Asset beta and WACC percentile for New Zealand gas distribution businesses

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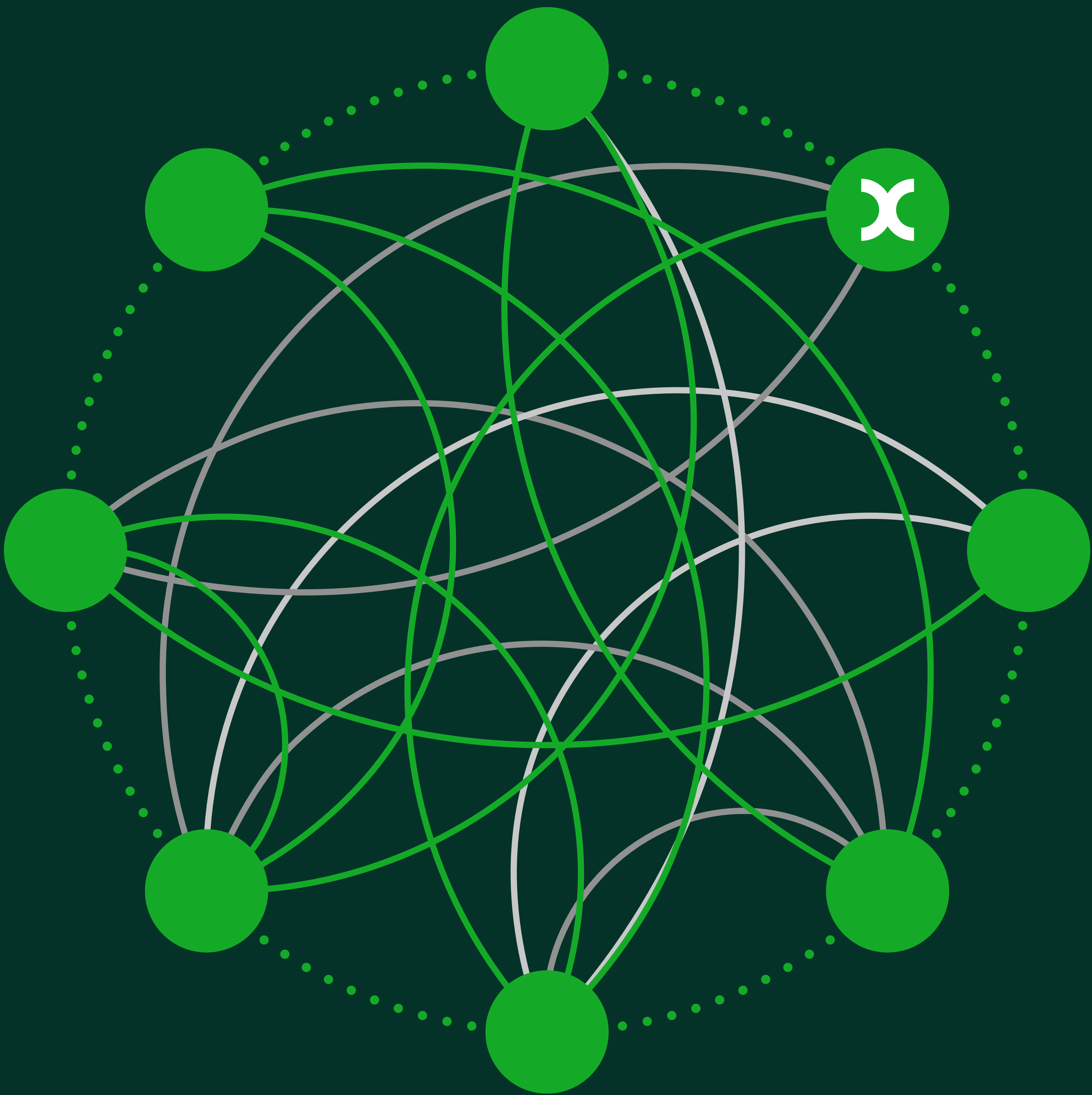
Prepared for Vector, Firstgas and Powerco

1 February 2023



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Executive summary

The New Zealand Commerce Commission (NZCC) has recently begun the process of reviewing the Input Methodologies (IMs), which were last reviewed in 2016.[1] As a first step in its assessment of the weighted average cost of capital (WACC), the NZCC has commissioned an economic consultancy CEPA to undertake a numerical update of the regulatory allowed asset beta estimate, as well as the assessment of the appropriateness of setting the WACC allowance at the 67th percentile, i.e. of 'aiming up'.[2]

On behalf of a group of New Zealand gas distribution businesses (GDBs)—including Vector, Firstgas and Powerco—in this report we review CEPA's analysis.

In the context of the energy transition and New Zealand's legislative commitment to achieving net zero by 2050, there is significant uncertainty about the pace and form of transition and about the level of future gas demand. Besides maintaining business-as-usual network activities, this thereby translates into an uncertainty about the timing, level and distribution of expenditure that will be required in relation to commissioning new assets (for repurposing gas pipelines and potentially connecting new customers) as well as decommissioning under-utilised assets (due to phasing out the use of natural gas). These uncertainties translate into additional risks that may require compensation via a higher asset beta allowance, to the extent that these risks are systematic, or aiming up on the overall WACC.

Asset beta for energy networks

By applying the same methodology to asset beta estimation as was used in the NZCC's 2016 decision, CEPA has estimated a regulatory allowed asset beta for energy networks of 0.35.[3] The NZCC is assessing separately whether any adjustments to this estimate are required due to the differences in systematic risks of New Zealand and comparator networks.

As a result of our assessment of the energy networks comparator sample, we have identified six companies that we exclude from CEPA's 2022 sample due to insufficient representation of utility network activities in their businesses and the insufficient liquidity of their stock.

Consistent with the NZCC's methodology, but based on our updated comparator sample, the table below shows the daily, weekly and four-

[1] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, https://comcom.govt.nz/__data/assets/pdf_file/0021/60537/Input-methodologies-review-decisions-Topic-paper-4-Cost-of-capital-issues-20-December-2016.pdf (accessed on 13 January 2023).
[2] CEPA (2022), 'Review of Cost of Capital 2022/2023', 29 November, p. 13, https://comcom.govt.nz/__data/assets/pdf_file/0014/301082/CEPA-report-on-Commerce-Commission-IM-Review-Cost-of-Capital-29-November-2022.pdf (accessed on 13 January 2023).
[3] Ibid., p. 14.

weekly asset beta estimates for the two most recent five-year periods of 2012–17 and 2017–22.

Oxera asset beta estimates for the overall energy sample

Specification	2012–17	2017–22
Daily asset beta	0.38	0.42
Weekly asset beta	0.33	0.39
Four-weekly asset beta	0.29	0.35
Number of companies in the sample	47	48

Note: The 2012–17 figures exclude Evergy Inc (EVGR) due to insufficient data. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

Typically, we would place weight on two- or five-year betas estimated based on the most recent available data. We would also use only daily betas, having filtered the sample of comparators for liquidity of their stock. Based on the estimates above, that would suggest a central asset beta of 0.42 (daily asset beta for 2017–22).

However, it is also important to consider regulatory stability. We observe that the NZCC places weight on the two most recent five-year periods (in this case, 2012–17 and 2017–22) and weekly and four-weekly estimates which are reported in the table above.

Given the benefits of using more frequent and recent data that is representative of current market conditions and given that the NZCC's concerns about stock illiquidity reducing the reliability of daily estimates is addressed by our multiple liquidity filtering checks, we include daily beta estimates in the assessment. This approach, i.e. the average of daily, weekly and four-weekly estimates over the 2012–17 and 2017–22 periods suggests an asset beta estimate of **0.36**, which is below the latest daily beta estimate of 0.42.

With the average leverage ratio of **40%**, based on our updated sample (compared with CEPA's 39%),[4] the re-levered equity beta corresponding to the asset beta of 0.36 would be **0.60** (compared with CEPA's 0.57).[5]

Upward adjustment for GDBs' asset beta

In 2016, the NZCC also set a 0.05 upward adjustment for gas pipelines' asset beta. In relation to this, CEPA noted that it found that the asset beta for gas comparators was greater than that for electricity, but that this difference was not statistically significant.

In line with the NZCC's approach, we assess the required adjustment for GDBs-specific risks by looking at the empirical and theoretical evidence.

- We find the empirical evidence to be mixed, as it was in the previous NZCC IM reviews: the gas subsample asset betas are above those

[4] Ibid., p. 4.
[5] Ibid., p. 4.

for electricity for the 2012–17 period and for daily asset betas in 2017–22. The difference, however, is not statistically significant.
- In terms of the theoretical evidence, the NZCC's 2016 decision to provide an uplift was based primarily on the high income elasticity of demand for gas and low penetration of gas connections in New Zealand, with the latter amplifying the growth and asset stranding risk. Although we have not undertaken a revised analysis of elasticities, it is reasonable to expect that this finding would persist, as these are characteristics of the industry. Moreover, we expect asset stranding risk to have increased with New Zealand's net zero commitment.

On balance, we conclude that, in the New Zealand context, given the high elasticity of demand and relatively low penetration rates of the network, as well as the use of price caps (rather than revenue caps) for GDBs, it remains reasonable to expect higher systematic risk than for the electricity networks, and therefore maintain an uplift on the gas asset beta.

WACC percentile

With regard to the WACC percentile, CEPA found that regulatory precedent had moved away from aiming up and towards aiming straight.[6] One of the reasons for this was that regulators have made increasing use of alternative performance-based regulatory tools that either reward networks for maintaining certain reliability standards, or require them to do so.[7]

CEPA found that the importance of network reliability had increased since the previous IM review, which would tend to provide more support for aiming up. However, CEPA also considered that the evidence on the impacts of underinvestment on network reliability could be overstated,[8] which would reduce the strength of the evidence for aiming up.

We have reviewed CEPA's report and conclude that, while it is true that some regulatory precedent has shifted towards aiming straight, a number of regulators continue to aim up. Some of these, such as the French regulator CRE, were not included in CEPA's report. Academic research by Romeijnders and Mulder, which also supports aiming up, has also been published since our 2014 report,[9] when the original aiming up methodology was developed. Furthermore, as those regulators that now aim straight do not formally adopt a network reliability framework to determine which percentile of the WACC distribution should be targeted, as the NZCC does, there may be limited read-across from the decisions that they make to those of the NZCC.

[6] Ibid., section 1 and section 4.8.
[7] Ibid., p. 27.
[8] Ibid., p. 39.
[9] Romeijnders, W. and Mulder, M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107. Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', https://www.oxera.com/wp-content/uploads/2018/07/Oxera-review-of-the-75th-percentile-approach.PDF.pdf (accessed on 24 January 2023).

While we agree that other performance-based regulatory tools can be used to mitigate underinvestment risk (i.e. to maintain reliability), New Zealand has chosen to use a WACC uplift to do so and therefore any move away from this and towards an alternative mechanism could introduce regulatory risk. Furthermore, there does not appear to be a clear case for changing the way in which gas (or electricity) network reliability is incentivised in New Zealand (i.e. even if regulatory risk were not a factor) because the WACC uplift does not seem to be causing excess profits based on NZCC analysis of the last seven years.[10]

We agree with CEPA that the evidence from the NZCC's network reliability framework supports aiming up, and find that CEPA's update to our 2014 analysis would support aiming up for the 80th percentile. However, we disagree with CEPA that the evidence used to generate the benefits of aiming up is likely to be overstated. This is because:

- other evidence on the costs of network failures could suggest higher costs than those assumed by CEPA;
- the annual costs of network failures that CEPA has updated could be difficult to reverse;
- if other elements of regulation, such as an asset beta uplift or accelerated depreciation, do not compensate gas networks for the additional risks associated with stranded assets in full, a WACC uplift or aiming up in the range could be applied to compensate for this;
- related to the point above, if the NZCC were also to consider (i.e. in addition to the network reliability framework) the impact that underinvestment may have on delaying the energy transition, the loss function considered by the NZCC would become more asymmetric, justifying greater aiming up on the WACC.

As we explained in our 2014 report, regulatory stability is valuable. We therefore consider that, taken together, the above arguments support the case for continuing to aim up for the 67th percentile of the WACC.

[10] Commerce Commission (2022), 'Part 4 Input Methodologies Review 2023 – Process and Issues paper', May, p. 61, https://comcom.govt.nz/__data/assets/pdf_file/0031/283864/Part-4-Input-Methodologies-Review-2023-Process-and-Issues-paper-20-May-2022.pdf (accessed on 24 January 2023).

1 Introduction

1.1 The New Zealand Commerce Commission (NZCC) has recently begun the process of reviewing the Input Methodologies (IMs), which were last reviewed in 2016.[11] The weighted average cost of capital (WACC) for energy networks is one of the topics on the NZCC's agenda and, as a first step, the NZCC has commissioned an economic consultancy CEPA to undertake a numerical update of the asset beta and leverage estimates, as well as an assessment of the appropriateness of the 67th WACC percentile—in both cases following the NZCC's methodology.[12]

1.2 On behalf of a group of New Zealand gas distribution businesses (GDBs)—Vector, Firstgas and Powerco—in this report we review CEPA's analysis, suggest improvements to the NZCC's approach to the estimation of the allowed asset beta, and consider whether it is still appropriate to set the allowance at the 67th percentile of the WACC range.

1.3 Our review is guided by the NZCC's economic principles from the **Decision Making Framework**.[13] These relate to:

- ex ante real financial capital maintenance (FCM);
- allocation of risk (between consumers and networks);
- the asymmetric consequences of over-/underinvestment.

1.4 The NZCC explains that these principles require regulated companies to be provided with an appropriate ex ante cost of capital allowance and can guide the decision of whether adjustments might be required to the regulatory WACC:[14]

> The FCM principle is that regulated suppliers should have the ex-ante expectation of earning their risk-adjusted cost of capital (ie, a 'normal return'),[…]
>
> In the context of the IMs, the principle of asymmetric consequences of over- /under-investment is relevant mainly to our [NZCC's] decision on whether an adjustment might be

[11] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, https://comcom.govt.nz/__data/assets/pdf_file/0021/60537/Input-methodologies-review-decisions-Topic-paper-4-Cost-of-capital-issues-20-December-2016.pdf (accessed on 13 January 2023).
[12] CEPA (2022), 'Review of Cost of Capital 2022/2023', 29 November, p. 13, https://comcom.govt.nz/__data/assets/pdf_file/0014/301082/CEPA-report-on-Commerce-Commission-IM-Review-Cost-of-Capital-29-November-2022.pdf (accessed on 13 January 2023).
[13] Commerce Commission (2022), 'Part 4 Input Methodologies Review 2023. Framework paper', 13 October, para. 4.2, https://comcom.govt.nz/__data/assets/pdf_file/0034/294793/Input-methodologies-2023-Decision-Making-Framework-paper-12-October-2022.pdf (accessed on 20 January 2023).
[14] Ibid., paras 4.7 and 4.23.

required when calculating the regulatory WACC to protect consumers from the risk of under-investment.

1.5 The context in which the NZCC is undertaking the IMs review is of critical importance. In 2021, New Zealand legally committed to achieving **net zero by 2050**, relying on the businesses to support this commitment.[15] While formalising the target and developing plans for the pathway, the commitment crystallises risks to energy networks. In particular, natural gas supply is likely to be gradually phased out by 2050, meaning that gas pipeline businesses (GPBs) will face asset obsolescence and as a consequence, asset stranding if they suffer a financial loss. It is thereby uncertain whether GPBs will be able to fully recover their investments and how expenditure will need to be redistributed to match the pace of the obsolescence. Moreover, GPBs are expected to invest in infrastructure that is capable of handling renewable gases, although the exact needs of the market are for the companies to identify.[16] Finally, the NZCC itself highlights a political risk of government intervention in setting regulatory price paths, given the circumstances of the transition to a low-carbon economy.[17]

1.6 In addition to the energy transition developments, since the NZCC's previous review of the IMs in 2016 the **COVID-19 pandemic** has had a significant impact on financial markets and businesses. Of particular relevance to the cost of capital assessment is the fact that a change in traded equity betas has been observed across the markets, as is explored further in the main body of this report.[18]

1.7 Another contextual matter that is critical to the assessment of asset betas is the GDBs' **regulatory regime**, which defines the risks to which regulated utility networks are exposed.

1.8 GPBs and electricity networks in New Zealand are subject to both price and revenue caps. Historically, both gas and electricity distribution have been subject to a price cap, with a view to providing incentives to suppliers to grow the network, whereas transmission has been subject to a revenue cap. However, since the 2016 IMs review, only gas distribution has been subject to a price cap.[19] In other words, for gas distribution, growth in volumes is dependent on encouraging

[15] New Zealand Ministry of Business, Innovation and Employment (2022), 'Gas Transition Plan', https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/gas-transition-plan/ (accessed on 24 January 2023).
[16] For example, First Gas intends to transition its network to hydrogen in full by 2050. See Firstgas (2021), 'Firstgas Group announces plan to decarbonise gas pipeline network in New Zealand', 29 March, https://firstgas.co.nz/firstgas-group-announces-plan-to-decarbonise-gas-pipeline-network-in-new-zealand-3/ (accessed on 25 January).
[17] Commerce Commission (2022), op. cit., para. 4.31.
[18] For example, see Figure 2.3 in section 2.
[19] Commerce Commission (2016), 'Input methodologies review decisions. Topic paper 1: Form of control and RAB indexation for EDBs, GPBs and Transpower', 20 December, para. X3.

existing customers to increase their gas consumption and, more critically, on increasing the number of connections.

1.9 In this context, in the rest of the report we assess the following points.

- In section 2, we discuss the process of setting the asset beta for energy networks in general.
- In section 3, we consider the reasons why an upward adjustment is required for GDBs on top of the asset beta estimate for energy networks.
- In section 4, we discuss the merits of keeping the 67th WACC percentile for GDBs in this IMs review.
- In section 5, we provide high-level comments on other WACC parameters that the NZCC may seek to consider as part of its forthcoming IM review.

2 Asset beta for energy networks

2.1 In this section, we assess the NZCC's methodology to setting a regulatory allowed asset beta for energy networks. We start from the NZCC's 2016 methodology and CEPA's 2022 update in section 2.1 before moving on to Oxera's suggested improvements to the estimation methodology in section 2.2. We summarise our assessment in section 2.3.

2.2 We assess the question of the uplift for GPBs in a separate section (section 3).

2.1 The NZCC's 2016 approach and conclusions, and CEPA's 2022 update

2.3 We start by outlining the NZCC's 2016 methodology and conclusions, before looking at CEPA's 2022 update.

2.1.2 The NZCC's approach and conclusions

2.4 In its Input methodology review decision published in December 2016, the NZCC set the asset beta for GPBs and electricity networks following a six-step approach, as set out in Figure 2.1.

Figure 2.1 Six-step process for estimating beta

Step 1
Identify a sample of comparator companies

Step 2
Estimate the equity beta for each firm in the sample

Step 3
De-lever each equity beta estimate to get an estimated asset beta for each firm in the sample (assuming a debt beta of zero)

Step 4
Calculate an average asset beta for the sample

Step 5
Apply any adjustments for regulatory differences or differences in systematic risk across services to the average asset beta for the sample

Step 6
Re-lever the average asset beta for the sample to an equity beta estimate using the NZCC's assumed notional leverage

Source: Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, pp. 60–61.

2.5 The NZCC looked at a sample of electricity and gas utilities from New Zealand, Australia, the UK and the USA. The international comparators were added to the sample due to the small number of comparable companies in New Zealand.

2.6 The approach that the NZCC used for sample selection is summarised in Box 2.1.

Box 2.1 The NZCC's approach to identify comparators

Identification of relevant companies

To find relevant comparator companies, the NZCC used Industry Classification Benchmarks (ICBs), as reported in the Bloomberg Industry Classification System. The NZCC's view was that there were not enough pure-play electricity and gas line comparators available. Therefore, it included the following four industries in its sample based on the ICB classifications: Electricity, Gas Distribution, Pipelines, and Multi-utilities.[1]

Filtering criteria

To filter the resulting sample of companies, the NZCC used three criteria—i.e. that the company should have at least five years of trading data; a market value of equity greater than US$100m; and shares being traded every day.[2] The last two criteria were intended to exclude illiquid firms from the sample.

Company description check

The NZCC assessed the nature of each business in the sample using 'Segment Analysis' information from Bloomberg, and excluded any that were deemed not to be sufficiently comparable.

Note: [1] The ICBs define Multi-utilities as 'utility companies with significant presence in more than one utility'. [2] The 'shares being traded' measure indicates the number of days in a year on which at least one share of the company was traded. A small proportion of days traded, relative to the total number of trading days in a year, indicates that the shares are thinly traded and the company's stock is likely to be illiquid.
Source: Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, pp. 62–65.

2.7 The comparators selection process resulted in a sample of 70 companies for the 2006–11 estimation window and 72 companies for 2011–16.

2.8 Based on the selected sample of comparators, the NZCC estimated the average of the weekly and four-weekly asset betas in the two most recent five-year periods (2006–11 and 2011–16).[20] This resulted in a 0.35 asset beta estimate set for electricity networks. Table 2.1 summarises NZCC's findings on the overall energy sample.

Table 2.1 Summary of NZCC's asset beta estimates for the overall energy sample

Specification	2006–11	2011–16
Daily asset beta	0.40	0.39
Weekly asset beta	**0.38**	**0.36**
Four-weekly asset beta	**0.35**	**0.30**
Number of companies in the sample	70	72

[20] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, paras 297–298.

Note: The NZCC's final estimate was 0.35—the average of the figures highlighted in bold.
Source: Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, p. 69.

2.9 As per the GPBs, the NZCC applied an upward adjustment of 0.05 to the asset beta of 0.35 'to reflect the greater exposure to systematic risk faced by gas pipelines'.[21]

2.1.3 CEPA's 2022 update

2.10 CEPA has been 'requested by the Commission to replicate the methodology applied in 2016 but updated for new data'.[22]

2.11 In its report, CEPA notes that the same process of comparator selection as the NZCC applied in 2016 will create a different set of comparators in 2022, mainly because of companies being delisted, comparators now having sufficient data for estimation (when they previously did not), and changing characteristics of the comparators themselves.[23]

2.12 In the updated sample, CEPA removes 22 companies because they have been delisted and two companies because it considers these to have a low percentage of regulated revenues.[24] At the same time, CEPA has identified six new companies as relevant and added them to the sample.[25]

2.13 The resulting sample considered by CEPA comprises 54 companies. Table A2.1 in appendix A2 shows the list.

2.14 Table 2.2 summarises CEPA's asset beta estimates.

Table 2.2 Summary of CEPA's asset beta estimates for the overall energy sample

Specification	2007–12	2012–17	2017–22
Daily asset beta	0.38	0.38	0.42
Weekly asset beta	0.36	**0.34**	**0.40**
Four-weekly asset beta	0.33	**0.30**	**0.37**
Number of companies in the sample	51	53	54

Note: CEPA's final estimate is 0.35—the average of the figures highlighted in bold.
Source: CEPA (2022), op. cit., p. 13.

2.15 By applying the same methodology as used in the NZCC's 2016 decision, CEPA has found an asset beta of 0.35 for electricity networks.[26] CEPA also notes that '[i]f the same 0.05 upward

[21] Ibid., para. 455.
[22] CEPA (2022), op. cit., p. 4.
[23] Ibid., p. 4.
[24] UGI Corp (UGI US) and APA Group (APA AU). See CEPA (2022), op. cit., p. 9.
[25] Alaska Power and Telephone Co. (APTL US) and Mount Carmel Public Utilities Co. (MCBP US) were first added by CEPA to the sample and then subsequently dropped for having a low percentage of days traded. See CEPA (2022), op. cit., p. 8.
[26] CEPA (2022), op. cit., p. 14.

adjustment to gas were applied this again results in exactly the same value for gas namely 0.40'.[27]

2.2 Oxera's review of the NZCC's 2016 approach and CEPA's 2022 analysis

2.16 We have reviewed the following aspects of the NZCC's 2016 methodology and CEPA's 2022 analysis:

- the process of comparator selection—covered in section 2.2.1;
- the frequency of observations for beta estimates—covered in section 2.2.2;
- the time period on which to draw conclusions—covered in section 2.2.3.

2.17 Below, we suggest some minor modifications to the approach and estimate the asset beta, leverage ratio and re-levered equity beta if those modifications are applied.[28]

2.2.1 Comparator selection

2.18 Based on the NZCC's three elements of the comparator sample selection process (which comprised identifying companies via Bloomberg screening,[29] applying filtering criteria, and checking companies' descriptions), we have proposed alternative filtering criteria and cross-checked whether companies in the sample undertake energy network activities.[30]

Comparators' business activities: cross-checks

2.19 As a result of the qualitative review of business activities, we have removed three companies from CEPA's sample: ONEOK Inc. ('ONEOK'), Centrica Plc ('Centrica'), and Scottish and Southern Energy plc ('SSE') because we did not find the nature of their operations sufficiently comparable to those of New Zealand GDBs. Table 2.3 provides the details.

Table 2.3 Comparators excluded from the sample due to the nature of business activities

Company	Oxera assessment
ONEOK	ONEOK is a USA-based company, engaged in the provision of midstream services. The company reports operations in: i) natural gas gathering and processing; ii) natural gas liquids; and iii) natural gas pipelines.[1] In 2021, the natural gas pipelines segment, which has regulated and non-regulated operations, accounted only for 3% of revenue and 16% of earnings before interest, taxes, depreciation and amortisation (EBITDA).[2] Thus, we exclude ONEOK from the sample.

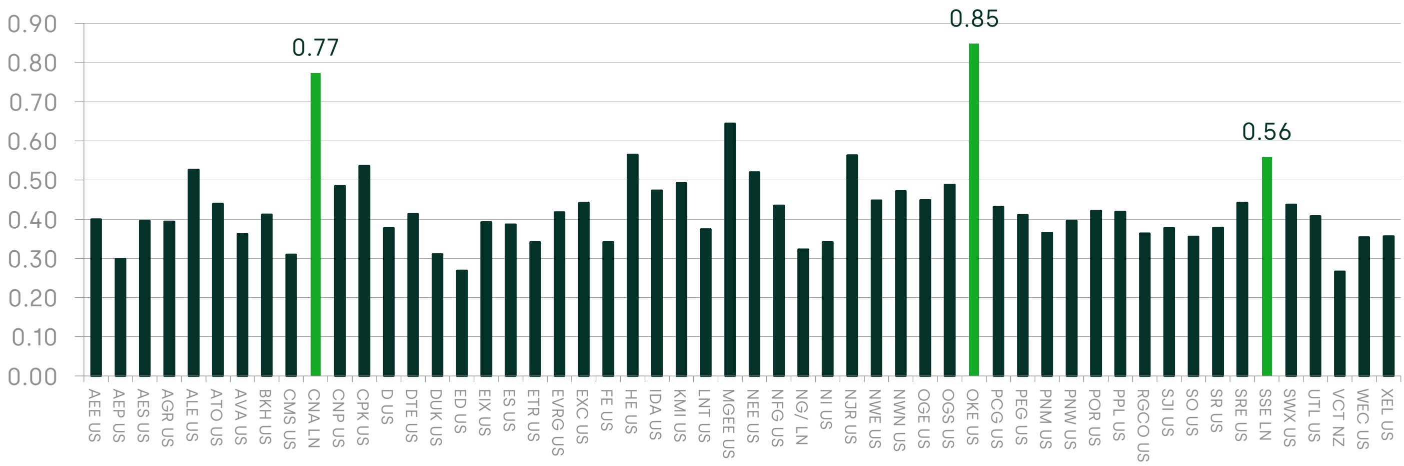
[27] Ibid., p. 14.
[28] Our calculations are based on the NZCC's 8 July 2016 'Asset beta spreadsheet' after correcting for the errors in the asset beta spreadsheet mentioned in NZCC's decision published in December 2016. Moreover, to compute returns we used (P2 – P1)/P1 instead of the revised formula that the NZCC reported, i.e. (P2 – P1)/P2. See Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, para. 292.
[29] We have not reproduced the Bloomberg screening, i.e. we have not checked that it was comprehensive and that CEPA identified all the companies that were potentially relevant for the analysis.
[30] For those companies for which the Bloomberg description was not sufficiently clear, we further investigated their relevance through desktop research, including an analysis of companies' websites, annual reports, and/or online articles.

Company	Oxera assessment
Centrica	Centrica is a UK-based integrated energy business, organised along six business segments, including electricity and gas supply, trading and optimisation activities and an oil and gas business.[3] We exclude this company as it does not have any network activities.[4]
SSE	SSE is an integrated UK-based company engaged in electricity generation, transmission and distribution. According to its 2022 Annual Report, SSE's regulated network transmission and distribution businesses accounted for c. 10% of total revenues while over 80% SSE's revenues were from non-regulated activities.[5] Therefore, we exclude SSE from the sample. Excluding SSE would be consistent with the UK precedent, where the regulator did not put weight on SSE beta in setting a regulatory allowance for energy networks and the UK Competition and Markets Authority (CMA) did not find that to be wrong.[6]

Note: [4] The company's revenues come primarily from its retail activities (accounting for c. 55% of total revenues in 2021) and its trading and optimisation activities (c. 32% in 2021). 'Retail activities' refers to 'British Gas Services & Solutions', 'British Gas Energy', and 'Bord Gáis Energy'. Trading and optimisation activities refer to 'Energy Marketing & Trading'. See Centrica (2022), op. cit., p. 16. [5] Non-regulated revenues are split as follows: Energy Portfolio Management (EPM): c. 38% of total revenues; energy customer solutions: c. 24%; gas storage: c. 15%; SSE thermal: c. 7%; and SSE Renewables: c. 5%. See SSE (2022), 'SSE Plc Annual Report 2022', pp. 224–228, https://www.sse.com/media/blhnuywb/sse-full-annual-report.pdf (accessed on 16 January 2023).
Source: [1] Securities and Exchange Commission (2022), 'Annual Report on Form 10-K of ONEOK', pp. 8–15, https://otp.tools.investis.com/clients/us/oneok_inc2/SEC/sec-show.aspx?FilingId=15621391&Cik=0001039684&Type=PDF&hasPdf=1 (accessed on 16 January 2023). [2] Securities and Exchange Commission (2022), op. cit., p. 97. [3] Centrica (2022), 'Annual Report and Accounts 2021', p. 13, https://www.centrica.com/media/5531/centrica-annual-report-and-accounts-2021.pdf (accessed on 16 January 2023). [6] Competition and Markets Authority (2021), 'Final determination: Volume 2A: Joined Grounds: Cost of equity', 28 October, paras 5.411–5.416, https://assets.publishing.service.gov.uk/media/617fe5468fa8f52980d93209/ELMA_Final_Determination_Vol_2A_publication.pdf (accessed on 17 January 2023).

2.20 The exclusion of these companies is also consistent with their asset betas as compared with the rest of the sample (see Figure 2.2): Centrica and ONEOK record the highest daily asset betas in the sample (0.77 and 0.85 respectively), while SSE's beta (0.56) is well above the sample median (0.41).

Figure 2.2 Daily five-year 2017–22 asset betas



Note: The cut-off date is 30 September 2022 so as to be consistent with the CEPA analysis. The chart shows all companies included in CEPA's 2022 sample.
Source: Oxera's calculations based on the 2016 NZCC Excel model.

Filtering criteria

2.21 As mentioned above, the NZCC (and CEPA) uses the following filtering criteria:

- availability of at least five years of trading data;
- a market value of equity greater than US$100m;
- shares being traded every day.

2.22 The first criterion ensures that sufficient trading data is available to estimate five-year asset betas—we agree with this criterion and make no modifications to it.

2.23 The other two criteria are related to the liquidity of the comparators' shares—if the shares' trading volumes or frequencies are low, i.e. if they are illiquid, returns may not reflect the risks of the company accurately and market betas may be distorted. To assess the comparators' liquidity, we complement the NZCC's liquidity filters mentioned above with the following three metrics.

1. **Average bid–ask spread.** The bid–ask spread is a widely accepted measure of liquidity that indicates how easy it is to buy and sell an asset at a fair price. It is the difference between the lowest price at which an asset is offered for sale in a market and the highest price that is offered for the purchase of the asset. The lower the bid–ask spread, the more liquid the security. A narrow bid–ask spread implies that an individual can buy and sell the underlying asset at similar prices.[31]
2. **Average share turnover.** The share turnover percentage captures the value of the actively traded shares relative to the market capitalisation of each firm. The higher this percentage, the greater the trade among market participants, and therefore the more liquid the stock is likely to be.
3. **Percentage of zero return days.** This measure indicates the percentage of trading days on which the stock price did not change from the previous day. A high proportion of zero return days would indicate that the shares are thinly traded and the company is likely to be illiquid.[32] This metric targets the same characteristic of the shares as the NZCC's requirement for the shares to be traded every day but is more comprehensive. In particular, the data shows that there are days which are counted as traded but on which the share price does not change—we consider it more appropriate to take account of those days as non-traded.

[31] The NZCC accepted that this metric was informative, but did not apply it in its own analysis due to data concerns in an unrelated sector (airports). See Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, footnote 178.

[32] The percentage of zero return days is in line with the use of the percentage of days traded, which in 2016 led the NZCC to exclude Jersey Electricity from the sample. See Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, para. 284.1.

2.24 Typically, we also assess the **average percentage of free-float shares.** The free float of a company is the proportion of shares that can be publicly traded. A small proportion of shares floated would create an impediment to active trading—for example, it would make it more difficult for an investor to exit a long position. Stocks with a low percentage of free-float shares could therefore be considered less liquid. In its 2016 IM review decision, the NZCC considered this metric to be of limited value, commenting that the sufficient monetary value matters most and therefore using its US$100m traded shares threshold.[33] We have therefore cross-checked that no additional companies would be considered illiquid if this metric were applied in addition to the ones listed above. However, we do not elaborate on this analysis in the section below.

2.25 We do not have objectively defined thresholds for these liquidity metrics. However, outliers typically depart from the rest of the sample significantly. Therefore, we focus on excluding outliers.

2.26 In addition to the liquidity filters described above, we apply an **equity beta filter** to test the robustness of the analysis. In particular, we exclude companies with raw equity betas that are below the NZCC's assumed debt beta of zero.[34] Indeed, in theory, an equity beta cannot be below a debt beta, as equity is at least as risky as debt. Therefore, an equity beta below a debt beta cannot be a robust estimate and must be affected by the quality of the data used to estimate it. In practice, as we show below, this filter only confirms the results of the liquidity filters.

2.27 Table 2.4 summarises the results of our filtering process and compares them with the NZCC's/CEPA's results. In summary, we exclude the three companies that NZCC or CEPA excluded from their samples due to the low liquidity of their stocks—these are Jersey Electricity (JEL), Alaska Power and Telephone Co. (APTL) and Mount Carmel Public Utilities Co. (MCPB).[35] Furthermore, we exclude three more companies that, according to our analysis, are not liquid either: RGC Resources (RGCO), Vector Limited (VCT), and Avangrid (AGR).

2.28 We acknowledge the value of information contained in the beta of Vector, given that it is the only New Zealand company in the sample. Therefore, although the liquidity analysis indicates that Vector can be screened out of the sample, we refer to the Vector beta in our analysis, as a check on the results.

[33] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, para. 285.1.
[34] Ibid., p. 119.
[35] Jersey Electricity (JEL) was excluded by the NZCC from the sample due to a low percentage of days traded in 2016. See Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, p. 64. Alaska Power and Telephone Co. (APTL) and Mount Carmel Public Utilities Co. (MCBP) were first added by CEPA to the sample and then subsequently dropped for having a low percent of days traded. See CEPA (2022), op. cit., p. 8.

Table 2.4 Summary of Oxera filtering results for the 2017–22 data

Company	NZCC/CEPA assessment summary[1]	Bid–ask spread	Average share turnover	Percentage of zero return days	Equity beta filter	Oxera assessment summary
Jersey Electricity (JEL)	×	×	×	×	Abnormally low daily raw equity beta but above zero	×
Alaska Power and Telephone Co. (APTL)	×	×	×	×	Abnormally low daily raw equity beta but above zero	×
Mount Carmel Public Utilities Co. (MCPB)	×	–	No data	×	×	×
RGC Resources (RGCO)	–	×	–	–	Abnormally low four-weekly raw equity beta but above zero	×
Vector Limited (VCT)	–	–	×	13% higher than the next highest percentage of zero return days	–	×[2]
Avangrid (AGR)	–	–	×	–	–	×

Note: × indicates that the company is excluded from the sample. [2] Vector is screened out of the sample but we have still estimated the beta of Vector and refer to it as a sense-check on our results, given that it is the only listed energy network company in New Zealand.
Source: Oxera analysis. [1] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, p. 222. CEPA (2022), op. cit., p. 8.

2.29 Our final sample consists of 48 companies, which are listed in Table A2.1 in Appendix A2.

2.2.2 Frequency and estimation accuracy

2.30 In its 2016 decision, the NZCC determined its allowed asset beta based exclusively on weekly and four-weekly data.[36] The NZCC acknowledges the trade-off between using more and less frequent data to estimate betas:[37]

- daily betas could be distorted by stocks' illiquidity;
- weekly and four-weekly betas are based on fewer observations and therefore lead to lower statistical significance of the results.

2.31 The NZCC also summarises Oxera's 2016 submission on this topic where we explained that it would be reasonable to put

[36] The NZCC's past approach in the 2010 IMs decision was almost the same as in the 2016 decision—in 2010, the NZCC used weekly and monthly rather than weekly and four-weekly observations. See Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, para. 307.
[37] Ibid., para. 306.

weight on daily betas alongside weekly and four-weekly betas.[38] In short, we acknowledged the trade-off but did not consider that putting zero weight on daily betas was appropriate, as they provide useful information when only relatively liquid stocks are included in the sample. In this context, we note that we have already filtered illiquid companies out of the sample in this report, such that it is reasonable to rely on the daily beta estimates.

2.32 The NZCC's grounds for putting zero weight on daily betas were threefold:

- 'averaging weekly and four-weekly betas across all possible reference days significantly reduces any concerns about a lack of observations for weekly and monthly estimates';[39]
- a study of evidence from Australia, Germany and the UK concludes that '[…]longer frequency betas have superior characteristics for regulatory purposes in these countries[…]' '[implying] that low frequency beta estimates should always be preferred to high frequency beta estimates';[40]
- in the past, NZCC's approach was to focus on weekly and monthly/four-weekly estimates.

2.33 The UK regulatory precedent is informative in considering these points. The UK CMA recently used the same approach as the NZCC, where daily observations were averaged over a week to avoid the 'reference day bias' and form the basis for weekly beta estimates. However, the UK CMA still put weight on all daily, weekly and monthly estimates.[41] Indeed, when averaging daily returns to form weekly and four-weekly observations, the NZCC loses the data granularity to observe intra-week and intra-month co-movements of share price and index returns.

2.34 Despite the study referenced by the NZCC, many major regulatory institutions in the UK relied on daily betas after the study was published: as mentioned above, the UK CMA recently relied on the mix of daily, weekly and monthly evidence;[42] the energy regulator Ofgem uses exclusively daily betas;[43] and the UK consortium of regulators (the UK regulators network, UKRN)

[38] Ibid., para. 304.
[39] Ibid., p. 71.
[40] Gregory, A., Hua, S. and Rajesh, T. (2015), 'In search of beta', April, https://centaur.reading.ac.uk/75035/1/In%20search%20of%20beta%20Final%20oct_2017.pdf (accessed on 17 January 2023). Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, p. 71.
[41] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations. Final report', 17 March, para. 9.465, https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf (accessed on 17 January 2023).
[42] Ibid.
[43] Ofgem (2019), 'Decision - RIIO-2 Sector Specific Methodology Decision – Finance', 24 May, p. 152, https://www.ofgem.gov.uk/sites/default/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_finance.pdf#page=152 (accessed on 17 January 2023).

also recently recommended daily betas in its cost of capital consultation.[44]

2.35 We also agree with the NZCC that the consistency of approaches over time is a valid factor in decision-making, but the NZCC may take into account concerns about consistent underfunding of the networks: daily estimates were higher than weekly and four-weekly estimates in 2016 and are higher than weekly and four-weekly estimates now.[45]

2.36 We have also looked at the average standard errors of individual comparators' beta estimates to see whether the statistical robustness of the daily beta estimates differs considerably from lower-frequency estimates. Table 2.5 shows that, in the two most recent five-year periods (2012–17 and 2017–22), daily asset betas on average had lower standard errors than the weekly and four-weekly asset betas, supporting the argument that higher frequency tends to lead to greater statistical accuracy.

Table 2.5 Average standard errors of individual comparators' five-year asset betas

Specification	2012–17	2017–22
For daily asset betas	0.019	0.019
For weekly asset betas	0.053	0.044
For four-weekly asset betas	0.120	0.083

Note: Based on the Oxera updated energy sample after applying liquidity and equity beta filters. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

2.37 Table 2.6 presents the standard errors of the energy sample asset betas (rather than standard errors of individual comparators' asset betas), estimated based on the NZCC's methodology.[46] This shows that, for the second-most recent five-year period (2012–17), the daily asset betas had slightly lower standard errors than the weekly betas but higher standard errors than the four-weekly betas, while these standard error estimates have converged for daily, weekly and four-weekly analyses in the 2017–22 period.

Table 2.6 Standard errors of five-year asset betas for the energy sample

Specification	2012–17	2017–22
For daily asset betas	0.104	0.076
For weekly asset betas	0.115	0.077

[44] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation', https://ukrn.org.uk/publications/ukrn-guidance-for-regulators-on-the-methodology-for-setting-the-cost-of-capital-consultation/ (accessed on 17 January 2023).
[45] For the 2016 results, see Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, p. 308. For the Oxera 2023 results, see Table 2.7. CEPA's daily estimates are also higher than its weekly and four-weekly estimates—see CEPA (2022), op. cit., p. 13.
[46] Commerce Commission (2010), 'Input methodologies (electricity distribution and gas pipeline services) Reasons paper', 22 December, para. H11.19; Lally, M. (2008), 'The weighted average cost of capital for gas pipeline businesses', 28 October, Appendix 3.

Specification	2012–17	2017–22
For four-weekly asset betas	0.078	0.075

Note: Based on the Oxera updated energy sample after applying liquidity and equity beta filters. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

2.38 The analysis presented above supports the conclusion that it is reasonable to include daily beta estimates in the assessment, especially after liquidity tests have already been applied to address the NZCC's concern about potential stock illiquidity.

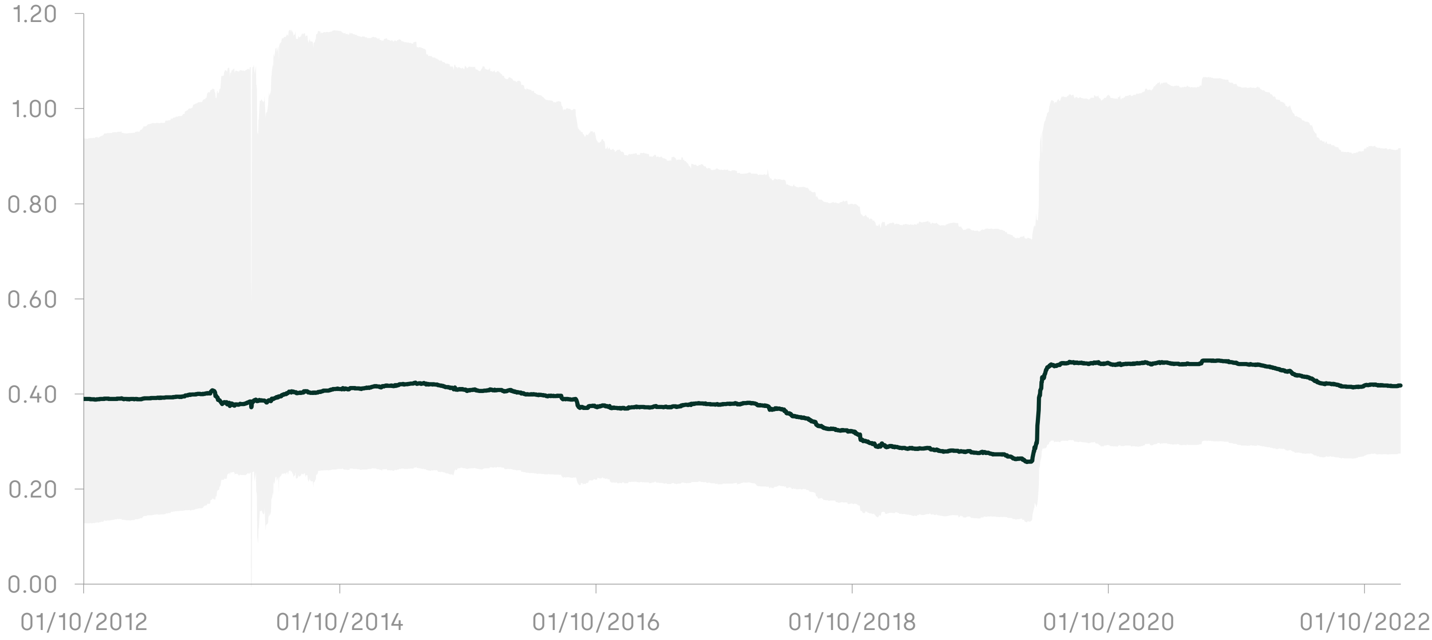
2.2.3 Time period

2.39 The NZCC, in its 2016 IMs review decision, and CEPA in its 2022 update, considered the two most recent five-year periods for setting the allowed asset beta (i.e. 2006–11 and 2011–16 for the NZCC, and 2012–17 and 2017–22 for CEPA).

2.40 We have plotted the evolution of five-year asset betas to see how they have changed over the last ten years. Figure 2.3 shows that betas surged at the start of the COVID-19 pandemic in early 2020 and are still at the pandemic level, suggesting a market re-pricing at times of volatility—the impact of the pandemic on energy networks may have been greater than the pre-pandemic market suggested. This movement in observed betas implies that taking an average of the latest two five-year periods risks underestimating the allowed asset beta, according to the latest market evidence.

2.41 We note also that the significant change in beta estimates is consistent with CEPA's findings (see Table 2.2 above for a comparison of the 2012–17 and 2017–22 estimates).

Figure 2.3 Five-year rolling daily asset betas (2012–22): whole energy sample



Note: The grey area shows the range of betas in the sample. Based on the Oxera updated energy sample after applying liquidity and equity beta filters.
Source: Oxera based on data from Bloomberg.

2.3 Results of Oxera's recommended asset beta for the energy sample

2.42 Table 2.7, Table 2.8 and Table 2.9 show the average five-year asset beta, leverage ratio and re-levered equity beta estimates for the Oxera sample of 48 comparator companies for the 2012–17 and 2017–22 periods. The sample excludes six companies from CEPA's 2022 sample due to insufficient representation of utility network activities in their businesses and the insufficient liquidity of their stock.

Table 2.7 Oxera asset beta estimates for the overall energy sample

Specification	2012–17	2017–22
Daily asset beta	0.38	0.42
Weekly asset beta	0.33	0.39
Four-weekly asset beta	0.29	0.35
Number of companies in the sample	47	48

Note: The 2012–17 figures exclude EVGR due to insufficient data. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

Table 2.8 Oxera leverage ratio estimates for the overall energy sample

Specification	2012–17	2017–22
Average leverage ratio	39.0%	40.1%

Note: The 2012–17 figure excludes EVGR due to insufficient data. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.

Source: Oxera based on data from Bloomberg.

Table 2.9 Oxera re-levered equity beta estimates for the overall energy sample

Specification	2012–17	2017–22
Daily re-levered equity beta	0.62	0.70
Weekly re-levered equity beta	0.54	0.65
Four-weekly re-levered equity beta	0.48	0.59

Note: The 2012–17 figures exclude EVGR due to insufficient data. The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

2.43 We are showing evidence on five-year betas over a ten year period in the tables above, in line with the NZCC methodology, however, typically, we would place weight on relatively more recent evidence, e.g. two- or five-year betas estimated based on the most recent available data. We would also use only daily betas, having filtered the sample of comparators for liquidity of their stock. Based on the estimates above, that would suggest a central asset beta of 0.42 (daily asset beta for 2017–22).

2.44 However, we also consider regulatory stability to be important. We observe that the NZCC places weight on the two most recent five-year periods (in this case, 2012–17 and 2017–22) and weekly and four-weekly estimates, which with our sample would result in an asset beta of 0.34.

2.45 Given the benefits of using more frequent data as representative of current market conditions, and given that the corresponding concerns about stock illiquidity reducing the reliability of these estimates is already addressed in our analysis by multiple filtering checks on liquidity, we consider that it would be appropriate for the NZCC to include daily asset beta estimates in the assessment. This approach would suggest an asset beta estimate of 0.36, which is below the latest daily beta estimate of 0.42.

2.46 With the average leverage ratio of **40%** (compared with CEPA's 39%),[47] the re-levered equity beta corresponding to the asset beta of 0.36 would be **0.60** (compared with CEPA's 0.57).[48]

2.47 We have separately estimated the asset beta for Vector, which was screened out of the sample but is the only listed energy network company in New Zealand and therefore presents a datapoint of interest. Table 2.10 shows that asset beta estimates for Vector are lower than the average estimates for the energy sample. This observation is consistent with the

[47] CEPA (2022), op. cit., p. 4.
[48] Ibid., p. 4.

finding that Vector's stock is relatively illiquid—betas of illiquid stocks tend to be biased downwards.[49]

Table 2.10 Asset beta estimates for Vector

Specification	2012–17	2017–22
Daily asset beta	0.30	0.27
Weekly asset beta	0.28	0.27
Four-weekly asset beta	0.27	0.29

Note: The cut-off dates are 30 September 2017 and 30 September 2022 so as to be consistent with the CEPA analysis.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

[49] It is well documented in the academic literature that thin-trading creates a downward bias in beta estimates. See, for example, an overview of the models correcting for the downward bias in McLelland, D.E., Auret, C.J. and Wright, T.K. (2014), 'Thin-Trading and Beta Estimation: Results from a Simulated Environment', *Studies in Economics and Econometrics*, **38**:2, pp. 19–32.

3 Adjustment to the asset beta for risks specific to New Zealand GDBs

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3.1 The adjustment to the asset beta for risks specific to New Zealand GDBs corresponds to Step 5 in the NZCC's beta estimation framework (see Figure 2.1 in section 2.1).

3.2 In the 2016 and 2010 IM reviews, the NZCC provided a GPBs-specific uplift to the asset beta estimated for all energy networks. In the 2010 IMs review, the uplift was 0.1.[50] The NZCC reports that there was significant theoretical support for the uplift due to potentially higher risks of GPBs relative to other energy networks in New Zealand.[51] However, the NZCC also mentions that, at that time, empirically, the gas networks' asset beta was assessed to be lower than that of electricity networks.[52]

3.3 In 2016, the NZCC set a lower 0.05 uplift for GPBs. The NZCC states that the main reasons for continuing to provide an uplift were a higher income elasticity of demand in gas than in electricity and a lower penetration of gas connections among New Zealand households than in the other countries in the comparator sample. Empirically, gas network asset betas were above those of electricity networks for the two latest five-year periods, i.e. for 2006–11 and 2011–16, but the difference was not statistically significant.[53]

3.4 Below, we discuss the statistical significance of the difference between gas and electricity asset betas and the weight to put on it, as well as the theoretical reasons supporting the need for a GPBs uplift.

3.1 Statistical significance of the difference between gas and electricity network asset betas

3.5 Although the NZCC assessed whether the difference between gas and electricity networks' asset betas was statistically significant, the regulator did not appear to put much weight on the results of this assessment: in 2010, it observed that gas betas were lower, while in 2016 gas betas were higher, but the difference was not statistically significant.

3.6 In Table 3.1 below, we present confidence intervals for asset betas of gas and electricity subsamples. We observe that, in 2012–17, gas network betas were above those of electricity, as were daily betas in 2017–22. Note, for example, that the daily beta estimates in 2017–22 for the gas businesses are 0.05 higher than those the electricity businesses and all energy businesses on average—this differential is consistent with the current allowed 0.05 gas uplift. Figure 3.1 shows the evolution

[50] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, para. 349.
[51] Ibid., paras 347–349.
[52] Ibid., para. 348.2.
[53] Ibid., para. 378 and figures 7–9.

of daily betas and that the differential between gas and electricity used to be even wider than it is now.

3.7 However, weekly and four-weekly betas of 2017–22 were almost the same for gas and electricity, and none of the differences mentioned above are statistically significant due to the standard errors of beta estimates implying a wide confidence interval.

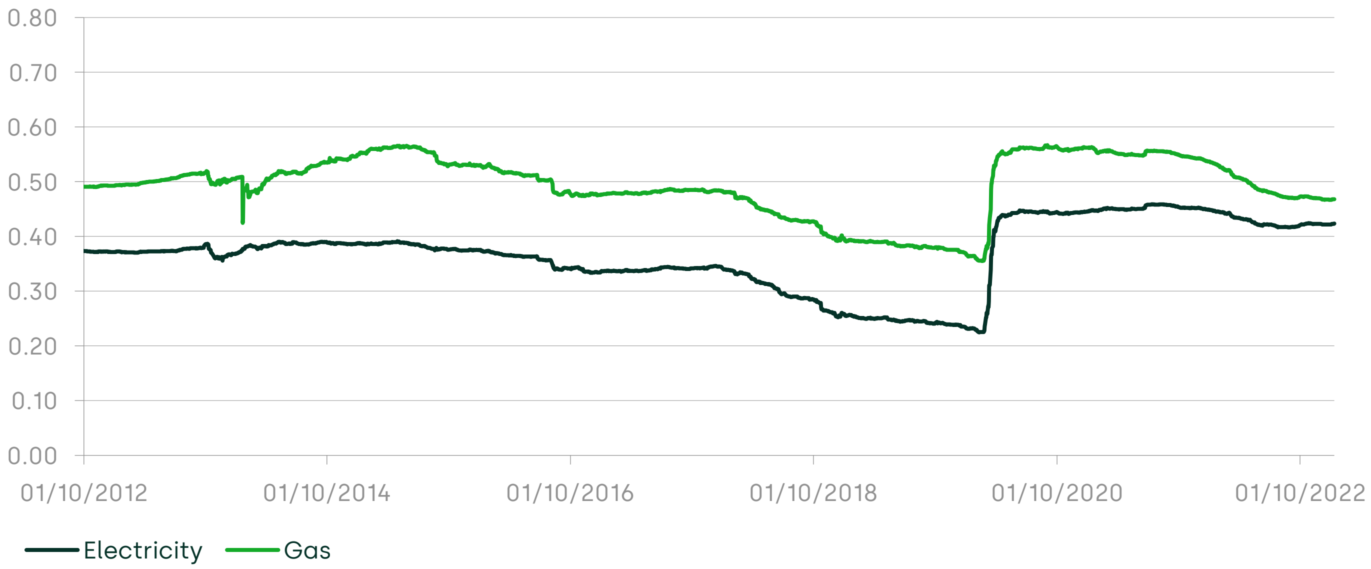
3.8 On average across the daily, weekly and four-weekly estimates over the two five-year periods, the difference between the gas subsample and total energy sample betas is 0.06, while the difference between the gas and electricity subsamples is 0.07.

Table 3.1 Statistical significance of the difference between asset betas of the gas and electricity subsamples

				2012–17				2017–22
	Gas	Electricity	Total energy sample	Gas higher/gas statistically significantly higher	Gas	Electricity	Total energy sample	Gas higher/gas statistically significantly higher
Daily	**0.49** (0.23–0.74)	**0.34** (0.20–0.49)	**0.38**	✓/✗	**0.47** (0.35–0.59)	**0.42** (0.25–0.59)	**0.42**	✓/✗
Weekly	**0.44** (0.06–0.82)	**0.30** (0.17–0.44)	**0.33**	✓/✗	**0.40** (0.23–0.57)	**0.41** (0.30–0.52)	**0.39**	✗/✗
Four-weekly	**0.37** (0.09–0.65)	**0.28** (0.22–0.33)	**0.29**	✓/✗	**0.36** (0.20–0.51)	**0.37** (0.30–0.44)	**0.35**	✗/✗
Average of daily, weekly and four-weekly	0.43	0.31	0.33		0.41	0.40	0.39	
Number of companies	9	11	47		9	12	48	

Note: The numbers of companies in the gas and electricity subsamples do not add up to the number of companies in the total energy sample due to the third 'integrated' companies subsample. Refers to the 95% confidence interval. Confidence intervals for each subsample have been estimated based on the following formula: (Average sample asset beta) ± (Sample standard error) * 1.96.
Source: Oxera based on the NZCC's asset beta spreadsheet and data from Bloomberg.

Figure 3.1 Rolling daily asset betas for gas and electricity subsamples (2012–22)



Note: Based on the Oxera gas and electricity updated subsamples after applying liquidity and equity beta filters.
Source: Oxera based on data from Bloomberg.

3.9 We now turn to evidence on the theoretical reasons for the gas uplift.

3.2 Theoretical evidence supporting the higher risk of GPBs

3.10 As mentioned above, in the 2016 IMs, the NZCC justified an asset beta uplift to GPBs with a combination of relatively high income elasticity of demand and a low penetration of gas connections. These conclusions are aligned with the analysis that we performed in 2016 in response to the NZCC's IMs review draft decision.[54]

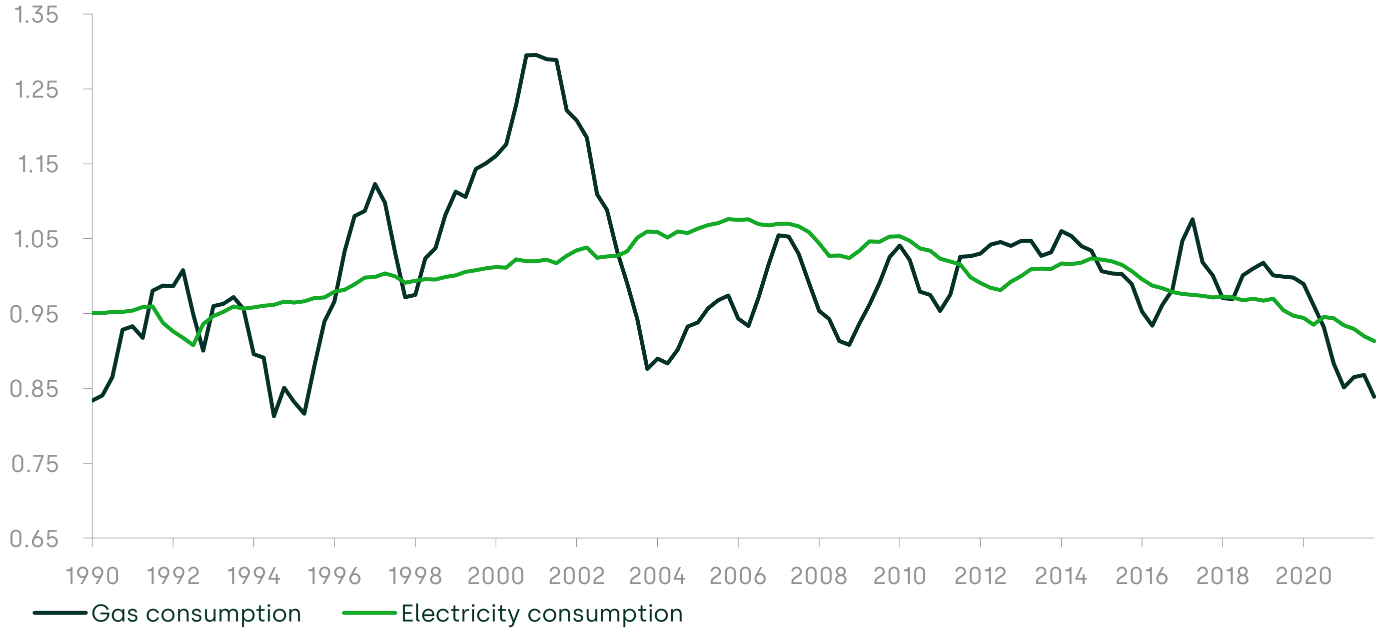
3.11 To summarise, we observed that GPBs in New Zealand faced higher demand-side risks than electricity networks, in terms of higher **volatility of consumption**. If translated into volatility in network returns, the volatility of consumption may be associated with both systematic and non-systematic risk (as also acknowledged by the NZCC).[55] However, **high elasticity of demand** suggests that at times of recession demand is more likely to be low, and vice versa. Therefore, the high elasticity of demand supports the interpretation that some of the demand volatility risk is systematic and therefore would justify an uplift to the GPBs' asset beta.

3.12 Figure 3.2 compares the volatility of gas and electricity consumption. In particular, it shows de-trended variation in total quarterly consumption for gas and electricity in New

[54] Oxera (2016), 'Asset beta for gas pipelines in New Zealand. Final Report. Prepared for First Gas', 3 August, section 3.
[55] Commerce Commission (2016), 'Input methodologies review decisions; Topic paper 4: Cost of capital issues', 20 December, paras 396–397.

Zealand. The figure shows a significantly higher variation in gas consumption relative to electricity.

Figure 3.2 Quarterly variations in gas and electricity consumption in New Zealand, 1990–2022 (petajoules, de-trended)



Note: Both the gas and electricity time series have been 'de-trended' in order to ensure comparability. Specifically, we calculated an annual moving average to account for seasonal fluctuations in consumption, and fitted a linear trend for each time series. The time series were then scaled (i.e. divided) by the trend line.
Source: Oxera analysis based on data from New Zealand Ministry of Business, Innovation and Employment (MBIE).

3.13 As rightly pointed out by the NZCC,[56] the regulatory regime has the potential to significantly modify the networks' exposure to volume risk. However, given that the New Zealand GDBs are regulated under the weighted average price cap, they are exposed to volume risk within the price control period (or, to be precise, the deviation of the actual demand from the demand forecast).

3.14 As for the relatively **low penetration** of gas connections, the NZCC reports two consequences for systematic risk and the asset beta:[57]

- growth options due to the potential for expansion when the economy is growing;
- a greater risk that the number of customers will decrease to a level where it would be insufficient to cover the networks' investment and expenses, which is related to both the short-term demand volatility and the long-term risk of economic asset stranding.

[56] Ibid., para. 344.1.
[57] Ibid., paras 419 and 423.

3.15 In the context of the energy transition (see New Zealand's commitment to achieving **net zero** by 2050[58]), the New Zealand Government has planned to phase out the use of fossil fuels while ensuring affordability. As a result, the demand for gas is more likely to become insufficient to cover gas pipelines' costs on an affordable basis, strengthening the asset stranding risk.

3.16 Some regulators compensate networks for the risk of asset stranding with higher asset beta allowances. For example, the French regulator CRE accounted for the asset stranding risk in setting the beta allowance for gas pipeline companies.[59] However, as explained above, the asset stranding risk is only one of the reasons why an uplift to the asset beta for New Zealand GDBs is justified.

3.17 Notably, accelerated depreciation targets the same risk—i.e. the risk of under-remuneration of the assets that may be under-utilised. However, while accelerated depreciation shortens the period for investment recovery, it does not eliminate the risk. Therefore, both of the regulatory tools—an uplift to the asset beta and accelerated depreciation—can be used together to mitigate the risk.

3.3 Conclusions on the GDBs-specific adjustment

3.18 In line with the NZCC's approach, we consider the required adjustment for GDBs-specific risks by looking at the empirical and theoretical evidence.

- We find the empirical evidence to be mixed, as it was in the previous NZCC IM reviews: the gas subsample asset betas are above those for electricity for the 2012–17 period and for daily asset betas in 2017–22. The difference, however, is not statistically significant.
- In terms of the theoretical evidence, the NZCC's 2016 decision to provide an uplift was based primarily on the high income elasticity of demand for gas and low penetration of gas connections in New Zealand. Although we have not undertaken revised analysis of elasticities, it is reasonable to expect that this finding would persist, as these are characteristics of the industry in New Zealand.

[58] New Zealand Ministry of Business, Innovation and Employment (2022), 'Gas Transition Plan'.

[59] Commission de Régulation de l'Energie (2020), 'Deliberation No. 2020-012. Deliberation by the French Energy Regulatory Commission of 23 January 2020 deciding on the tariffs for the use of GRTgaz's and Teréga's natural gas transmission networks', 23 January, p. 42, https://www.cre.fr/en/Documents/Deliberations/Decision/tariffs-for-the-use-of-grtgaz-s-and-terega-s-natural-gas-transmission-networks (accessed on 23 January 2023). Commission de Régulation de l'Energie (2020), 'Deliberation No. 2020-010. Deliberation by the French Energy Regulation Commission of 23 January 2020 deciding on the equalised tariff for the use of GRDF's public natural gas distribution networks', 23 January, p. 34, https://www.cre.fr/en/Documents/Deliberations/Decision/equalised-tariff-for-the-use-of-grdf-s-publicnatural-gas-distribution-networks (accessed on 23 January 2023).

3.19 Moreover, we expect asset stranding risk to have increased with New Zealand's net zero commitment and the associated policy interventions affecting demand.[60]

3.20 On balance, we conclude that, in the New Zealand context, given the relatively high income elasticity of demand for gas, low penetration rates of the gas networks as well as the use of price caps (rather than revenue caps) for GDBs, it remains reasonable to expect higher systematic risk than in the New Zealand electricity sector, and therefore maintain an uplift on the gas asset beta.

[60] For example, between 2021 and 2022 the Energy Efficiency and Conservation Authority (EECA), has invested in several projects aimed at replacing natural gas in industrial process heat. Moreover, in December 2022 the NZ's Ministry for Environment published a Cabinet paper, entitled 'National Direction on Industrial Greenhouse Gas Emissions', seeking approval for the development of a policy direction and a supporting rule framework for phasing out fossil fuels in process heat. See EECA, Approved GIDI projects, https://www.eeca.govt.nz/co-funding/industry-decarbonisation/approved-gidi-projects/ (accessed on 31 January 2023); Ministry for the Environment (2022), 'Cabinet Paper – National Direction on Industrial Greenhouse Gas Emissions: approval to develop a National Policy Statement and National Environment Standard', Cabinet papers and regulatory impact statements, 20 December, https://environment.govt.nz/what-government-is-doing/cabinet-papers-and-regulatory-impact-statements/cabinet-paper-national-direction-on-industrial-greenhouse-gas-emissions-approval-to-develop-a-national-policy-statement-and-national-environment-standard/ (accessed on 31 January 2023).

4 WACC percentile

4.1 We start our assessment of whether the WACC percentile of 67th is still appropriate for the NZCC's IMs by explaining the NZCC's approach in section 4.1. Then, we move on to our review of CEPA's analysis in section 4.2, before concluding in section 4.3.

4.1 The NZCC's approach

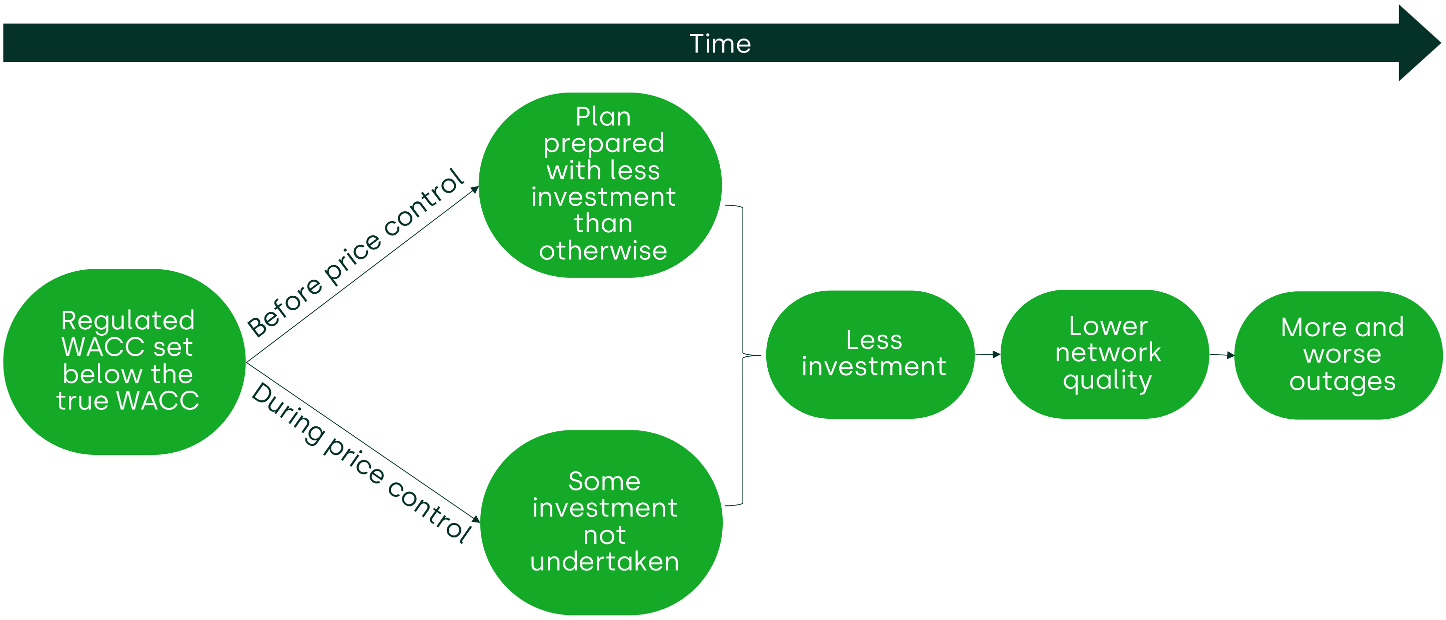
4.2 The conceptual framework that the NZCC uses to assess the percentile of the WACC distribution that should be targeted is based on a 2014 report by Oxera.[61] This framework considers the extent to which aiming up on the WACC generates network reliability benefits to the energy sector as a whole, rather than focusing on electricity and gas separately. Due to the greater availability of research and data on the reliability of electricity rather than gas networks, the framework has been calibrated primarily using data on electricity networks.

4.3 The framework begins by considering the causal mechanism under which a regulated WACC (i.e. the WACC set by a regulator) that is below the true WACC of an energy network could lead to underinvestment. This is shown in Figure 4.1 below, which depicts a causal chain from the regulated WACC to consumer outcomes. The figure explains that, if the true WACC rises above the regulated WACC, two mechanisms will create incentives for the energy network to underinvest:

- if the true WACC is above the regulated WACC *before* the start of a regulatory period,[62] the regulated network will have an incentive to prepare a plan with less investment;
- if the true WACC is above the regulated WACC *during* a regulatory period, the network will have an incentive to undertake the minimum legally permissible amount of investment. This may affect its willingness to prepare a plan with high levels of investment in the next regulatory period, such that there is an interaction between these two mechanisms.

[61] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', https://www.oxera.com/wp-content/uploads/2018/07/Oxera-review-of-the-75th-percentile-approach.PDF.pdf (accessed on 24 January 2023).
[62] More precisely, this would need to happen prior to the network submitting its investment plans for a regulatory period.

Figure 4.1 Causal mechanism explaining why consumers face negative impacts when the regulated WACC is below the true WACC



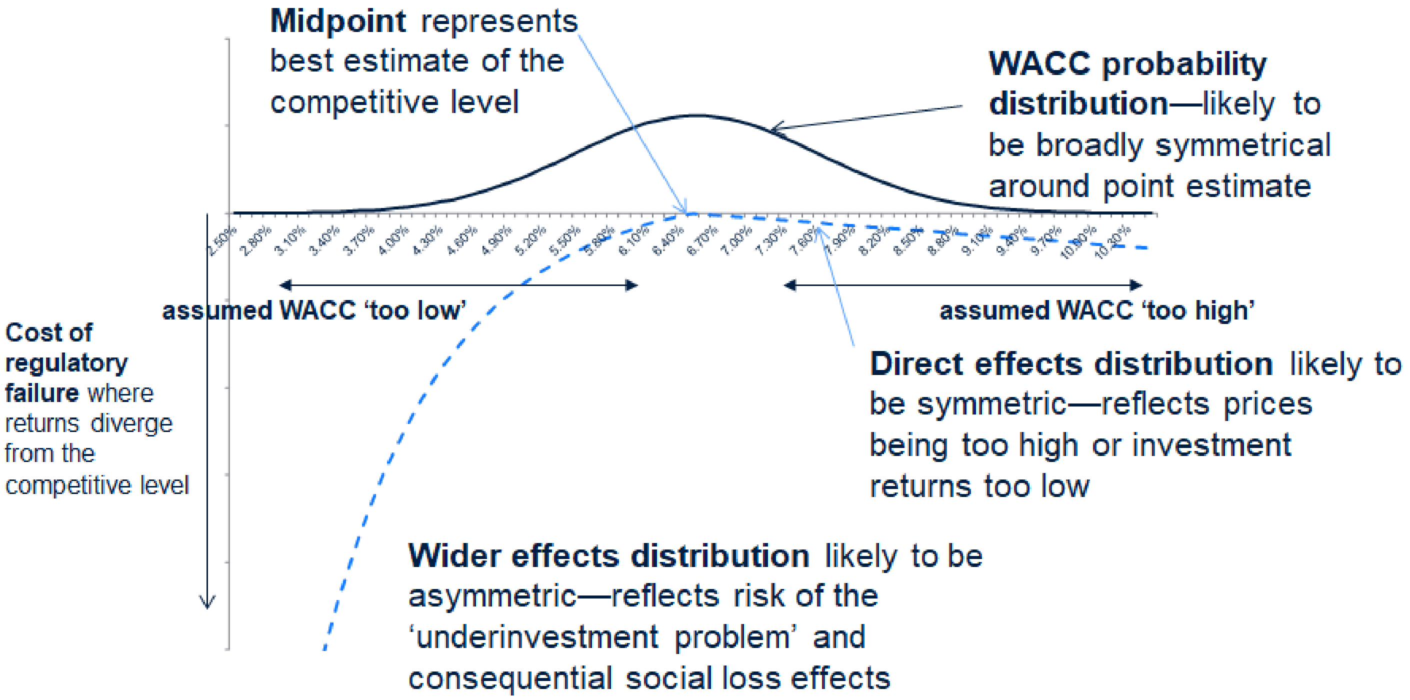
Source: Oxera.

4.4 The framework then explains that the decision of whether to aim up for the WACC should be based on a cost–benefit assessment. The costs of aiming for a higher WACC percentile are the additional costs to consumers arising from the need for the energy network to pass on its higher revenue allowance. The benefits consist of reducing the probability and magnitude of network outages and their consequential impacts (together, the 'impact' of network outages).

4.5 Importantly, the framework shows an asymmetric distribution of the effects of aiming for a higher WACC percentile. This asymmetric distribution exists because the costs of network outages are generally considered to be substantially higher than the fairly small increment that a higher WACC would apply to energy prices.

4.6 Figure 4.2 below shows this framework diagrammatically. The dark blue line shows the distribution of the WACC. The dashed, lighter blue line shows the net socioeconomic costs incurred by society. This line declines significantly towards the left of the WACC distribution, while it drops off only slightly at the right of the WACC distribution. This reflects the fact that aiming up on the WACC (i.e. targeting a point to the right of the distribution) results in a higher cost to consumers, but this cost is low relative to the reduced probability of network outages.

Figure 4.2 Illustration of the framework for the WACC percentile



Source: Oxera.

4.7 The key conclusion to be drawn from this figure is that targeting a WACC that is close to the midpoint creates a greater risk that the true WACC will be below it, resulting in society taking the risk of ending up on a point of the blue dashed line to the left of the graph. By contrast, targeting a higher WACC gives more assurance that this will not happen, meaning that the outcomes for society are more likely to be on the right-hand side of the graph. From an economics perspective, aiming up on the WACC is therefore similar to taking out an insurance policy against the very bad outcomes located on the far left of the asymmetric 'wider effects' distribution.

4.8 As part of the NZCC's review of the cost of capital, CEPA was commissioned to review the framework used by the NZCC to aim up to a particular WACC percentile.[63] CEPA reached two main conclusions.

4.9 First, CEPA found that the evidence for aiming for a higher percentile remained strong within the framework used by the NZCC, highlighting that the benefits of aiming for a higher percentile are higher than the costs at the 70th and 60th percentiles.[64] Our review of CEPA's evidence has found that the benefits of aiming for a higher percentile exceed the costs for every percentile, with the largest difference between benefits and costs, i.e. the highest level of net benefit, being found at the 80th percentile.

[63] CEPA (2022), op. cit.
[64] Ibid., section 4.8.

4.10 This can be seen in Table 4.1 below, which combines the data that CEPA produced on the costs and benefits of aiming for a particular percentile to produce the net benefits.[65] The benefits column contains the (estimated) monetary value of the reduced risks of network underinvestment that CEPA calculated would arise from targeting a higher percentile. The costs column calculates the total additional costs that end-consumers would face after the additional WACC (i.e. from targeting a particular percentile rather than the 50th) is applied to the regulatory asset base (RAB) of the networks, assuming 100% pass-on of those costs to end-consumers. The net benefits column is equal to the midpoint of the benefits column, less the costs column. Taken alone, this suggests that the 80th percentile would be the most appropriate percentile for the NZCC to target because net benefits start to fall at higher percentiles.

Table 4.1 CEPA estimates of the net benefits of aiming up at different WACC percentiles

Percentile	Benefits (NZ$m)	Costs (NZ$m)	Net benefits (NZ$m)
50%	0	0	0
55%	80–55	25	42.5
60%	160–105	50	82.5
65%	230–145	70	117.5
70%	300–185	100	142.5
75%	360–215	125	162.5
80%	420–245	155	177.5
85%	470–265	195	172.5
90%	520–285	240	162.5
95%	560–300	305	125

Note: In line with CEPA's suggestions in section 4.8 of its report, which in turn draw on the suggestions in Oxera's 2014 report, the benefits have been taken from the 0.5% and 1% columns in Table 4.17. These two percentages correspond to the level that the true WACC needs to drop by relative to the regulated WACC in order for underinvestment to start. Therefore, the 0.5% column shows the benefits of aiming for a higher WACC if underinvestment is assumed to start when the true WACC is 0.5% below the regulated WACC, while the 1% column assumes that underinvestment starts only when the true WACC is 1% below the actual WACC. The net benefits column reflects the midpoint of the difference between the benefits and costs.
Source: CEPA (2022), 'Review of Cost of Capital 2022/2023', Tables 4.8 and 4.17.

4.11 Second, CEPA found that, in recent years, fewer regulators have aimed up on the WACC than in the past.[66]

4.12 CEPA does not state whether its update has specific recommendations for the percentile that the NZCC should target. However, in our review of the evidence presented by CEPA we observe that the evidence on the costs and benefits of aiming up is more supportive of aiming up than was the case in 2014. Furthermore, while we agree that most regulators now aim straight rather than up, we note that there is limited direct read-across where other regulators are not using the network reliability framework approach, as is the case for the NZCC.

[65] Ibid., Tables 4.8 and 4.17.
[66] Ibid., section 4.3.

Also, a number of regulators do still aim up, both in the energy sector and in other industries.

4.13 We explain these conclusions in further detail in the sections below.

4.2 Oxera's review of CEPA's conclusions regarding the WACC percentile

4.14 Balancing the need to maintain security of supply and delivering decarbonisation as part of the energy transition in the gas sector is an important concern for New Zealand. The transmission and distribution networks play a vital role in meeting these objectives.[67]

4.15 The need to maintain security of supply in New Zealand is important context for assessing the percentile of the WACC distribution that the NZCC should target. As gas networks balance the multiple roles of maintaining the reliability of the current gas supply, while redeploying assets as well as potentially investing in assets to facilitate (the option of and transition to) lower carbon fuels such as hydrogen or biogas (or blends), it is likely that a high proportion of gas infrastructure expenditure will have reliability implications if it is not undertaken.

4.16 In the remainder of this section, we turn to the specifics of CEPA's report as follows.

- While we agree with CEPA that there is now less regulatory precedent for aiming up than in the past, a number of regulators still do aim up and academic research continues to suggest that a WACC uplift is appropriate (section 4.2.1).
- The conclusion of the Australian Energy Regulator (AER) that any adjustments to the WACC based on 'aiming-up' logic would be arbitrary and would introduce 'further costs' does not appear to take into account the economic fundamentals underpinning the NZCC's framework for assessing the WACC. This approach is consumer-focused—it allows for non-arbitrary adjustments to be made based on a calculation of the relative benefits and costs. We also explain how underestimating the true WACC would be likely to lead to persistent underinvestment (section 4.2.2).
- The approach taken by CEPA to updating the evidence on the impact of network failures is appropriate. However, we do not agree with CEPA's view that the estimates may overstate the impact of network outages. In fact, we note that there are number of reasons why they may understate them (section 4.2.3).

[67] In response to a government request, Gas Industry Co published a report in 2021 that explained that, in order to maintain security of supply, additional investment in gas pipelines will be needed to safely and securely deliver natural gas to customers. Gas Industry Co (2021), 'Gas Industry Co. Market Settings Investigation', p. 17, https://www.gasindustry.co.nz/our-work/work-programmes/gas-market-settings-investigation/ (accessed on 24 January 2023).

- While other regulatory tools, such as incentive and performance-based mechanisms, can, in principle, be used to reduce the risks of underinvestment, there is not a clear case for doing so in New Zealand, particularly as GPBs do not seem to be over-remunerated and there is a risk that the change could introduce regulatory risk (section 4.2.4).
- There are a number of reasons why decarbonisation could increase the rationale for aiming up. These include: (i) the risks that underinvestment in renewable gas infrastructure could slow the rate at which hard-to-decarbonise sectors can reduce the carbon-intensity of their activities; (ii) asset stranding; and (iii) the need to ensure an orderly transition (section 4.2.5).

4.2.1 Review of regulatory precedent

4.17 CEPA's report has highlighted that regulators generally do not aim up on the WACC as much as they did in the past.[68] It explains that:

- between 2008 and 2014, UK regulators, on average, chose the 73rd percentile, and the midpoint was not chosen once. More recently, however, UK regulators have moved away from a WACC above the midpoint and towards selecting the midpoint WACC estimate;[69]
- the AER in Australia explicitly considered a WACC percentile above the midpoint in its 2018 decision, but concluded that there was insufficient evidence for a shift away from the midpoint. However, the AER did note that it was important not to set the allowed WACC below the true WACC, due to the potential for disincentivising underinvestment, which ultimately has adverse impacts on consumers.

4.18 However, CEPA also explains that another Australian regulator, the Independent Pricing and Regulatory Tribunal of New South Wales (IPART), noted that applying its standard WACC methodology may lead to large estimation errors during periods of increased macroeconomic uncertainty, which could lead to an understatement of the true WACC and underinvestment.[70] IPART has the power to diverge from its standard WACC methodology during periods of high macroeconomic uncertainty. While it is not entirely clear how IPART would choose to depart from its methodology, CEPA concludes that an uplift to the WACC could be an appropriate approach for IPART to take.[71] Given that inflation in New Zealand is currently high (7.2% in September 2022[72]), and

[68] CEPA (2022), op. cit., section 4.3.
[69] Ibid., pp. 26–30.
[70] Ibid., p. 32.
[71] Ibid., p. 32.
[72] Stats NZ (2022), 'Annual inflation at 7.2 percent', https://www.stats.govt.nz/news/annual-inflation-at-7-2-percent/#:~:text=The%20consumers%20price%20index%20increased,in%20the%20March%202022%20quarter (accessed on 24 January 2023).

monetary policy is expected to tighten,[73] this could mean that, under IPART's methodology, aiming up would be applied in New Zealand.

4.19 While recent regulatory decisions include fewer aiming-up decisions than previously, many regulators still consider aiming up to be reasonable. We summarise these precedents in Table 4.2 below and discuss some of them in further detail below.

Table 4.2 Precedents of aiming up in energy and non-energy regulation

Regulator	Year	Sector	Percentile
CAR (Ireland)	2019/22	Aviation	62
CRE (France)	2021	Electricity transmission	63
CRE (France)	2020	Gas transmission	81
CRE (France)	2020	Gas distribution	100
Identified by CEPA:			
UK CMA	2019	Water	78
UK Ofcom	2021	Wholesale fixed telecoms	59
UK Ofgem	2022	Electricity distribution	51

Note: CAR, Commission for Aviation Regulation. The percentiles are calculated from the selected WACC point and the lower and upper bounds of the range, based on a uniform distribution assumption. Since the French regulator CRE does not provide a range in its final determination, the consultation range is used for the percentile calculation.
Source: Commission for Aviation Regulation (2022), 'Decision on an Interim Review of the 2019 Determination in relation to 2023-2026', pp. 151–152, https://www.aviationreg.ie/_fileupload/2022%20Decision/Final%20Decision_2022_23Dec(2).pdf (accessed on 24 January 2023); CRE (2021), 'Délibération de la CRE du 21 janvier 2021 portant décision sur le tarif d'utilisation des réseaux publics de transport d'électricité (TURPE 6 HTB), https://www.cre.fr/Documents/Deliberations/Decision/tarif-d-utilisation-des-reseaux-publics-de-transport-d-electricite-turpe-6-htb (accessed on 24 January 2023); CRE (2020), 'Délibération de la CRE du 23 janvier 2020 portant décision sur le tarif d'utilisation des réseaux de transport de gaz naturel de GRTgaz et Teréga', https://www.cre.fr/Documents/Deliberations/Decision/tarif-d-utilisation-des-reseaux-de-transport-de-gaz-naturel-de-grtgaz-et-terega (accessed on 24 January 2023); CRE (2020), 'Délibération de la CRE du 23 janvier 2020 portant décision sur le tarif péréqué d'utilisation des réseaux publics de distribution de gaz naturel de GRDF, https://www.cre.fr/Documents/Deliberations/Decision/tarif-pereque-d-utilisation-des-reseaux-publics-de-distribution-de-gaz-naturel-de-grdf (accessed on 24 January 2023); CEPA (2022), 'Review of Cost of Capital 2022/2023', table 4.2.

4.20 The CMA overturned Ofwat's decision to choose the midpoint of the cost of equity for PR19, and selected the 67th percentile instead. The CMA's reasoning was based on the fact that aiming up can deliver a number of benefits, such as a more appropriate balance of risk, addressing the level of risk to investment, compensation for any asymmetries in the broader financial settlement, and financeability of the sector.[74]

4.21 The Irish Commission for Aviation Regulation includes an uplift to the WACC allowance of 50bps in the two most recent price

[73] OECD (2022), 'Economic Outlook November 2022 – New Zealand projection note', November. International Monetary Fund (2022), 'New Zealand – Selected issues', May.
[74] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations – Final Report', https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf (accessed on 24 January 2023).

control periods. The Commission for Aviation Regulation's rationale appears to be based on a similar framework to the one used in New Zealand, as it explained that:[75]

> The reasoning behind applying the aiming up component remains unchanged compared to the Draft Decision and the original 2019 Determination: i) Risk of measurement errors in the WACC components. ii) Asymmetric economic effects of underinvestment relative to overinvestment, since underinvestment is likely to have asymmetric dynamic effects on welfare. iii) No implicit aiming up is included in other WACC components.

4.22 The description of 'asymmetric economic effects' appears to be a reference to the degradation of assets as a result of underinvestment, with the Commission for Aviation Regulation stating that:[76]

> We reiterate our views on the risks of underinvestment, which both restricts Dublin Airport's ability to expand (benefitting future users) and potentially leads to the degradation of existing assets, which would not be in the interests of current or future users.

4.23 The French energy regulator, CRE, has also aimed up in its most recent decisions for electricity transmission and distribution.[77] Specifically, the CRE granted a WACC of 4.6% from a range of 3.87–5.03% for the transmission system operator (TSO). This corresponds to the 63rd percentile of the WACC range. For the distribution system operators (DSOs), a different remuneration methodology was used, which was based on the same parameters as the WACC. The relevant rates, called the return on assets (marge sur actif) and return on equity (rémunération des capitaux propres régulés) were determined respectively at 2.5% from a range of 2.4–2.5% and at 2.3% from a range of 2.1–2.5%.

4.24 The CRE has also selected point estimates for the WACC above the midpoint in the most recent decisions and consultations for gas transmission and distribution tariffs.[78] For gas transmission, the range in the consultation was 3.6–4.4%, with the final WACC set at 4.25% (the 81st percentile of the range). For gas distribution, the final WACC was set at 4.10%, from a range in

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[75] Commission for Aviation Regulation (2022), 'Decision on an Interim Review of the 2019 Determination in relation to 2023-2026', pp. 151–152.
[76] Ibid., pp. 151–152.
[77] CRE (2021), 'Délibération de la CRE du 21 janvier 2021 portant décision sur le tarif d'utilisation des réseaux publics de transport d'électricité (TURPE 6 HTB); CRE (2021), 'Délibération de la CRE du 21 janvier 2021 portant décision sur le tarif d'utilisation des réseaux publics de distribution d'électricité (TURPE 6 HTA-BT)', https://www.cre.fr/Documents/Deliberations/Decision/tarif-d-utilisation-des-reseaux-publics-de-distribution-d-electricite-turpe-6-hta-bt (accessed on 24 January 2023).
[78] CRE (2020), 'Délibération de la CRE du 23 janvier 2020 portant décision sur le tarif d'utilisation des réseaux de transport de gaz naturel de GRTgaz et Teréga'; CRE (2020), 'Délibération de la CRE du 23 janvier 2020 portant décision sur le tarif péréqué d'utilisation des réseaux publics de distribution de gaz naturel de GRDF'.

the consultation of 3.5–4.1% (the 100th percentile—i.e. the top of the range).

4.25 Moreover, academic research has continued to be published examining the relationship between WACC allowance uplifts and consumer welfare. We have reviewed a paper by Romeijnders and Mulder from 2022,[79] which uses a theoretical model that assumed that electricity grid operators invest in infrastructure replacement only if the WACC allowance is set above the true WACC, while no investments are performed if the WACC allowance is set below the true WACC. The authors' model also links the underinvestment to network failures and damage to consumers, quantified using estimates of the value of lost load (VoLL). The authors conclude from their theoretical model that in most cases the optimal WACC allowance is above the historical midpoint of the WACC range (which we can consider to be a proxy for the WACC estimate).

4.26 While the authors have presented their findings in terms of a percentage uplift to the WACC when the standard deviation of the WACC is at a particular level, it is possible to convert these WACC uplifts into percentile targets.[80] We have done this in Table 4.3 below, which shows how the optimal WACC percentile varies across:

- standard deviations of the WACC that are close to the NZCC's standard deviation estimate of 1.01%;
- different proportions of the asset base that can be replaced in one year;
- the persistence of the WACC, with values closer to 1 indicating higher persistence and values closer to 0 indicating lower persistence.

[79] Romeijnders, W. and Mulder, M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.
[80] By dividing the percentage uplift by the standard deviation we calculate how many standard deviations the uplift is away from the mean. This allows us to use a standard normal distribution to determine the equivalent percentile that the percentage uplift corresponds to. For example, if the ratio of the uplift to the standard deviation is 0.5, this would imply, based on a standard normal distribution table, that the optimal WACC percentile was the 69th.

Table 4.3 Optimal WACC percentile for different combinations of the WACC standard deviation, the percentage of investment that can be replaced in a year, and the persistence of the WACC

Uncertainty of the WACC, measured by standard deviation	Percentage of asset base replaced in one year[1]	Persistence[2]	Optimal WACC percentile
0.50%	10%	0.92	91.92%
1%	10%	0.92	81.59%
1.50%	10%	0.92	74.75%
2%	10%	0.92	67.36%
0.50%	7%	0.92	93.32%
1%	7%	0.92	88.49%
1.50%	7%	0.92	82.47%
2%	7%	0.92	77.34%
0.50%	10%	0.5	78.81%
1%	10%	0.5	72.57%
1.50%	10%	0.5	63.06%
2%	10%	0.5	58.90%
0.50%	10%	0	72.57%
1%	10%	0	59.87%
1.50%	10%	0	55.30%
2%	10%	0	52.99%

Note: [1] The percentage of the asset base that can be replaced in one year determines the speed at which networks can recover from periods of underinvestment. Therefore, the higher the percentage of the asset base that can be replaced, the lower will be the impacts of underestimating the WACC. [2] The persistence is the autocorrelation factor of the model and measures how close the previous period's value of the WACC is to the predicted WACC. The higher the persistence, the closer the predicted WACC value will be to the previous period's.
Source: Oxera analysis based pp. 102–105 of Romeijnders, W. and Mulder, M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.

4.27 We consider the salient points for the NZCC from Table 4.3 to be that:

- at high levels of persistence in the WACC (i.e. situations where underinvestment could occur for multiple years), the optimal WACC percentile is always above the 67th;[81]
- at lower levels of persistence (i.e. situations where it is less likely that underinvestment could occur for multiple years), and where the standard deviation is similar to the standard deviation calculated by the NZCC,[82] the suggested

[81] This can be seen from the optimal WACC percentile in the rows that have a persistence parameter of 0.92.
[82] This can be seen by looking at the rows with a standard deviation of between 0.5% and 1.5%, as the NZCC's most recent estimate of the standard deviation of the WACC was 1.01%. Commerce Commission (2016), 'Input Methodologies Review Decisions. Topic paper 4: Cost of capital issues', para. 580, https://comcom.govt.nz/__data/assets/pdf_file/0021/60537/Input-methodologies-review-decisions-Topic-paper-4-Cost-of-capital-issues-20-December-2016.pdf (accessed on 24 January 2023).

percentile is between 55% and 72%, thereby encompassing the 67th percentile used by the NZCC;[83]

- the most relevant rows to consider are likely to be those that have a standard deviation of c. 1%, and persistence of higher than 0 (i.e. 0.5 or 0.92). These rows are most relevant because the NZCC currently has an estimate of the standard error that is approximately 1%.[84] Furthermore, as the persistence parameter of 0.92 is estimated using actual market data from the Netherlands, it seems relatively unlikely that a persistence parameter of 0 would be an appropriate assumption for New Zealand. These rows suggest a mean percentile of 81%, which is materially higher than the NZCC's current percentile.

4.28 It is important to note that there are limitations to this model, specifically because it assumes that:

- no investment is undertaken when the regulated WACC is below the true WACC. This increases the WACC percentile that should be targeted relative to a situation where some investment still takes place, and, in reality, networks would probably continue to make some investments;
- a relatively high proportion of the asset base, at 7–10%, can be replaced in a single year, which reduces the WACC percentile that it targets relative to a situation where a more realistic assumption about asset replacement is made.

4.29 Therefore, the precise point estimates implied by the paper do not read across directly to the New Zealand context. Rather, this academic evidence provides intuitive and empirical support, calibrated to the Dutch market, to underpin the approach taken in New Zealand of aiming up in the WACC range.

4.30 Overall, while we agree with CEPA that there is less regulatory precedent for aiming up than there has been in the past, there are still a number of regulators that do aim up, and academic research continues to suggest that a WACC uplift is appropriate.

4.2.2 CEPA's reference to the AER's conclusions regarding aiming up on the WACC

4.31 While CEPA has concluded that regulators in general are increasingly aiming straight, it appears to have given specific weight to the AER, as it is the only regulator mentioned in its conclusion. CEPA has stated that:[85]

> the AER reviewed selecting a WACC estimate away from the midpoint and observed that any adjustment would be arbitrary and could lead to less efficient outcomes than the midpoint.

[83] This can be seen by looking at the optimal WACC percentiles for the rows where the standard deviation is between 0.5% and 1.5% and persistence is either 0 or 0.5.
[84] Commerce Comission (2016), 'Input Methodologies Review Decisions. Topic paper 4: Cost of capital issues', para. 580.
[85] CEPA (2022), op. cit., p. 47.

They argued that if the estimation of the rate of return was not systematically bias [sic], then the probability of the rate of return being too high or too low is symmetrical. This argument implies that over the long run the true rate or return should not be persistently underestimated, leading to persistent underinvestment.

4.32 This quote appears to suggest that the AER concluded that, as long as the rate of return is not systematically biased, there will not be persistent underinvestment.

4.33 We have not been able to identify the reference to persistent underinvestment in the AER's 2018 Rate of Return Explanatory Statement.[86] However we have found that the AER concluded that:[87]

- it is just as likely for a regulator to over- as to underestimate the true WACC;
- it is not possible to identify the appropriate adjustment to the WACC to take into account the relative costs of estimating a WACC that is either above or below the true WACC;
- adding further adjustments to the WACC is likely to introduce further costs.

4.34 We agree with the first bullet, because the 50th percentile of the WACC gives an unbiased estimate of the true WACC. However, we disagree with the second and third bullets.

4.35 We disagree with the third bullet because it ignores the fact that there is an asymmetric distribution of the effects of the regulated WACC being below the true WACC. As we explained in our 2014 report, the existence of this asymmetric distribution is well documented in a 2011 paper by Professor Ian Dobbs.[88] Since our 2014 report, the above paper by Professors Romeijnders and Mulder on the optimal WACC percentile to target in tariff-setting has used a similar framework.[89] It is precisely the existence of this asymmetric distribution that explains why the costs of aiming up on the WACC are less than the costs of aiming straight.

4.36 We disagree with the second bullet because it ignores the framework that the NZCC has built and used for the purpose of identifying a non-arbitrary adjustment. This framework weighs up the costs of targeting a WACC above the 50th percentile with the benefits of doing so. While the use of this framework requires assumptions to be made about the costs of network reliability, and a degree of judgement, this is also true of other

[86] AER (2018), 'Rate of Return Instrument: Explanatory Statement', Chapter 13, https://www.aer.gov.au/system/files/Rate%20of%20Return%20Instrument%20-%20Explanatory%20Statement.pdf (accessed on 24 January 2023).
[87] Ibid., p. 407.
[88] Dobbs, I. (2011), 'Modelling welfare loss asymmetries arising from uncertainty in the regulatory cost of finance', *Journal of Regulatory Economics*, **39**, pp. 1–28.
[89] Romeijnders, W. and Mulder, M. (2022), op. cit., pp. 89–107.

parameters in regulatory WACC determination.[90] As we explain in section 4.1, CEPA's calibration of this framework suggests that the 80th percentile should be targeted, which demonstrates how the framework can be used to generate a non-arbitrary adjustment.

4.37 Despite the fact that, as mentioned above, we have not found references in the AER's paper to the specific point of persistent underinvestment, we consider it helpful to explain why setting the regulated WACC below the true WACC would in general be expected to lead to persistent underinvestment.

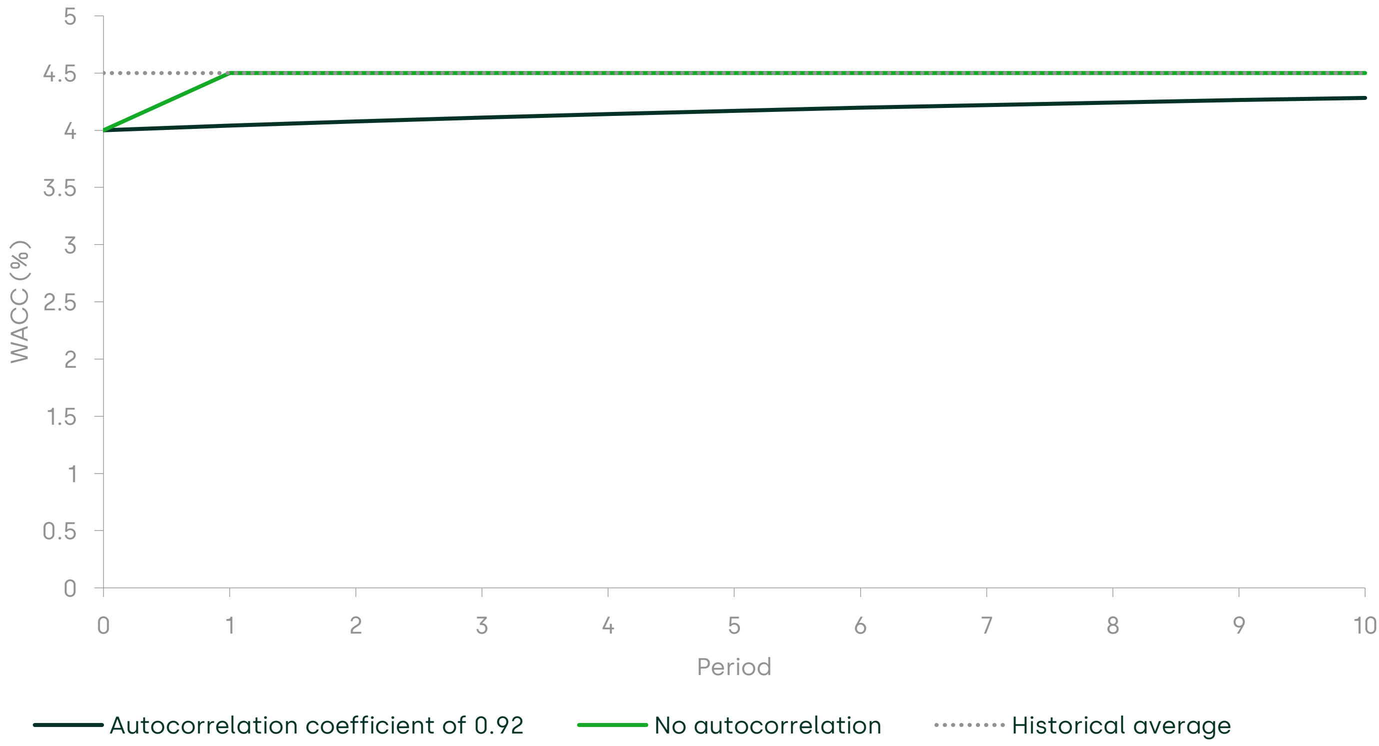
4.38 First, even if underinvestment lasts for only a short time, (construction) capacity constraints at the level of the transmission and distribution operators, or their suppliers, could mean that the underinvestment cannot be easily fixed.

4.39 Second, the true WACC is likely to exhibit 'stickiness' or autocorrelation, as explained in the paper by Romeijnders and Mulder (2022).[91] Autocorrelation refers to a mathematical relationship where the value of a particular variable (in this case the WACC) is likely to be more similar to its value in recent periods than its value in periods further back in the past: it is therefore a formal way of testing for 'stickiness'. If this is the case then, if the WACC is mis-estimated at the start of a regulatory period, it is more likely to remain mis-estimated throughout the regulatory period because the true WACC is unlikely to change significantly during this time.

4.40 We illustrate this graphically in Figure 4.3. The true WACC shown in the figure is based on the autocorrelation process in the Romeijnders and Mulder paper, where the WACC is assumed to follow an AR(1) process over time.[92] In this figure, the dark green line shows how the WACC would develop when it exhibits autocorrelation, and the light green line shows how the WACC would develop when it does not. The dark green line takes longer for the WACC to return to its 'average', which can be interpreted as the estimate that the regulator makes if it aims straight, and therefore shows that, when the true WACC exhibits autocorrelation, it is possible for the regulated WACC to remain above the true WACC for multiple periods.

[90] We also understand that the network reliability framework has not been subject to a merits review in New Zealand.
[91] Romeijnders, W. and Mulder M. (2022), op. cit., pp. 89–107.
[92] The precise formula that the WACC follows in the paper is $w_t^c = \mu_{wacc} + \rho(w_{t-1}^c - \mu_{wacc}) + \varepsilon_t$, where w_t^c is the WACC in time t, μ_{wacc} is the long-term average of the WACC, and ε_t is an idiosyncratic shock factor. This formula illustrates a process whereby the WACC in period t is a function of: (i) its long-term average, which can be interpreted as the estimate that the regulator makes of the WACC if it aims straight; (ii) its value in the previous period—with the previous period value playing a more important role the higher is the autocorrelation coefficient (iii) an idiosyncratic shock, which could be interpreted as any transitory change to the WACC.

Figure 4.3 Time taken for the true WACC to return to the historical average with and without autocorrelation



Source: Oxera, based on Romeijnders, W. and Mulder, M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.

4.41 Third, the risks of persistent underinvestment are greater in New Zealand than in Australia because the NZCC does not index any of the WACC parameters, while the AER indexes the allowed cost of debt.[93] This means that the calculation of the regulated WACC will be adjusted more often in Australia than in New Zealand, reducing the probability that the true WACC would rise above the regulated WACC during this period.

4.2.3 Evidence on the impact of network failures

4.42 The assumed cost of network failures is an important determinant of the WACC percentile that should be targeted. This is because higher costs imply that any underinvestment will have more adverse effects on consumers, and therefore provide a rationale to aim up for a higher percentile of the WACC than if the costs of network failure were lower.

4.43 In our 2014 report, we calculated the impact of network failures by dividing the total costs of network outages by the GDP of the relevant country in a number of studies. This gave us the impact of network outages as a proportion of a country's GDP, which we then applied to the GDP of New Zealand to produce

[93] AER (2022), 'Draft Rate of Return Instrument Explanatory Statement', June, p. 20, https://www.aer.gov.au/system/files/Draft%202022%20Rate%20of%20Return%20Instrument%20-%20Explanatory%20Statement%20-%2016%20June%202022.pdf (accessed on 24 January 2023).

an approximate impact of network outages on the New Zealand economy.[94]

4.44 CEPA has updated our analysis by adjusting it for changes in New Zealand's GDP growth rate and the VoLL since 2014. It initially conducted this analysis in 2013 price terms and then inflated it to 2022 prices.[95]

4.45 We have also assessed the two main concerns that CEPA has raised about our approach. CEPA's two concerns are:[96]

1. that we have used the costs of one-off events to estimate the impacts of underinvestment on the New Zealand economy;
2. that we have assumed that the probability of network failures in a world of perfect investment is zero.

4.46 If either of these assumptions were correct then our (and, by extension, CEPA's) estimate of the costs of underinvestment could be inflated. This could suggest that a lower percentile should be targeted (relative to the 80th suggested by CEPA's analysis).

4.47 While it is true that our 2014 study reports the impacts of one-off events,[97] the main damages estimates that we use (of NZ$1bn) are equal to the average of the impacts that we reported for the ASCE study.[98] The ASCE study models the expected annualised impacts of underinvestment on the US economy. It also explains that their modelling allows for network failures to still exist if the investment gap is closed. Specifically, the ASCE says that:[99]

> Even if sufficient investment is made to close the investment gap, the result will not be a perfect network for electricity generation and delivery, but rather one that has dramatically reduced, though not eliminated, power quality and availability interruptions

4.48 We therefore understand that this study covers only the impacts of *incremental network failures* that arise as a result of underinvestment, which is aligned with what we were aiming to assess in our 2014 report.

4.49 Furthermore, it is not necessarily the case that the impacts of one-off events are lower than the annualised effects of underinvestment: they could be higher or lower. It is reasonable

[94] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', Table 5.1.
[95] CEPA (2022), op. cit., p. 41.
[96] Ibid., p. 39.
[97] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', Table 5.1.
[98] Ibid., first two rows of Table 5.1.
[99] ASCE (2011), 'Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure', *American Society of Civil Engineers*, January, https://ascelibrary.org/doi/epdf/10.1061/9780784478783 (accessed on 24 January 2023).

to expect that the impacts of network failure on an economy are the same regardless of what causes them, and therefore these studies still provide useful context as to what the possible impacts of network failure events could be on an economy.

4.50 We have updated our summary of the impacts of network failure and present the results of this in Table 4.4 below. While none of the studies in Table 4.4 provides a perfect comparator for New Zealand and the full range of impacts is very wide—between NZ$0.5bn and NZ$21bn—it does suggest that the potential impacts of underinvestment could be even larger than was suggested by CEPA.

Table 4.4 Summary of studies into the economic cost of power outages

Study	Country	Event period (year)	Cost of outage (US$bn)	GDP in year of study (US$bn)[1]	Cost (percentage of GDP)	NZ GDP in 2021 (NZ$bn)	Implied cost of outages in New Zealand (NZ$bn)[2]
Annual studies (i.e. studies of equivalent annualised effect)							
ASCE (2011)	USA	2012–20	55	18,869	0.29	355	1.0
ASCE (2011)	USA	2020–40[3]	97	25,648	0.38	355	1.3
LaCommare et al. (2004)	USA	2004	79	12,300	0.6	355	2.1
Nexant (2003)	Nepal	2001	0.025	6.3	0.4	355	1.4
EPRI (2001)	USA	2001	119–188	10,600	1.1–1.8	355	3.9–6.4
Swaminathan and Sen (1997)	USA	1998	39	9,100	0.4	355	1.4
Targosz and Manson (2007)	EU-25	2003–04	180	16,546	1.1	355	3.9
Zachariadis and Poullikas (2012)	Cyprus	2011	1.52	24.98	6.1	355	21.655
EBP (2020)	USA	2020–29[3]	63.7	24,525	0.26	355	0.92
Annual, weather-related only							
Campbell (2012)	USA	2012	25–55	16,200	0.15–0.4	355	0.5–1.4
Council of Economic Advisors et al. (2013)	USA	2003–12	18–33	14,116	0.13–0.23	355	0.46–0.82
Specific event							
Reichl et al. (2013)	Austria	2013	2.3	417.6	0.6	355	2.1

Note: [1] GDP is reported in current prices. For studies spanning several years, the average value of the GDP has been taken. Forward GDP figures have been estimated assuming a constant growth of 2% per year. [2] Based on the same proportion of GDP as in the country of occurrence. [3] These studies present simulations of outages in the future.
Source: Oxera analysis, based on various academic studies: ASCE (2011), 'Failure to act: The economic impact of current investment trends in electricity infrastructure', *American Society of Civil Engineers*; January; LaCommare, K. and Eto, J. (2004), 'Understanding the cost of power interruptions to U.S. electricity consumers', *Lawrence Berkeley National Lab*, September, https://eta-publications.lbl.gov/sites/default/files/lbnl-55718.pdf (accessed on 24 January 2023); Nexant (2003), 'Economic impact of poor power quality on Industry, *USAID-SARI/Energy Program*, Nepal', October, https://synergyforenergy.files.wordpress.com/2011/06/economicimpact_poorpowerquality_nepal_complete.pdf (accessed on 24 January 2023); EPRI (2001), 'The Cost of Power Disturbances to Industrial & digital economy companies', https://www.epri.com/research/products/3002000476 (accessed on 24 January 2023);

Swaminathan, S. and Sen, R.K. (1997), 'Review of power quality applications of energy storage systems', *Sandia National Lab*, May, https://www.osti.gov/biblio/661550 (accessed on 24 January 2023); Targosz, R. and Manson, J. (2007), 'Pan-European lpqi power quality survey', *19th International Conference on Electricity Distribution*, May, https://www.academia.edu/73221926/Pan_European_Lpqi_Power_Quality_Survey (accessed on 24 January 2023); Zachariadis, T. and Poullikas, A. (2012), 'The cost of power outages: A case study from Cyprus', *Energy Policy*, **51**, December, https://www.researchgate.net/publication/257126288_The_costs_of_power_outages_A_case_study_from_Cyprus (accessed on 24 January 2023); EBP (2020), 'Failure to act: Electric infrastructure investment gaps in a rapidly changing environment', https://www.ebp-us.com/en/projects/failure-act-electric-infrastructure-investment-gaps-rapidly-changing-environment-2020 (accessed on 24 January 2023); Campbell, R.J. (2012), 'Weather-related power outages and electric system resiliency', *Washington, DC: Congressional Research Service, Library of Congress*, August, https://sgp.fas.org/crs/misc/R42696.pdf (accessed on 24 January 2023); Executive Office of the President (2013), 'Economic Benefits of Increasing Electric Grid Resilience to Weather Outages', *Council of Economic Advisors et al.*, August, https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf (accessed on 24 January 2023); Reichl, J., Schmidthaler, M. and Friedrich, S. (2013), 'Power Outage Cost Evaluation: Reasoning, Methods and an Application', *Journal of Scientific Research & Reports*, **2**:1, April, https://www.researchgate.net/publication/259840992_Power_Outage_Cost_Evaluation_Reasoning_Methods_and_an_Application (accessed on 24 January 2023); Data from World Bank and Statistics New Zealand (2021), 'Regional Gross Domestic Product', March, available here. Oxera (2014), 'Review of the 75th percentile approach', https://www.oxera.com/wp-content/uploads/2018/07/Oxera-review-of-the-75th-percentile-approach.PDF.pdf (accessed on 25 January 2023).

4.51 Despite the possibility of high impacts, we consider that the most reliable estimate of damages is given by the ASCE paper from 2011 and, therefore, by extension, the updates that have been based on this paper, including CEPA's update of NZ$1.9bn discussed above.

4.52 We note that the ASCE published an update to its 2011 paper in 2020. The implied damages from this paper are also included in Table 4.4 above, but these cover only the lost output from businesses. This may therefore be an understatement of the full losses (due to, for example, excluding the impacts on households), and we therefore consider the estimates of NZ$1bn—NZ$1.9bn from the ASCE 2011 paper to be more reliable.

4.53 If the lower end of this range, at NZ$1bn, were taken, the results would be very similar to those that we produced in our 2014 report, where we concluded that the 67th percentile was appropriate. This is because most of the analysis that we conducted in our 2014 report was based on the NZ$1bn assumption for the impacts of underinvestment.

4.54 However, these estimates may understate the true impact of network failure because, if it is not easy or quick to rectify the underinvestment, the effective annualised costs of underinvestment will be greater. This is because it could take several years to rectify the underinvestment, meaning that one year of underinvestment could result in more than one year of the effects of underinvestment.[100] In this context it is important

[100] This can be most easily seen through the following example. Consider an underinvestment problem that results in economic costs of NZ$1bn per annum from year

to note that the NZCC does not consider that it is easy to observe and rectify underinvestment in energy networks,[101] which implies that the annual costs of underinvestment in New Zealand could exceed NZ$1bn–NZ$1.9bn.

4.55 In short, we consider that the updates made by CEPA are reasonable, but consider that these may be underestimates rather than overestimates.

4.56 As mentioned earlier, the evidence base in Table 4.4 above is drawn from studies looking into the impact of reliability on the electricity sector. While we are not aware of studies into the impact of underinvestment in gas networks on reliability,[102] we note that a study has been undertaken in New Zealand that shows that industries that consume 93% of natural gas account for 57% of the value added to the economy.[103] While the authors of the report explain that their findings should not be interpreted as describing the economic value that is attributable exclusively to natural gas,[104] the report does provide evidence that in New Zealand, gas-intensive industries generate significant economic value.

4.2.4 Use of other investment incentive mechanisms

4.57 CEPA explains in its reports that regulators are increasingly aiming straight rather than up on the regulatory allowed WACC, and that part of the reason for this has been the inclusion of 'appropriate incentive and performance-based conditions'.[105] We assume that here CEPA may be referring to, for example, the use of incentive schemes that reward regulated companies if they outperform selected reliability metric(s).

4.58 While we agree that aiming up on the WACC is not the only way in which the NZCC could prevent underinvestment, we consider

t. Suppose that, at year t+2, the regulator identifies the problem and implements a policy (such as an increase of the WACC percentile) that aims to rectify it. However, suppose that this policy takes two years to take effect, for example because there is a two-year lag while the regulated companies receive the higher regulated return, make an investment plan, tender for the new investments, and finally construct those new investments such that the NZ$1bn impact is reversed. In this example, the effective annual costs of the underinvestment are NZ$2bn because the regulator reverses the policy that caused underinvestment in period t+2, but it is only in period t+4 that the effects of the underinvestment are fully reversed.

[101] Commerce Commission (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.798, https://comcom.govt.nz/__data/assets/pdf_file/0022/226507/Fibre-Input-Methodologies-Main-final-decisions-reasons-paper-13-October-2020.pdf (accessed on 24 January 2023).

[102] We have, however, been able to perform an analysis that estimates what the annual impact of underinvestment in gas networks (across both transmission and distribution) would need to be in order for the 67th percentile to be optimal. We find that this would be the case if the annual impact of underinvestment in gas networks were NZ$77m.

[103] NZIER (2012), 'Value added associated with gas demand', https://www.gasindustry.co.nz/assets/DMSDocumentsOld/commissioned-reports/27357.-2012-october-nzier-value-added-associated-with-gas-demand-final.pdf (accessed on 26 January 2023).

[104] This is because the estimates do not cover the willingness to pay for preventing outages, and nor do they take into account the ability of firms to substitute for alternative sources of energy.

[105] CEPA (2022), op. cit., p. 27.

that there are two reasons why changing to an alternative incentive and performance-based mechanism may be inappropriate.

4.59 First, a change in the regulatory mechanism used to prevent underinvestment could create regulatory instability. Therefore, unless the alternative mechanism were materially more effective at preventing underinvestment, it would be unlikely to be net beneficial.

4.60 Stable regulatory regimes provide benefits to consumers because they reduce the regulatory risk that investors need to be compensated for. If regulation becomes more unstable and investors are not compensated for this, there is a risk that they will not invest further and/or divest. This leads to higher required returns for debt and equity holders in regulated networks, and consequently higher consumer prices. Regime stability was an important consideration in our 2014 advice to the NZCC, where we explained that 'any premium should be applied to all RAB assets and applied consistently, as the expected whole-life return on assets should be the relevant test for investors'.[106] This highlighted the regulatory risk of the NZCC choosing a particular WACC percentile at the time, only to change it in future periods.

4.61 Research in the context of the European renewable energy sector showed that retroactive policy changes decrease the investment activity of firms, by 45% for solar PV and 16% for onshore wind, which indicates a lasting impact of policy uncertainty.[107] While these impacts cannot be directly read across to regulated networks, where there is an expectation that elements of the regulatory regime will be tweaked from one regulatory period to the next, it does demonstrate what could happen if a fundamental part of a regulatory regime were removed in its entirety, and without compensation.

4.62 Second, if an alternative mechanism were ever introduced, it is likely that it would be more appropriate to introduce it on at least a net present value (NPV)-neutral basis. This is particularly important because the current regulatory regime in New Zealand appears to remunerate GPBs in line with their required return. This is evident by the NZCC noting in its 'Input Methodologies Review' of 2023 that:[108]

> The rates of return for GDBs and the GTB [gas transmission businesses] were generally in line with our estimates of their reasonable rate of return adjusted for ex post inflation,

[106] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', p. 6.
[107] Sendstad, L.H., Hagspiel, V., Mikkelsen, W.J., Ravndal, R. and Tveitstøl, M. (2022), 'The impact of subsidy retraction on European renewable energy investments', *Energy Policy*, **160**, 112675.
[108] Commerce Commission (2022), 'Part 4 Input Methodologies Review 2023 – Process and Issues paper', May, p. 61.

suggesting that they have generally not made excessive profits over the last seven years.

4.63 In addition, the electricity distribution businesses (EDBs) appear to have underperformed relative to return expectations.[109]

4.64 Therefore, any NPV-negative changes would probably lead to the expected returns of networks falling below their WACC, which would create a potential underinvestment problem and, in extreme cases, divestment.

4.2.5 The impact of decarbonisation on natural gas transmission and distribution

4.65 The activities of gas networks are changing substantially due to the energy transition. In some areas, gas networks are expected to slowly decommission assets, in some they are expected to maintain them, and in others they are expected to commission the new infrastructure needed to deliver renewable gases to end-consumers. In the context of this broad role that gas networks have, we have identified three reasons why decarbonisation could provide further reasons for aiming up on the WACC:

- to compensate gas networks for any residual risk that their assets will become stranded (i.e. if any risk is left after an asset beta uplift and accelerated depreciation);
- to enable investment in renewable gas infrastructure;
- to ensure an orderly energy transition.

4.66 We explain each of these in turn.

4.67 As we explain in section 3, decarbonisation can lead to natural gas assets becoming stranded—i.e. partially or wholly under-utilised and financially under-compensated. One of the approaches taken by regulators to mitigate this risk has been to uplift the allowed returns that are given to gas networks in order to compensate them for the additional risk of stranded assets. In section 3, we mention how the French energy regulator, CRE, uplifted the asset beta for gas networks in order to reflect these additional risks.[110]

4.68 In addition, regulators use accelerated depreciation. With this regulatory tool, networks recover their investment in the asset base faster, reducing the probability of the assets becoming economically stranded. As a result, as explained in section 3.2, the risk is reduced, but not eliminated.

4.69 With some assets to be maintained, some built and some decommissioned in light of the energy transition, there are higher chances of introducing inefficiencies into the system relative to times of business-as-usual operation. This is because gas networks could build more than required or decommission

[109] We have not commented on Transpower's profitability because the NZCC also did not comment on it. Commerce Commission (2022), 'Part 4 Input Methodologies Review 2023 – Process and Issues paper', May, pp. 50–52.
[110] See para. 3.16.

assets either too early or too late. With the probability of under-utilisation and subsequent financial losses being potentially higher than over-utilisation and subsequent financial gains, there is likely to be an asymmetry of financial outcomes.

4.70 A general uplift to the WACC, for example through aiming up, would be appropriate if the extent of asset stranding risk cannot be or has not been fully remunerated in other elements of the WACC calculation such as asset beta, or with other regulatory tools such as accelerated depreciation. For example, the Austrian regulator for gas TSOs (E-Control) includes a risk premium in the cost of equity allowance in the 2021–24 price control. The premium is composed of two parts: a sector-wide uplift of 3.5% to the cost of equity allowance, and an individual risk premium for estimated capacity risk of specific regulated networks.[111] The additional income from these two risk premia must be entirely ring-fenced, and therefore cannot be distributed to shareholders and has to be retained by the network companies as reserve to compensate for losses if risk materialises.[112]

4.71 As New Zealand decarbonises its economy, there is likely to be a greater need for it to construct infrastructure for renewable gases. While New Zealand is still in the early stages of developing its Gas Transition plan, with publication expected in late 2023, we understand that a major part of it will focus on the role that renewable gases such as green hydrogen, biomethane and renewable LPG will have in the future.[113] Further details on the role of natural gas in New Zealand's energy transition can be found in Box 4.1 below.

Box 4.1 The role of gas in New Zealand's energy transition

As part of the Emissions Reduction Plan, the government of New Zealand is currently developing an overall Energy Strategy, a key input of which will be the Gas Transmission Plan for the natural gas sector. The Gas Transmission Plan outlines actions to be taken up to 2035 to reduce emissions in the natural gas sector, with the goal of a net zero carbon economy by 2050. This includes steps to decarbonise and reduce reliance on natural gas, while some natural gas is expected to remain in use in 2035.

[111] E-Control (2020), 'Methodology pursuant to section 82 Gaswirtschaftsgesetz (Gas Act, GWG) 2011 for the fourth period for transmission systems of Austrian Gas Transmission System Operators (TSOs)', sections II.3 and III.2, https://www.e-control.at/documents/1785851/1811582/E-Control_Cost_Methodology_2021_2024_EN.pdf/81ad7664-3c27-9360-5283-81a39e3a815e?t=1596794285387 (accessed on 24 January 2023).
[112] Ibid., sections II.3 and III.2.
[113] MBIE (2022), 'Terms of Reference – Gas Transition Plan', https://www.mbie.govt.nz/dmsdocument/20265-terms-of-reference-gas-transition-plan (accessed on 24 January 2023).

New Zealand's Gas Transmission Plan has two pillars: the first pillar involves transition pathways for the natural gas sector with a particular focus on the period up to 2035, the identification of additional required measures and actions, and the development of milestones for progress assessment. The second pillar focuses on the development of a cohesive view on renewable gases, focusing on how these can be used to reduce emissions and lower transition costs for customers that currently use natural gas.

Source: New Zealand Ministry of Business, Innovation and Employment (2022), 'Gas Transition Plan', https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/gas-transition-plan/ (accessed on 24 January 2023). The finalised Gas Transition Plan is expected to be published by the end of 2023, with the overall Energy Strategy expected by the end of 2024.

4.72 Ensuring that the efficient investment costs of gas networks are recovered is likely to help with an orderly energy transition. Gas consumers in New Zealand are likely to want to maintain reliable access to the gas network, which will require additional reliability investment (e.g. in the form of maintenance) from gas networks. This will occur precisely at a time when investor appetite for additional investment could be falling, due to the risks of asset stranding. While the precise details of New Zealand's energy transition are yet to be developed, and will evolve over time, it is possible that many of the existing stakeholders in gas (and electricity) infrastructure will remain the same. This could be in the form of gas networks being repurposed for renewable gas or equity and debt investors in gas networks being the same investors that would fund investment in new infrastructure.

4.73 The greater the role that renewable gases have in New Zealand's energy transition, the more important it will be to ensure that new transmission and distribution infrastructure is constructed on a timely basis. This is less likely to happen if the WACC of the (renewable) gas network operator is above the regulated WACC. Due to the high social costs of delaying the energy transition, this risk is likely to increase the asymmetry of the loss function relative to the NZCC's current approach, where the asymmetry arises exclusively from the network reliability framework. This increased asymmetry will provide greater reason to aim for a higher percentile.

4.3 WACC percentile conclusions

4.74 We consider that the evidence for aiming up on the WACC remains strong. While it is true that a few regulatory precedents are focused on aiming straight than aiming up, a number of regulators do still aim up, and recent academic research by Romeijnders and Mulder supports this. Furthermore, none of the regulators that now aim straight formally use the same framework as the NZCC to assess the appropriate WACC percentile. The decisions adopted by these regulators may therefore not have direct read-across to the NZCC context.

4.75 The evidence from the NZCC's network reliability framework suggests that, based on CEPA's update of our 2014 analysis, the optimal percentile for the NZCC to aim for would be the 80th. We disagree with CEPA that the benefits of aiming up could be overstated within this framework, and find that there are a number of reasons to consider that the optimal percentile could be even higher. These reasons are that:

- other evidence on the costs of network failures could suggest higher costs than those assumed by CEPA;
- the annual costs of network failures that CEPA has updated could be difficult to reverse;
- if other elements of regulation do not compensate gas networks for the additional risks associated with stranded assets in full, a WACC uplift or aiming up in the range could be applied to compensate for this;
- if the NZCC's network reliability framework is expanded to consider the costs of underinvestment for the energy transition then the loss function considered by the NZCC will become more asymmetric.

4.76 While we agree that performance-based mechanisms can also be used to limit the risks of underinvestment, we do not consider that this would be appropriate in New Zealand. This is because changing the regulatory mechanism could create regulatory risk, thereby increasing the costs of energy to consumers in the medium to long term. Furthermore, there is no clear case for change in New Zealand, especially as the NZCC's own evidence suggests that networks are not being over-remunerated.

4.77 Overall, we find that evidence from the NZCC's network reliability framework supports a percentile above the 67th. We explained in our 2014 paper that there is value in regulatory stability, and therefore consider that an appropriate course of action would be for the NZCC to maintain its previous decision and aim for at least the 67th percentile.

5 Other WACC parameters

5.1 In conclusion to our assessment of the asset beta and WACC percentile, we now make a few remarks on other parameters of the NZCC's methodology for the cost of capital allowance.

5.2 Over the last three years, since the start of the COVID-19 pandemic, a number of unusual events have affected capital markets and macroeconomic conditions across the globe. There has been significant volatility in interest rates and therefore the cost of borrowing, in parallel with upward inflationary pressure.

5.3 These events are likely to have influenced the risk premia demanded by investors in various jurisdictions and in various sectors of the economy. Within the capital asset pricing model (CAPM) framework, this could have affected the risk-free rate, the equity risk premium and the beta of regulated utilities. It is also likely to have affected the cost of debt financing for corporates, including regulated utilities.

5.4 Below, we highlight the factors that the NZCC may consider relevant as part of its upcoming IM review in addition to the estimation of the asset beta and the choice of the WACC percentile, especially in light of recent macroeconomic developments.

- **Risk-free rate indexation**: in principle, at times of market uncertainty, a mechanism to account for unexpected changes in specific parameters may be helpful to ensure that companies remain financeable and healthy within price control periods. In the UK, for example, some regulators have adopted an indexation mechanism whereby the risk-free rate is updated on a yearly basis. This method seeks to provide companies with some incentive to outperform while providing protection against market shocks—such that exposure to adverse shocks would be limited to the period between indexation dates. As the benchmark is specified at the beginning of the control period, the adjustment to the allowed returns would be automatic and undertaken with a consistent methodology during the price control period, for transparency. Other mechanisms for managing market uncertainty in interest rates could also be considered by the NZCC, such as reopeners to the cost of capital allowance or allowing headroom above spot rates when setting the allowance ex ante.
- **Risk-free rate convenience premium:** there is a question as to whether it is appropriate to directly read across the current market evidence on government bond yields into the CAPM used in a regulatory context. The academic literature explains that government bonds have special safety, collateral, hedging and liquidity characteristics relative to other securities. The demand for government bonds is also increased by regulatory requirements for banks and other

financial institutions to hold such assets. These features give rise to a convenience premium.[114] The convenience premium pushes the yields on government bonds below the required rate of return for a zero-beta asset. Therefore, in order to be used as a proxy for the risk-free rate, the yields on bonds issued by governments with a high sovereign credit rating would need to be adjusted upwards to remove the impact of the convenience premium. Regulators such as ARERA (Italy) and BNetzA (Germany) specifically uplift the risk-free rate to account for the convenience premium.[115]

- **Financeability test:** holistically, the regulatory control package should allow operators to carry out regulated activities that are efficiently undertaken, with minimal disruption; this is in line with protecting consumer interests in relation to essential services such as energy. This includes seeking to ensure financial resilience of efficient operators in times of uncertain macroeconomic conditions. A financeability test is used to ensure that the allowed returns are set at a level at which operators can comfortably meet their financial expenses and maintain a given credit rating. Financeability tests are especially useful when combined with a number of sensitivities to test the robustness of an operator's financials over the control period.

5.5 The NZCC may wish to consider these topics in the context of the upcoming IMs review alongside other aspects of the cost of capital assessment.

[114] The convenience premium reflects the money-like convenience services offered by government bonds, which have special safety and liquidity characteristics. We explain the concept of the convenience premium in detail in Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', prepared for the Energy Networks Association, 20 May. See also Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), 'The Aggregate Demand for Treasury Debt', *Journal of Political Economy*, **120**:2, April, pp. 233–67.
[115] ARERA (2021), 'Criteri per la determinazione e l'aggiornamento del tasso di remunerazione del capitale investito per i servizi infrastrutturali dei settori elettrico e gas per il periodo 2022-2027'. Bundesnetzagentur (2021), 'BK4-21-055'.

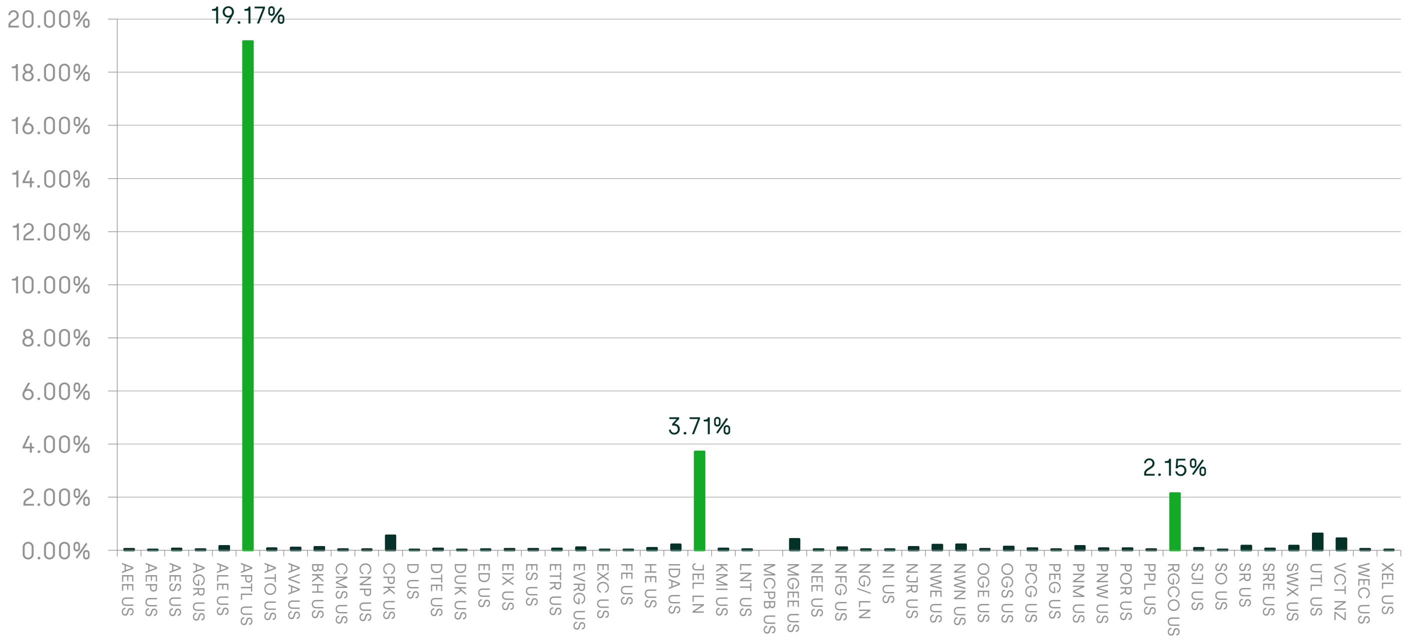
A1 Oxera liquidity filtering

A1.1 In this appendix, we provide the details of our filtering analysis. We show the results of the following fiters in turn:

- average bid–ask spread;
- average free-float share percentage;
- average share turnover;
- percentage of zero return days;
- equity beta filter.

A1.2 Figure A1.1 shows the **average bid–ask spread** for the initial sample of comparators. The figure shows three clear outliers: Alaska Power and Telephone Co. (19.2%), Jersey Electricity (3.7%) and RGC Resources (2.1%). We exclude these companies from the sample.

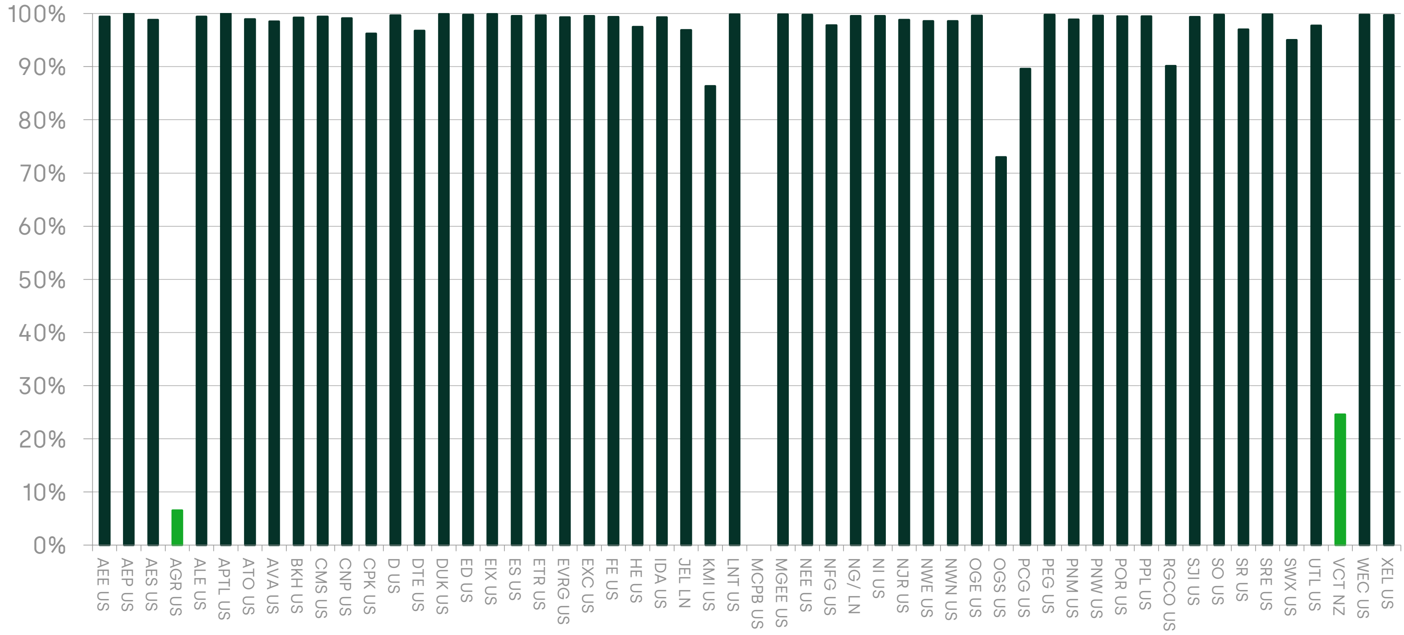
Figure A1.1 Average bid–ask spread (2017–22)



Note: The chart shows the companies included in CEPA's 2022 sample (after removing the three companies that we exclude as a result of the qualitative review of business activities) together with the three companies that NZCC or CEPA excluded from their samples due to the low liquidity (for further information, refer to footnote 35).
Source: Oxera analysis based on data from Bloomberg. The period covered is from 1 October 2017 to 30 September 2022.

A1.3 As for the percentage of free-float shares, without considering Mount Carmel Public Utilities Co., for which no data is available, Avangrid Inc (AGR US) and Vector Limited (VCT NZ) are the comparators showing the lowest values within the sample, at 6.5% and 24.6% respectively (see Figure A1.2).

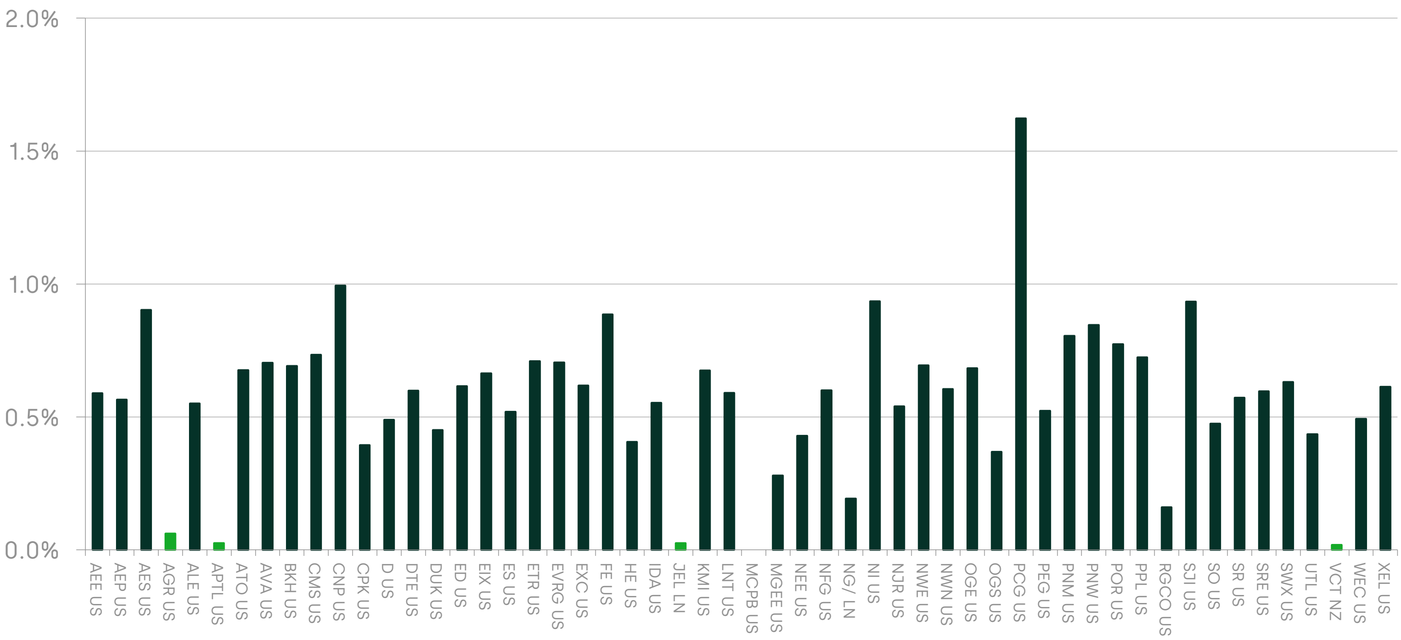
Figure A1.2 Average free-float share percentage (2017–22)



Note: The chart shows the companies included in CEPA's 2022 sample (after removing the three companies that we exclude as a result of the qualitative review of business activities) together with the three companies that NZCC or CEPA excluded from their samples due to the low liquidity (for further information, refer to footnote 35).
Source: Oxera analysis based on data from Bloomberg. The period covered is from 1 October 2017 to 30 September 2022.

A1.4 On the analysis of the average share turnover (Figure A1.3), without considering Mount Carmel Public Utilities Co., for which no data is available, there are four companies showing exceptionally low values of share turnover: Alaska Power and Telephone Co. (0.025%), Vector Limited (0.018%), Jersey Electricity (0.025%), and Avangrid Inc. (0.061%).

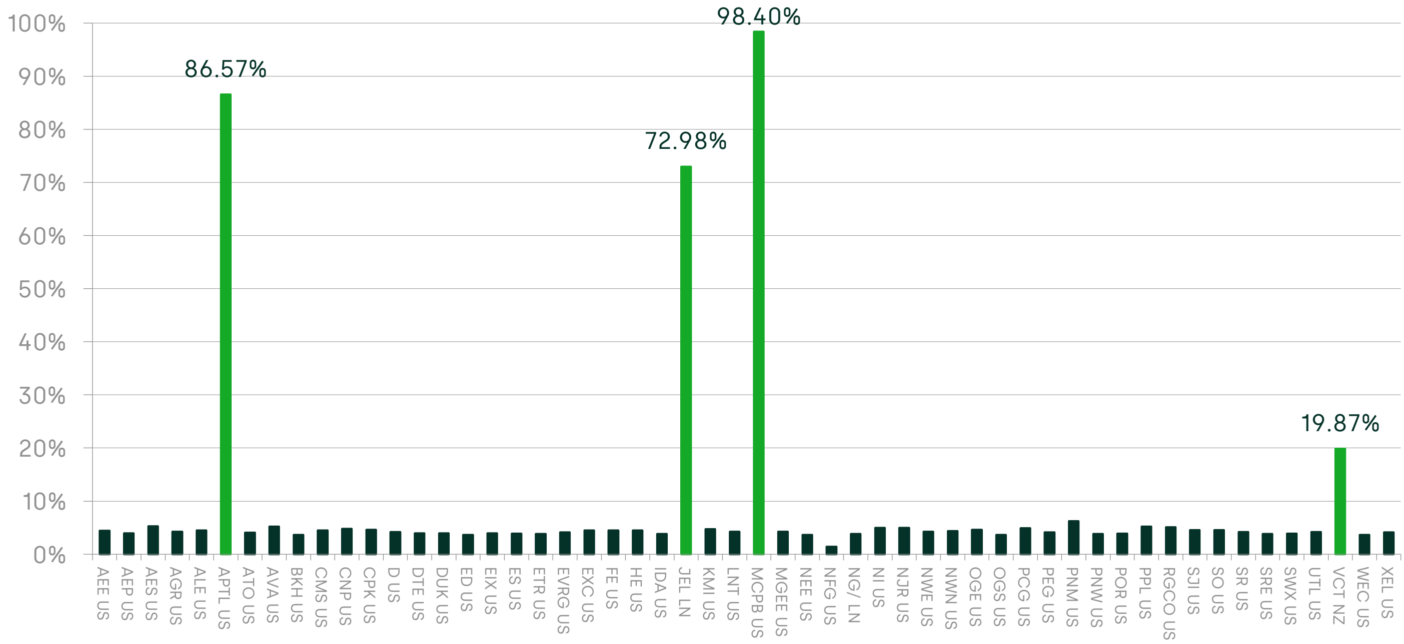
Figure A1.3 Average share turnover (2017–22)



Note: The chart shows the companies included in CEPA's 2022 sample (after removing the three companies that we exclude as a result of the qualitative review of business activities) together with the three companies that NZCC or CEPA excluded from their samples due to the low liquidity (for further information, refer to footnote 35).
Source: Oxera analysis based on data from Bloomberg. The period covered is from 1 October 2017 to 30 September 2022.

A1.5 Figure A1.4 shows the number of trading days with zero return for each comparator. By applying the liquidity filter based on the number of zero return days, three companies would be excluded as outliers: Alaska Power and Telephone Co. (86.6%), Jersey Electricity (73.0%) and Mount Carmel Public Utilities Co. (98.4%). Vector Limited appears to have a percentage of zero return days (19.9%) above the sample average (9.1%).

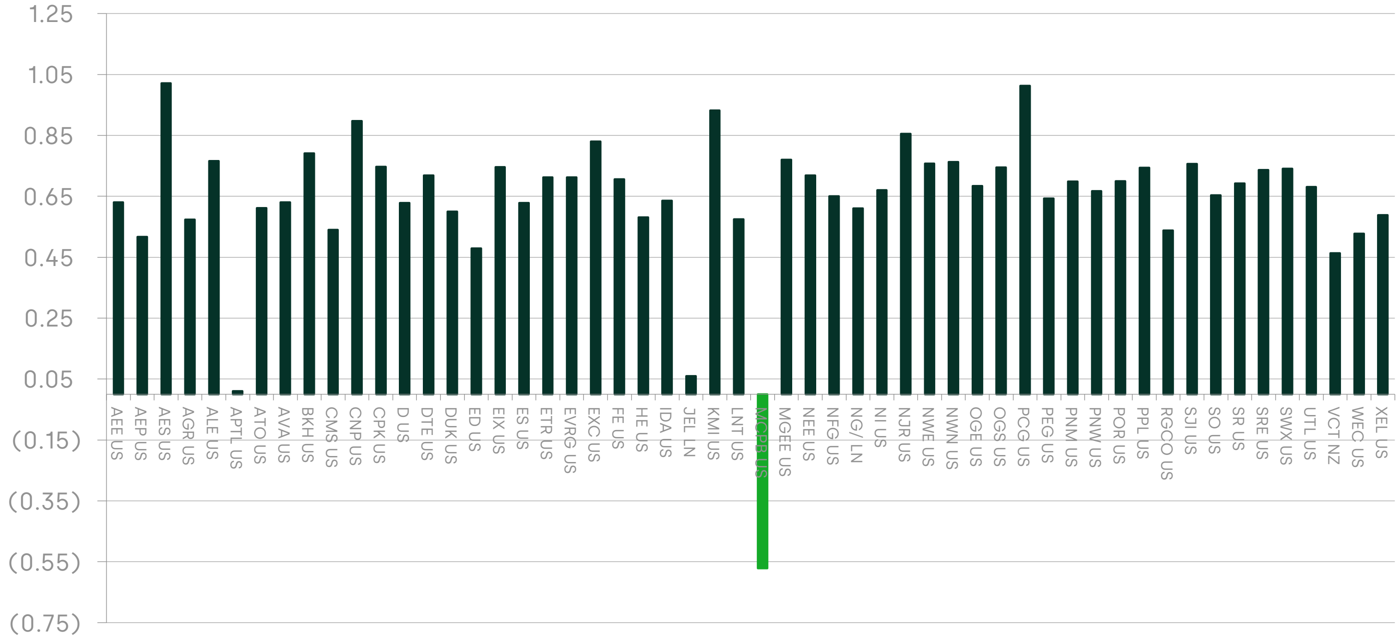
Figure A1.4 Percentage of zero return days (2017–22)



Note: The chart shows the companies included in CEPA's 2022 sample (after removing the three companies that we exclude as a result of the qualitative review of business activities) together with the three companies that NZCC or CEPA excluded from their samples due to the low liquidity (for further information, refer to footnote 35).
Source: Oxera analysis based on data from Bloomberg. The period covered is from 1 October 2017 to 30 September 2022.

A1.6 Figure A1.5 shows the comparators' daily raw equity beta to compare it against the assumed debt beta of zero. In particular, assuming a debt beta equal to zero, the equity beta filter would lead to the exclusion of all companies with negative equity betas, as equity is supposed to be higher risk than debt. Mount Carmel Public Utilities Co. shows a negative equity beta (equal to -0.57), which cannot reflect business risks accurately. It is worth highlighting that Alaska Power and Telephone Co. and Jersey Electricity, assesed to be illiquid based on other filters, show abnormally low daily raw equity betas, at 0.01 and 0.06 respectively. Similarly, RGC Resources shows an abnormally low four-weekly raw equity beta, at 0.02.

Figure A1.5 Daily five-year raw equity beta (2017–22)



Note: Based on a five-year daily regression analysis. The chart shows the companies included in CEPA's 2022 sample (after removing the three companies that we exclude as a result of the qualitative review of business activities) together with the three companies that NZCC or CEPA excluded from their samples due to the low liquidity (for further information refer to footnote 35).
Source: Oxera analysis based on data from Bloomberg. The cut-off date is 30 September 2022 so as to be consistent with the CEPA analysis.

A1.7 As concluded in section 2.2.1, based on the liquidity and equity beta filters, we exclude the following six companies from the sample:

- Jersey Electricity (JEL LN);
- Alaska Power and Telephone Co. (APTL US);
- Mount Carmel Public Utilities Co. (MCPB US);
- RGC Resources (RGCO US);
- Vector Limited (VCT NZ);
- Avangrid Inc (AGR US).

A1.8 Our final sample therefore comprises 48 companies. For further details on Oxera's 2023 sample, please refer to Table A2.1 in Appendix A2.

A2 Oxera's 2023 sample

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A2.9 Table A2.1 shows the comparators contained in Oxera's 2023 sample, together with their geographical area and energy subsample. Our sample contains 48 companies, out of which:

- 27 are integrated energy companies;
- 12 are electricity distribution companies;
- nine are gas distribution companies.

Table A2.1 Oxera's 2023 sample: components, geographical area, energy subsample

No.	Company name	Ticker code	Energy subsample	Reason for excluding from the Oxera sample
1	Ameren Corporation	AEE US	Integrated	n.a.
2	American Electric Power	AEP US	Electricity	n.a.
3	AES Corp	AES US	Electricity	n.a.
4	Allete Inc	ALE US	Electricity	n.a.
5	Atmos Energy Corp	ATO US	Gas	n.a.
6	Avista Corp	AVA US	Integrated	n.a.
7	Black Hills Corp	BKH US	Integrated	n.a.
8	CMS Energy Corp	CMS US	Integrated	n.a.
9	Centerpoint Energy Inc	CNP US	Integrated	n.a.
10	Chesapeake Utilities Corp	CPK US	Gas	n.a.
11	Dominion Energy Inc	D US	Integrated	n.a.
12	DTE Energy Company	DTE US	Integrated	n.a.
13	Duke Energy Corp	DUK US	Integrated	n.a.
14	Consolidated Edison Inc	ED US	Integrated	n.a.
15	Edison International	EIX US	Electricity	n.a.
16	Eversource Energy	ES US	Integrated	n.a.
17	Entergy Corp	ETR US	Electricity	n.a.
18	Evergy Inc	EVRG US	Electricity	n.a.
19	Exelon Corp	EXC US	Integrated	n.a.
20	First Energy Corp	FE US	Integrated	n.a.
21	Hawaiian Electric Inds	HE US	Electricity	n.a.
22	Idacorp Inc	IDA US	Electricity	n.a.
23	Kinder Morgan Inc	KMI US	Gas	n.a.
24	Alliant Energy Corp	LNT US	Integrated	n.a.
25	MGE Energy Inc	MGEE US	Integrated	n.a.
26	Nextera Energy Inc	NEE US	Electricity	n.a.
27	National Fuel Gas Co	NFG US	Gas	n.a.
28	National Grid Plc	NG/ LN	Integrated	n.a.
29	Nisource Inc	NI US	Integrated	n.a.
30	New Jersey Resources Corp	NJR US	Gas	n.a.
31	Northwestern Corp	NWE US	Integrated	n.a.
32	Northwest Natural Holding Co	NWN US	Gas	n.a.
33	Oge Energy Corp	OGE US	Integrated	n.a.
34	One Gas Inc	OGS US	Gas	n.a.
35	P G & E Corp	PCG US	Integrated	n.a.
36	Public Service Enterprise GP	PEG US	Integrated	n.a.
37	PNM Resources Inc	PNM US	Electricity	n.a.

No.	Company name	Ticker code	Energy subsample	Reason for excluding from the Oxera sample
38	Pinnacle West Capital	PNW US	Electricity	n.a.
39	Portland General Electric Co	POR US	Integrated	n.a.
40	PPL Corp	PPL US	Integrated	n.a.
41	South Jersey Industries	SJI US	Integrated	n.a.
42	The Southern Company	SO US	Electricity	n.a.
43	Spire Inc	SR US	Gas	n.a.
44	Sempra Energy	SRE US	Integrated	n.a.
45	Southwest Gas Holdings Inc	SWX US	Gas	n.a.
46	Until Corp	UTL US	Integrated	n.a.
47	WEC Energy Group Inc	WEC US	Integrated	n.a.
48	Xcel Energy Inc	XEL US	Integrated	n.a.
Excluded from CEPA sample by Oxera				
49	ONEOK Inc	OKE US	Gas	Business activities
50	Centrica Plc	CAN LN	Gas	Business activities
51	Scottish and Southern Energy plc	SSE LN	Integrated	Business activities
52	RGC Resources	RGCO US	Gas	Liquidity
53	Vector Ltd	VCT NZ	Integrated	Liquidity
54	Avangrid Inc	AGR US	Integrated	Liquidity

Source: Oxera.

A2.10 Table A2.2 summarises the 2017–22 daily asset betas and leverage estimates of the comparators contained in Oxera's 2023 sample.

Table A2.2 Oxera's 2023 sample: daily asset betas and leverage estimates for 2017–22

No.	Company name	Ticker code	Daily asset beta	Leverage
1	Ameren Corporation	AEE US	0.40	37%
2	American Electric Power	AEP US	0.30	42%
3	AES Corp	AES US	0.40	61%
4	Allete Inc	ALE US	0.53	31%
5	Atmos Energy Corp	ATO US	0.44	28%
6	Avista Corp	AVA US	0.36	42%
7	Black Hills Corp	BKH US	0.41	48%
8	CMS Energy Corp	CMS US	0.31	43%
9	Centerpoint Energy Inc	CNP US	0.49	46%
10	Chesapeake Utilities Corp	CPK US	0.54	28%
11	Dominion Energy Inc	D US	0.38	40%
12	DTE Energy Company	DTE US	0.41	42%
13	Duke Energy Corp	DUK US	0.31	48%
14	Consolidated Edison Inc	ED US	0.27	44%
15	Edison International	EIX US	0.39	47%
16	Eversource Energy	ES US	0.39	39%
17	Entergy Corp	ETR US	0.34	52%
18	Evergy Inc	EVRG US	0.42	41%
19	Exelon Corp	EXC US	0.44	47%
20	First Energy Corp	FE US	0.34	52%
21	Hawaiian Electric Inds	HE US	0.56	3%

No.	Company name	Ticker code	Daily asset beta	Leverage
22	Idacorp Inc	IDA US	0.47	26%
23	Kinder Morgan Inc	KMI US	0.49	47%
24	Alliant Energy Corp	LNT US	0.37	35%
25	MGE Energy Inc	MGEE US	0.64	16%
26	Nextera Energy Inc	NEE US	0.52	28%
27	National Fuel Gas Co	NFG US	0.43	33%
28	National Grid Plc	NG/ LN	0.32	47%
29	Nisource Inc	NI US	0.34	49%
30	New Jersey Resources Corp	NJR US	0.56	34%
31	Northwestern Corp	NWE US	0.45	41%
32	Northwest Natural Holding Co	NWN US	0.47	38%
33	Oge Energy Corp	OGE US	0.45	34%
34	One Gas Inc	OGS US	0.49	34%
35	P G & E Corp	PCG US	0.43	57%
36	Public Service Enterprise GP	PEG US	0.41	36%
37	PNM Resources Inc	PNM US	0.37	48%
38	Pinnacle West Capital	PNW US	0.40	41%
39	Portland General Electric Co	POR US	0.42	40%
40	PPL Corp	PPL US	0.42	44%
41	South Jersey Industries	SJI US	0.38	50%
42	The Southern Company	SO US	0.36	46%
43	Spire Inc	SR US	0.38	45%
44	Sempra Energy	SRE US	0.44	40%
45	Southwest Gas Holdings Inc	SWX US	0.44	41%
46	Until Corp	UTL US	0.41	40%
47	WEC Energy Group Inc	WEC US	0.35	33%
48	Xcel Energy Inc	XEL US	0.36	39%
	Average		**0.42**	**40%**

Note: [1] Assuming a zero debt beta and a notional leverage equal to 40%, re-levered equity betas are calculated using the following formula: $\beta_e = \beta_a$ / (1 - notional leverage). The cut-off date is 30 September 2022.
Source: Oxera's calculations based on the 2016 NZCC Excel model.

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