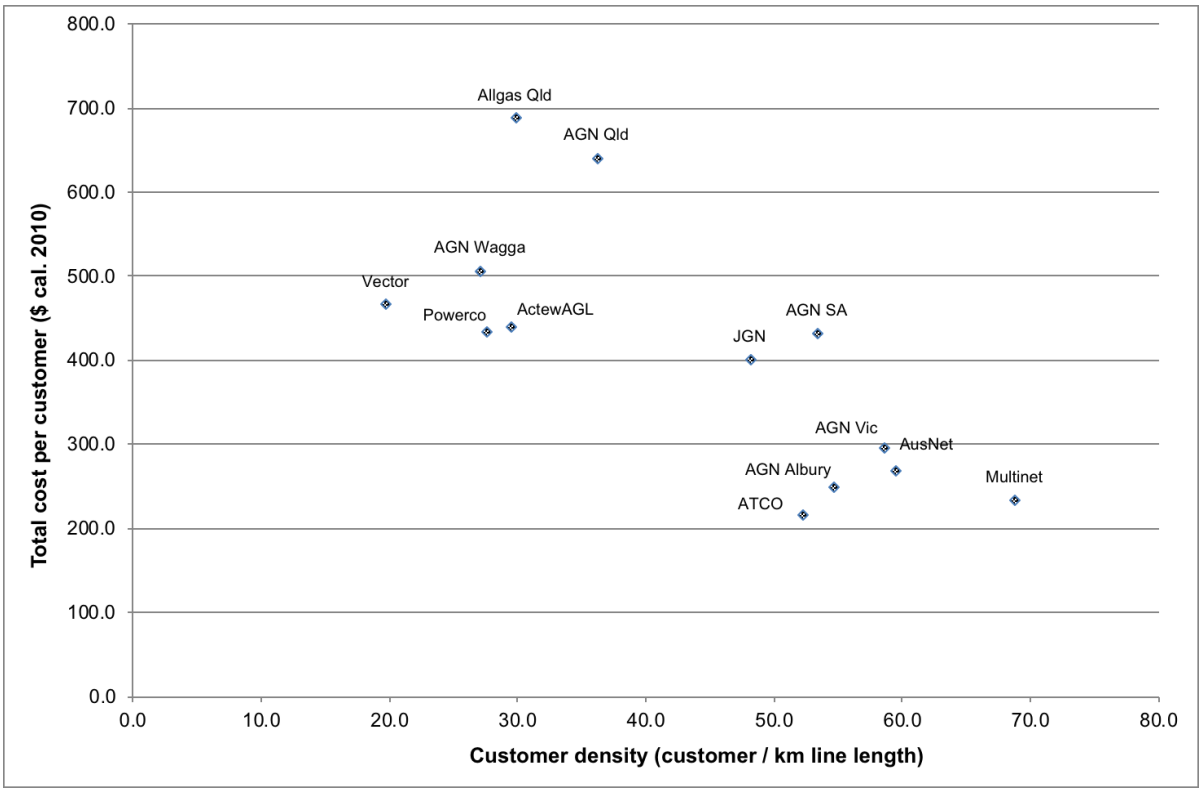
Figure 3.5 plots total cost per customer against customer density, where total cost is the sum of opex and asset cost shown in Figures 3.1 and 3.3 respectively. This chart shows the very clear relationship between cost per customer and customer density. The average cost per customer of ATCO in the period 2013 to 2017 ($217), was similar to, but lower than, several other GDBs that have relatively high customer density such as Multinet ($234), AGN Albury ($249), AusNet ($269) and AGN Vic ($296). The two remaining GDBs that have relatively high customer density, Jemena and AGN SA, had higher total costs per customer ($402 and $433 respectively). For the seven GDBs with higher customer density, the average total cost per customer was $300. ATCO's total cost per customer was well below this.

The total costs per customer were usually larger for the GDBs with lower customer density. These include Vector ($467), Powerco ($435), ActewAGL ($441), AGN Wagga ($507), AGN Queensland ($641) and Allgas ($689). Total cost per customer for this group of GDBs averaged $530 over the latest five-year period. ATCO's total cost per customer was the lowest in the sample.

Figure 3.6 shows total cost per km of mains plotted against customer density. Although total cost per km appears to increase slightly with customer density, there is considerable variation among the GDBs. Several low density GDBs have relatively low total cost per km including Vector ($9,190), Powerco ($11,945), ActewAGL ($13,002) and AGN Wagga ($13,734). Some GDBs with relatively high customer density have low total cost per km, including ATCO ($11,311) and AGN Albury ($13,617). The Victorian GDBs have intermediate levels of total cost per km (AusNet, $15,972; Multinet, $16,107; and AGN Vic, $17,334). Some of the low density GDBs such as Allgas and AGN Queensland, and some of the higher density GDBs such as Jemena and AGN SA, have relatively high total cost per km (Allgas, $20,547; AGN Qld, $23,193; Jemena, $19,311; and AGN SA, $23,074).

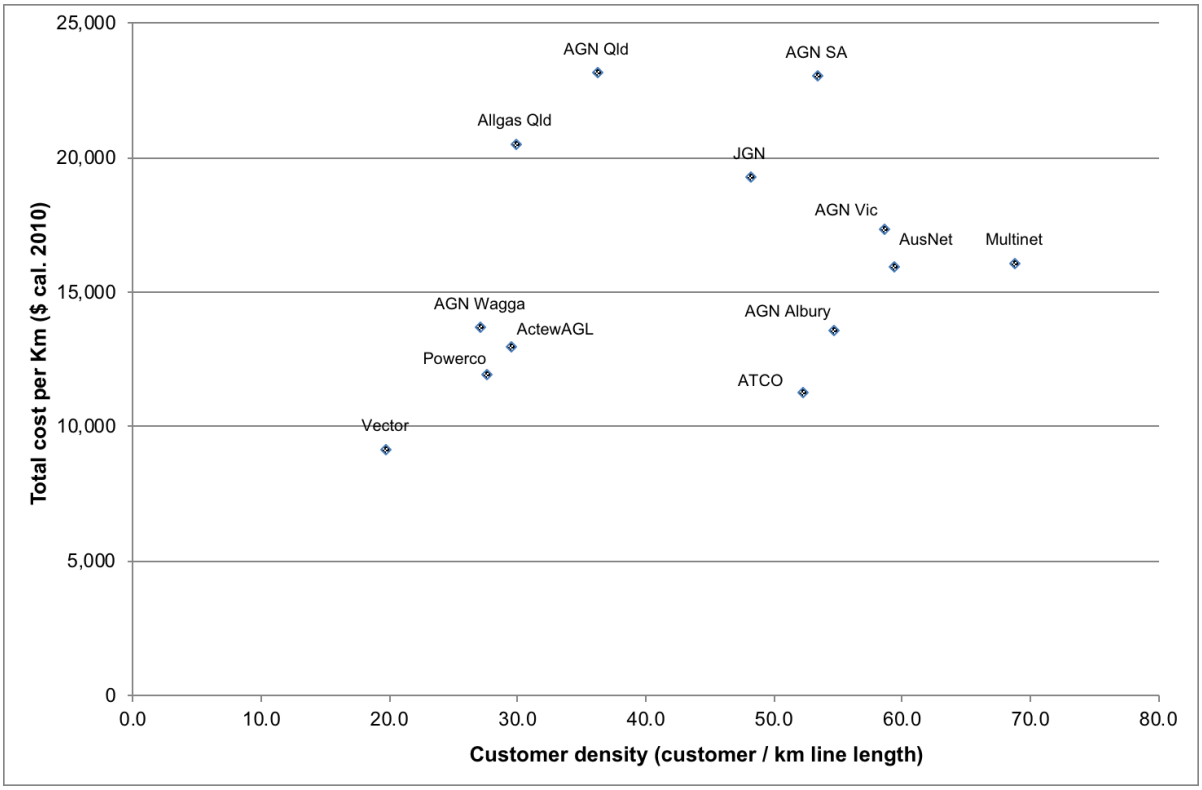
Once again, caution is needed in drawing strong conclusions for these comparisons alone. That said, the results tend to indicate that ATCO is one of the lowest cost and most efficient of the GDBs included in the sample.

Figure 3.5: Total cost per customer relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database

Figure 3.6: Total cost per mains km relative to customer density (avg. 2013–2017)



Source: Economic Insights gas utility database

3.4 Summary

ATCO's operating environment characteristics can be summarised as follows:

- After Jemena in NSW (the largest GDB in the sample), ATCO is the second largest in terms of customer numbers and network length, but is fifth largest in terms of gas deliveries. In terms of network length and customer size, ATCO is closely comparable in size to the Victorian GDBs, but in terms of gas deliveries it is more closely comparable in size to AGN SA.
- ATCO's customer density is similar to Jemena, AGN SA and AGN Albury. It somewhat lower than the three Victorian GDBs. The other GDBs in the sample, which tend to be smaller in size, also have lower customer densities.
- ATCO's energy density per customer is the lowest in the sample. In terms of energy density the most comparable GDBs are AGN SA, ActewAGL, AGN Qld and Jemena.
- ATCO has relatively low energy deliveries per km or 'network utilisation'. The GDBs with comparable levels of network utilisation are ActewAGL, AGN Wagga, Powerco, AGN Qld and Vector (after its relatively recent divestment).

ATCO's opex per customer is the lowest in the sample, and its asset cost per customer is amongst the lowest in the sample. ATCO's total cost per customer is the lowest in the sample. Comparisons of cost per customer suggest that ATCO compares well amongst its peers with higher customer density, and is amongst the most efficient of the GDBs in the sample.

The partial indicators analysis presented in this report does not enable influences such as scale economies or different mixes of inputs to be controlled for in a rigorous fashion. This means that care needs to be taken when drawing inferences. Based on these indicators and recognising the nature of their networks, ATCO has performed at better than average levels, achieving comparatively low levels of opex per customer, asset cost per customer and hence total cost per customer.

APPENDIX A: GAS DISTRIBUTION BUSINESSES INCLUDED IN THE STUDY

The database formed for the study includes 11 Australian GDBs and two New Zealand GDBs. A brief summary of the operations of the included GDBs follows.

Australian GDBs

ActewAGL, Australian Capital Territory

ActewAGL is the distribution business supplying gas and electricity in the Australian Capital Territory (ACT).[2] The total population of the ACT in 2017 was 413,000. Gas is distributed to a predominantly residential customer base with Canberra the largest market. Outside the ACT ActewAGL supplies gas to Queanbeyan and Bungendore in NSW. There are relatively few major industrial users in its supply area. Canberra covers a large geographical area and the majority of urban development is low density. Moreover, gas distribution in residential areas utilises a dual mains configuration with mains on both sides of a street, rather than a single sided system with longer across-road service connection. For these reasons, it is a low-density distribution network when measured in terms of customers per kilometre of main. In 2017 ActewAGL supplied 140,200 customers with 7,600 TJ of gas from a distribution network of around 4,700 kilometres of mains.

Allgas Energy Pty Ltd (Allgas), Queensland

Allgas is owned by Marubeni Corporation, SAS Trustee Corporation and the APA Group. It supplies gas to consumers in several areas in and around Brisbane and to several Queensland regional areas. The Allgas distribution system is separated into three operating regions. About 59 per cent of the network is located in Brisbane (south of the Brisbane river to the Albert River), 19 per cent in the Western region (including Toowoomba and Oakey) and the remaining 22 per cent on the South Coast (including the Gold Coast, and Tweed Heads in NSW).

Queensland's mild to hot climate means that residential and commercial heating demand is low. Residential demand for gas is mainly for hot water systems and cooking. In 2016 southeast Queensland's population was around 3.3 million. Approximately 70 per cent of Allgas' gas demand is from around 100 large demand class customers. In 2016 Allgas supplied approximately 99,600 customers with 10,300 TJ of gas from a distribution network of 3,200 kilometres of mains. From 2015-16, Allgas is no longer required to have an approved access arrangement, and instead the AER arbitrates any access disputes.

AGN Albury, NSW

Australian Gas Networks Limited (AGN) is, since 2017, part of the Australian Gas Infrastructure Group, owned by a consortium led by CK Infrastructure Holdings.

AGN Albury operates in the large regional centre on the border of NSW and Victoria often referred to as Albury–Wodonga. It operates on the North side of the Murray River in Albury and Ettamogah which in 2016 had a population of approximately 51,000. There is a small

[2] ActewAGL includes an energy retailing partnership and an energy distribution partnership. Only the latter is relevant to this study, which is owned jointly by Icon Water and Jemena Networks (ACT) Pty Ltd.

number of large industrial customers which represent over half of its gas deliveries. In 2017 AGN Albury supplied its 22,100 customers with around 2,200 TJ of gas from a distribution network of 400 kilometres of mains. Prior to 2017, AGN had separate approved access arrangements for AGN Albury and AGN Victoria, but these are now consolidated into a single approved access arrangement.

AGN Queensland, Queensland

AGN Queensland is an operating division of AGN, with a distribution network that supplies a Brisbane region (including Ipswich and suburbs north of the Brisbane river); and a Northern region (serving Rockhampton, Gladstone and Bundaberg). The network comprises approximately 2,600 kilometres of low, medium, high and transmission pressure mains. Assets used to service the Brisbane region comprise 88 per cent of the network with the balance of 12 per cent attributable to the Northern region.

AGN Queensland is subject to similar climatic influences on residential gas demand as Allgas. Customer numbers are similar to those for Allgas but gas volumes for customers included in this study are smaller. However, AGN has a number of industrial customers with very large volumes that are not reflected in the data used in this study. In 2016 there were approximately 96,600 customers consuming 6,100 TJ of gas. From 2015, AGN Queensland is no longer required to have an approved access arrangement, and instead the AER arbitrates any access disputes.

AGN SA, South Australia

AGN SA's distribution network services: greater Adelaide; to the north-east of Adelaide, the Barossa Valley, Riverland and Mildura in Victoria; to the north, Peterborough, Port Pirie and Whyalla; and in the east and south-east regions, Murray Bridge and Mt Gambier. Adelaide's population in 2016 was approximately 1.3 million. As with Melbourne, Adelaide's winter climate is conducive to relatively high residential gas demand for heating.

In 2017, AGN SA supplied 442,300 customers with 23,000 TJ of gas from a distribution network of 8,200 kilometres of mains. The Adelaide network makes up 93 per cent of the total network length.

AGN Victoria, Victoria

AGN Victoria serves parts of the greater Melbourne metropolitan area (population of 4.85 million in 2016) including the northern suburbs, the Mornington Peninsula and Pakenham/Cranbourne. AGN Victoria also supplies the north central Victorian area (including Seymour, Wodonga, Wangaratta, Shepparton-Mooropna and Echuca among others). It also supplies rural townships and cities in the Gippsland region (including Bunyip, Drouin, Warragul, Traralgon, Morwell and Sale among others), and a number of outlying towns in East Gippsland such as Bairnsdale and Paynesville (which are in the new Eastern Zone). The Distribution System is divided into four Zones – North, Central, Murray Valley and Eastern.

Melbourne's gas market is well established and cool to mild climatic conditions result in high residential gas consumption for heating, cooking and hot water systems. A relatively high concentration of industry also supports industrial gas demand provided that prices are competitive with other sources of energy supply. In 2017 there were 640,900 customers using 54,100 TJ of gas, supplied from a distribution network of 10,800 kilometres of mains.

AGN Wagga Wagga, NSW

AGN (formerly Envestra) took over gas supply from the NSW Government's Country Energy from October 2010. It supplies gas to the city of Wagga Wagga (estimated population of 48,300 in 2016) in southern regional NSW.

In 2015 there were approximately 20,100 customers. AGN supplied these customers with 1,600 TJ of gas from a distribution network of 750 kilometres of mains. In April 2014 the NSW Energy Minister, the Honourable Anthony Roberts, determined that coverage of the Wagga Wagga gas distribution network be revoked, and economic regulation of the network by the AER ceased at that time.

ATCO Gas Australia, Western Australia

ATCO acquired the network previously operated by WA Gas Networks (WAGN) in July 2011. ATCO Gas Australia is the principal GDB for Western Australian businesses and households. It operates the gas distribution system in the mid-west and south-west of Western Australia, including the greater Perth Metropolitan region (with a population of approximately 1.9 million in 2016), Busselton and Bunbury (together a population of 96,000), Geraldton, Kalgoorlie and the Albany region (each with a population of approximately 30,000). Each of these urban areas has a separate gas distribution network (Albany is supplied with reticulated LPG). In 2017, ATCO supplied approximately 738,100 customers with 25,300 TJ of gas from a distribution network of 13,800 kilometres of mains.

AusNet Services, Victoria

AusNet's Victorian gas distribution business was formerly TXU networks, which was formerly Westar (Assets) Pty Ltd, and is now part of AusNet Services, an ASX-listed business. The AusNet gas distribution business delivers gas to a number of urban centres across a geographically diverse region spanning the western half of Victoria, including the Western part of Melbourne, from the Hume highway in metropolitan Melbourne west to the South Australian border and from the southern coast to Horsham and just north of Bendigo. Its supply area includes the major Victorian regional centres of Geelong, Ballarat and Bendigo, and many other cities and towns in western Victoria. In 2017, AusNet supplied its 677,800 customers with 71,800 TJ of gas from a distribution network of 11,300 kilometres of mains.

Jemena Gas Network, NSW

Jemena Gas Network (JGN) was formed from the sale of Alinta Ltd in 2007, Alinta itself having acquired the gas assets of AGL Gas Networks (AGLGN) in 2006. It is now co-owned by State Grid Corporation of China and Singapore Power. The JGN network provides gas to customers in Sydney, Newcastle, Wollongong and the Central Coast, and over 20 country centres including those within the Central Tablelands, Central West, Southern Tablelands and Riverina regions of NSW. Jemena has the largest distribution network and customer base of the Australian GDBs. In 2017 it supplied 1,330,800 customers with 86,200 TJ of gas from a distribution network of 26,800 kilometres of mains.

Multinet Gas, Victoria

Multinet Gas is, since 2017, part of the Australian Gas Infrastructure Group, owned by a consortium led by CK Infrastructure Holdings, following that consortium's acquisition of the

DUET Group. The Multinet gas distribution system covers the eastern and south–eastern suburbs of Melbourne extending over an area of approximately 1,600 square kilometres as well as comparatively recent extensions of supply to townships in the Yarra Valley and South Gippsland. In 2017, Multinet supplied 697,300 customers with 54,800 TJ of gas from a distribution network of 10,100 kilometres of mains.

New Zealand GDBs

The New Zealand gas distribution industry is generally less mature than Victoria's with penetration rates still increasing relatively quickly, but comparatively low customer density at present.

Powerco Limited

Powerco is based in New Plymouth (population 56,000 in 2015) and distributes gas in the central and lower North Island regions. It is a dual gas and electricity network business. Powerco's gas networks in the central North Island region include the Taranaki (including New Plymouth), Manawatu and Horowhenua (including Palmerston North, population 83,500 in 2015), and Hawkes Bay networks (including Napier-Hastings, population 130,000 in 2015). In the lower North Island it supplies Wellington City (population of 203,000 in 2015), Hutt Valley (estimated population 141,000 in 2015) and Porirua (district population of 54,000 in 2015). Powerco acquired part of UnitedNetworks' gas operations in 2002 comprising the Hawkes Bay, Wellington, Horowhenua and Manawatu networks. In 2017, Powerco supplied 106,000 customers with 8,700 TJ of gas from a distribution network of 3,900 kilometres of mains.

Vector Ltd

Vector Ltd operates the gas distribution network in Auckland (estimated population of 1,418,000 including North Shore City, and the urban parts of Waitakere and Manukau cities). It is listed on the NZ Stock Exchange and is about 75 per cent owned by the Auckland Energy Consumer Trust. Vector acquired the remaining part of UnitedNetworks' gas operations in 2002 comprising its Auckland gas network and the National Gas Corporation's gas distribution business in 2004 and 2005. The Vector data from 2006 represent the combined operations of Vector and the former NGC Distribution. In November 2015 it sold its regional gas pipelines business via which it supplied a number of regional towns and cities in the North Island. In 2015, Vector supplied 105,900 gas distribution customers with 14,100 TJ of gas from a distribution network of 6,500 kilometres of mains.

APPENDIX B: DATABASE USED IN THE STUDY

The data used for most of the GDBs included in this study have been sourced from documents in the public domain and relate to the period 1999 to 2017. The public domain data sources used for the Australian GDBs include:

- Access Arrangement Information (AAI) filings as proposed and as amended by a regulator's decision
- Regulators' final decisions, sometimes with amendment following appeal, and
- Annual Reports from the GDB or its parent firm.

The public domain data source used for the NZ GDBs is the Information Disclosure Data filings required by the Gas (Information Disclosure) Regulations 1997. There are fewer consistent observations publicly available for the New Zealand GDBs, reflecting the impact of mergers, asset sales and industry restructuring.

Much of the data for ATCO and was sourced from a survey carried out by Economic Insights. Where public domain data was missing, some observations for AusNet, AGN Vic, Multinet, AGN SA and JGN were source from survey data obtained for this study and the accompanying study on total factor productivity (TFP). The detailed data surveys carried out for the major Australian GDBs followed a common format, covering key output and input value, price and quantity information over the period from 1998 or 1999 to the latest year available (usually 2017, but in some cases 2016).

Data used includes throughput, customer numbers, distribution pipeline length, opex, capex and regulatory asset value. In a few cases missing observations were estimated based on growth rates for the variable or a related variable before and after the missing year. In a number of cases adjustments were made to ensure the data related to comparable activities and measures (eg unaccounted for gas allowances for non-Victorian GDBs have been excluded to put those GDBs on a comparable basis with Victorian reporting).

The data used for the Australian GDBs cover only the regulated (or previously regulated) activities. Data relating to large industrial users whose supply is not regulated are not included. Inclusion of this data would require access to information not generally in the public domain and has been beyond the scope and timeframe of this study.

Despite the existence of the National Gas Law and Regulations and their predecessors, the amount of detail provided by both regulators and GDBs differs and data are typically not drawn together in the one location. The transfer of regulatory responsibilities from jurisdictional regulators to the Australian Energy Regulator (AER) also tended to fragment the historic data available. Some differences remain in the coverage of distribution activities across states although this is now more consistent than in earlier years. While every effort has been made to make the publicly available data used in this study as consistent as possible, the limitations of currently available public domain data need to be recognised.

The data derived from public sources relate to the time periods normally reported by each GDB, and some GDBs use calendar year reporting while others use financial year reporting, and sources varied in reporting data in nominal and real terms. All cost data were first converted to nominal terms (where necessary) using the All Groups Consumer Price Index in Australia and the equivalent in New Zealand. The nominal series were then converted to real

series in 2010 dollars using the same price indexes. The New Zealand data were then converted to Australian dollars using the OECD (2014) purchasing power parity for 2010. Purchasing power parities are the rates of currency conversion that eliminate differences in international price levels and are commonly used to make comparisons of real variables between countries. The use of 2010 as the deflator base year is consistent with previous similar Economic Insights studies (including Economic Insights 2012, 2015, 2016).

The measure of opex covers regulated distribution activities only and excludes all capital costs. It includes all non–capital costs allowed by the regulatory authorities, including directly employed labour costs, contracted services, materials and consumables, administration costs and overheads associated with operating and maintaining the distribution service. It excludes unaccounted for gas for all the GDBs as this is treated differently in Victoria compared to the other Australian States and excluding this item provides the best basis for like–with–like comparisons. In line with earlier studies, full retail contestability (FRC) costs are included as reported. All of the cost data are expressed in $A 2010 prices. The estimates of capital assets are based on depreciated asset values for regulatory purposes or those calculated using the same approach as used in regulatory accounts in $A 2010.

REFERENCES

Australian Energy Regulator (AER) 2013, 'Better Regulation: Expenditure Forecast Assessment Guideline for Electricity Distribution'.

Australian Energy Regulator (AER) 2014, 'Electricity distribution network service providers, Annual benchmarking report'.

Economic Insights 2009, 'Assessment of Data Currently Available to Support TFP-based Network Regulation', in *Report prepared by Denis Lawrence and John Kain for Australian Energy Market Commission*.

Economic Insights 2012, 'Benchmarking the Victorian Gas Distribution Businesses' Operating and Capital Costs Using Partial Productivity Indicators: report prepared for Envestra Victoria, Multinet and SP AusNet'.

Economic Insights 2015, 'Benchmarking Australian Gas Networks' South Australian Business Operating and Capital Costs Using Partial Indicators' (Report prepared for Australian Gas Networks Limited).

Economic Insights 2016, 'The Productivity Performance of Victorian Gas Distribution Businesses: report prepared for AusNet Services, Australian Gas Networks Limited and Multinet Gas'.

Organisation of Economic Cooperation and Development (OECD) 2014, *Economics: Key tables from OECD - Purchasing power parities for GDP*.