Review of the percentile of the WACC distribution that should be targeted by the NZCC

Prepared for
Aurora, Orion, Powerco, Unison, Vector, Wellington Electricity

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1 Executive summary

In its 2010 Input Methodologies (**IM**) Decision for energy networks, the New Zealand Commerce Commission (**NZCC**) set the WACC at the 75th percentile. This meant that, after estimating the mid-point for the WACC, the NZCC then adjusted this mid-point to the 75th percentile by assuming that the WACC was normally distributed with a standard error that was estimated as part of the NZCC's WACC methodology. Following a court challenge in 2013, the NZCC reduced the WACC uplift to the 67th percentile for the 2016 IM Decision. More recently, in 2020, the NZCC set the WACC percentile for regulated fibre to the 50th percentile.

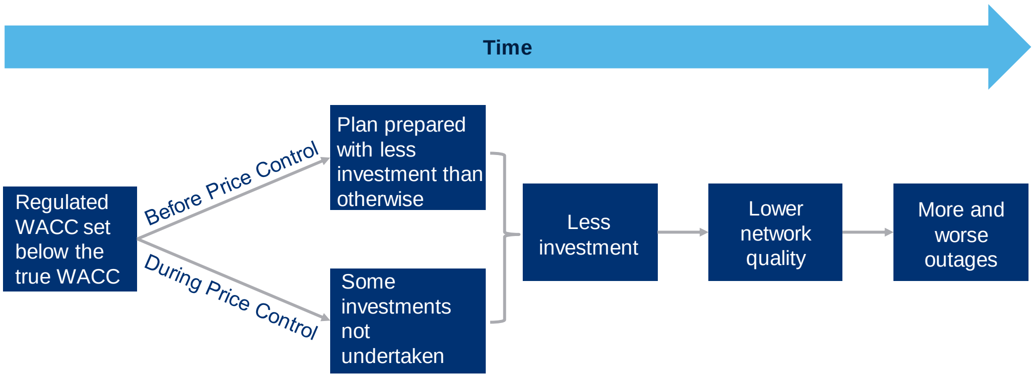
Oxera has been commissioned by Aurora, Orion, Powerco, Unison, Vector, and Wellington Electricity (together, '**the Electricity Distribution Businesses (EDBs)**') to assess the appropriate percentile that the NZCC should aim for in its methodology. The purpose of this report is to inform the EDBs in relation to the percentile of the WACC distribution that the NZCC targets for regulated energy networks and, specifically, electricity distribution. The report is being written in the context of the NZCC's ongoing review into its methodology for the 2023 IM for energy networks.

In this report, we find that the evidence supports the NZCC in targeting a WACC estimate that is in the range of the 65th to 75th percentile. This would suggest that the 70th percentile of the WACC distribution would be the most appropriate percentile to target. However as the NZCC targeted the 67th percentile in the last regulatory period, and (i) this percentile is within our range; (ii) we consider there to be substantial value in maintaining regulatory stability, we conclude that it would be appropriate for the NZCC to continue targeting the 67th percentile of the WACC. The process that would need to be taken to accurately calculate the 67th percentile of the WACC distribution would be to start with an unbiased estimated of the 50th percentile, then adjust this estimate to reach the 67th percentile, based on the distribution of the WACC.

First, we assess the implications of using a network reliability framework. This is the framework that the NZCC has used historically, to assess the appropriate percentile to target in a range of regulated industries. Within this framework, it is necessary to decide how to select a point estimate within a WACC range (i.e. what percentile, and whether to 'aim up' relative to the mid-point of the range) because there is uncertainty about the level of the 'true' WACC, i.e. the risk-adjusted return that is required in the sector. This means, in turn, that the regulated (allowed) WACC can differ from the true WACC.

The causal mechanism that explains the relationship between the level of the regulated WACC and the true WACC is depicted in Figure 1.1 below. This shows that a regulated WACC set below the true WACC creates incentives for networks to propose less investment prior to a regulatory period and to undertake fewer investments during a regulatory period. This lower level of investment will reduce the quality of the network and eventually lead to more and worse outages, which is not in the long-term interests of consumers.

Figure 1.1 How might the regulated WACC being below the true WACC undermine network reliability?



Source: Oxera.

The network reliability framework thereby trades off the additional consumer costs of aiming for a higher WACC percentile against the reduced likelihood and severity of outages. Importantly, it also finds that there is likely to be an 'asymmetric loss function', whereby the effects of increased outages are more damaging to society than any additional costs which consumers incur for electricity if a WACC percentile above the mid-point is selected. In concluding on the reasonableness of the 65th to 75th percentile range, we observe that the evidence we have reviewed in this report shows that—from a network reliability perspective—a percentile anywhere between the 65th and 85th could be reasonable.

Second, we consider how the asymmetric effects of delaying the connection of low-carbon technologies (**LCTs**) could generate further reasons to aim up on the WACC percentile. We refer to this as the 'decarbonisation framework' and consider that if regulated utilities are unable to upgrade their networks in a way that allows for timely connection of LCTs,[1] then this will generate a further source of asymmetric costs, because the social costs of delaying decarbonisation are substantial. This additional benefit would increase the range that should be targeted, although it has not been possible for us to identify the precise magnitude of this effect. We therefore interpret this to indicate that: (i) the bottom end of the range we identified (i.e. around the 65th percentile) is not appropriate; (ii) maintaining a WACC uplift (at the 67th percentile) is more strongly supported now than it was in 2014, when we wrote our previous report for the NZCC.

Third, as a countervailing consideration to aiming up within the WACC range, we consider that the upper end of the range may prove unnecessarily expensive for end-consumers, as other regulatory tools can also play a role in mitigating the risks of under-investment. Selecting too high a percentile could unnecessarily increase the incentives for 'gold-plating' in relation to network investments. We consider this to rule out targeting a WACC percentile above the 80th, as we find that targeting the 85th percentile of the WACC results in consumers experiencing an increase in electricity bills that is approximately twice as high as what they experience at the 70th percentile.

We also observe that the evidence from the most recent (ongoing) energy regulatory period is largely supportive of maintaining the 67th percentile as an appropriate percentile estimate. Specifically, we have found that, across the course of the ongoing regulatory period, both the asset health and age of the

[1] Irrespective of whether the investment in LCTs is undertaken by the EDBs or by third parties.

networks has increased slightly. This suggests that networks have maintained network quality without significant net increases in the installed asset base, indicating that the regulatory period has effectively delivered a balance between maintaining (in fact, improving) network quality and preventing over-investment.

Fourth, we note the fact that the NZCC has not found any evidence of over-compensation of energy networks. In fact, the NZCC has published evidence that regulated utilities have been under-compensated (i.e. earned relatively low returns) over the period. This indicates that, despite setting the WACC at the 67th percentile in the previous control, consumers have not faced unduly high electricity costs.

Taken together, we therefore find that two pieces of evidence—specifically, the outcomes of the last regulatory period and the ability for other regulatory measures to mitigate some risk of under-investment—suggest that a percentile from the lower part of the 65th to 85th percentile range should be selected. The presence of decarbonisation benefits acts against this and suggests a percentile from the upper end of the range could be more appropriate.

Owing to the fact that we consider the two reasons for selecting a percentile from the lower end of the range to be more compelling than the reasons for selecting a percentile from the upper end, we conclude that a percentile between the 65th and 75th is appropriate.

We note that our conclusion on the appropriateness of the 65th to 75th percentile range has not been informed by evidence from regulatory precedents. We observe in this report that recent international regulatory precedent within the energy sector has typically (but not always) been for regulators to aim straight, rather than up, on the WACC. While, in principle, the frameworks that we considered apply to all regulated network activities where the social costs of under-investment exceed the benefits, in practice most regulators do not consider this framework when setting the appropriate WACC percentile with the same level of rigour that the NZCC has. Therefore, the lack of international regulatory precedent on using this framework to infer the extent to which the regulator needs to aim up, above the mid-point of the estimated WACC range, should not be seen as invalidating the NZCC's approach. This would suggest that the 70th percentile of the WACC distribution would be the mid-point to target, but as explained above, we give weight to the 67th percentile from the last regulatory period as there is substantial value in maintaining regulatory stability for long-lived network investments.

In addition to our conclusions on the WACC percentile, we also explain that the NZCC should re-consider the way that it calculates the standard error of the WACC. Currently, the NZCC only includes the standard errors of some parameters of the WACC. While the standard errors of many of the parameters that it excludes may be relatively small, and therefore their exclusion could be justified on the basis of immateriality, this is not the case with leverage (i.e. the gearing ratio) as in New Zealand this is calculated on the basis of a large number of comparators, with very different levels of leverage. Consequently, the standard error of leverage is likely to be material and to reflect genuine uncertainty as to the notional leverage that should be assumed. We therefore do not see a good reason for excluding this parameter from the calculation of the WACC standard error. The consequence of adding the standard error of leverage into the estimate of the WACC standard error would be to increase the standard error of the WACC, meaning that aiming for a particular percentile of the WACC distribution would result in a higher regulated WACC.

2 Scope and context

In its 2016 IM for EDBs, the NZCC chose to set the WACC at the 67th percentile of the WACC distribution. The EDBs have asked Oxera to provide an independent view on whether the 67th percentile is the appropriate level at which to set the WACC in New Zealand, or whether it should be amended to an alternative percentile.

We have conducted our work in the context of the NZCC's review of the IMs for EDBs, gas pipelines, and airports. This review started in April 2021 and is planned to end in December 2023,[2] and the findings of this report are intended to inform the EDBs in their engagement with the NZCC on the WACC percentile that it should target in its regulatory decision.

Oxera's terms of reference in relation to this review cover investigation of the following questions.

- Why a regulator might want to aim for a percentile of the WACC distribution that is above the 50th percentile. In answering this question, we have been asked to consider both the reasons already included in the NZCC's framework, as well as any new reasons that may be relevant.
- Whether the rationale behind such a decision applies in the context of New Zealand and, if so, whether the 67th percentile represents the appropriate level.
- Whether the findings of the IM Decision for regulated fibre from October 2020, which determined that the 50th percentile was appropriate for providers of regulated Fibre Fixed Line Access Services (FFLAS), are applicable to EDBs.
- How regulators in other jurisdictions deal with uncertainty in the WACC.

The remainder of this report is structured as follows:

- section 3 explains the approach that the NZCC has historically taken to assessing which percentile of the WACC should be targeted;
- section 4 explains an appropriate percentile for the NZCC to aim for within the context of the framework that it has historically used;
- section 5 expands this framework, considering new evidence regarding the NZCC's framework that was not available to the NZCC during previous regulatory periods;
- section 6 concludes.

Box 2.1 CEPA update

After the original publication of our report, we were asked by the EDBs to consider CEPA's subsequently published report 'Review of Cost of Capital 2022/2023' (henceforth 'the CEPA report').[3] We have added high-level considerations in relation to the CEPA report in relevant sections of this report, within boxes whose titles start with 'CEPA update'.

[2] NZCC (2022), '2023 input methodologies review', accessed 25 August 2022, available here.
[3] CEPA (2022), 'Review of Cost of Capital 2022/2023', available here.

3 The NZCC's approach to setting a percentile for the WACC

This section is split into two subsections:

- section 3.1 summarises the reasons why the NZCC chose to set the WACC for EDBs at the 67th percentile in its last IM Decision;
- section 3.2 summarises the reasons why the NZCC chose to set the WACC for providers of regulated FFLAS at the 50th percentile in its most recent IM Decision for fibre.

Accordingly, this section provides important context for understanding the NZCC's network reliability framework— specifically, how the framework influences the choice of an appropriate point estimate in the WACC range. This framework subsequently forms the basis of our discussion of the percentile of the WACC distribution that should be targeted, in section 4.

3.1 Reasons why the NZCC chose to target the 67th percentile of the WACC distribution for EDBs

In its 2014 Reasons paper about why it chose to set the WACC at the 67th percentile for EDBs and gas pipelines (henceforth '**2014 Reasons Paper**'),[4] the NZCC broadly followed a two-step approach. First, it explained why it considered that the WACC should be set at a level above the 50th percentile.[5] Second, it considered the specific WACC percentile that should be targeted,[6] although this part of its report primarily focused on why the WACC should be below the 75th percentile. To align with the NZCC's two-step approach, we first explain why the NZCC chose to aim above the 50th percentile (section 3.1.1), then turn to why it chose to aim below the 75th percentile (section 3.1.2).[7]

3.1.1 Why did the NZCC choose a WACC percentile above the mid-point?

This section first explains the general framework used by the NZCC for assessing the trade-off between setting the WACC at different percentiles. It then explains why the NZCC considered that a higher WACC percentile could reduce the incentives for under-investment. Finally, it discusses a number of other considerations regarding why the NZCC should target a higher WACC percentile.

The framework that the NZCC used for assessing the trade-off between targeting different WACC percentiles

The framework that the NZCC used to consider whether a WACC percentile above the mid-point would be appropriate was primarily a **network quality** or **network reliability** framework.[8] Within this framework, aiming up on the WACC is appropriate if a higher WACC is more likely to result in the levels of

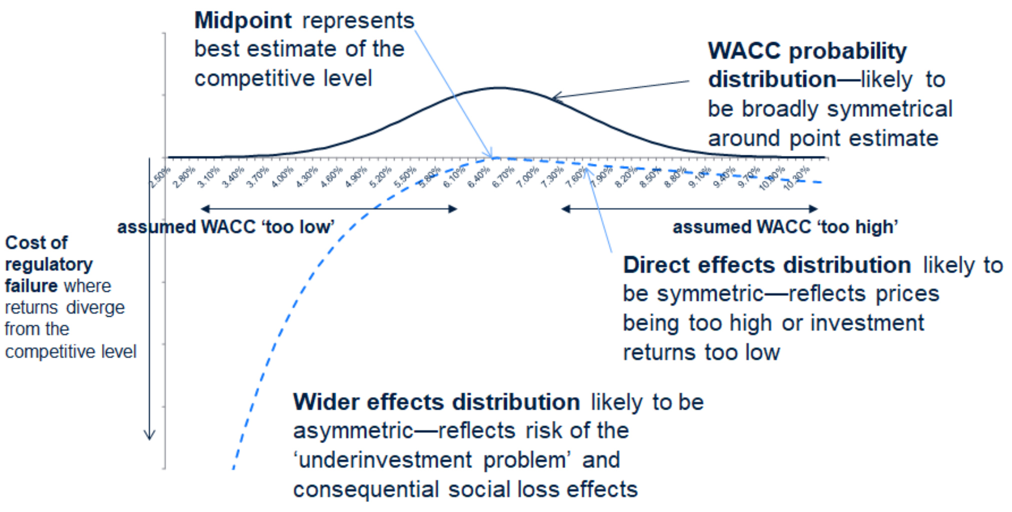
[4] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', available here.
[5] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', section 5, available here.
[6] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', section 6, available here.
[7] While section 3.1.1 primarily draws from section 5 of the 2014 Reasons Paper and section 3.1.2 primarily draws from section 6, we have also included factors that we understand affected the NZCC's decision but which are located elsewhere.
[8] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 5.78–5.79.

investment meeting the appropriate level, and if the benefits of meeting this investment level (i.e. through having fewer outages) exceed the additional costs that consumers face as a result of a higher WACC. The reason why consumers face higher costs as a result of a higher WACC is that it is typically assumed in energy markets that costs are (approximately) fully passed through, meaning that consumers pay for the higher regulated return on the RAB.

This network reliability framework was developed for the NZCC by Oxera, and was applied by the NZCC in its decision-making.[9] The framework can be visualised as in Figure 3.1 below, which maps the WACC distribution against an asymmetric loss function. The figure shows:

- the distribution of the estimated WACC of the regulated industry as a black line.[10] The distribution of the estimated WACC is centred around a mid-point that is assumed to reflect the true WACC. This means that the regulator's estimate of the WACC is more likely to be close to, than far away from, the true WACC, which is why the distribution has the characteristic bell-shape;
- the loss function, which is shown as a light-blue line, declines significantly towards the left of the WACC distribution, while it only drops off 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 relatively low compared to the cost of setting the WACC 'too low'.

Figure 3.1 Illustration of the framework for the WACC percentile



Source: Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', p. 2, available here. NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', Figure 6.8, available here.

This result (i.e. of an asymmetric loss function) arises because the cost of setting a WACC that is too low results in a greater risk of under-investment in the network and, consequently, outages. As the (social) cost of outages is typically assessed to be greater than the additional cost that the consumer

[9] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 5.28 and 5.60, available here.
[10] In the figure, the WACC is assumed to be normally distributed. This is because the WACC is typically estimated by summing a series of parameters whose asymptotic distributions are normal.

bears, the loss function will be asymmetric in the way shown in Figure 3.1. We note that the NZCC agrees with the basic principle that the potential impacts of outages could be significant,[11] and therefore with the characterisation of the asymmetric loss function in the New Zealand energy industry.

We also note that the NZCC placed some, but little, weight on considerations outside of the network reliability framework. Specifically, the NZCC considered that areas outside of network reliability (i.e. demand growth, innovation, and economic investments) did not exhibit an asymmetric loss, and therefore that under-investment in these areas would not lead to social costs in excess of the additional costs that consumers have to pay for a higher WACC. In short, they stated that the case for aiming up was 'relatively weak' in these areas.[12] While we understand this to mean that the NZCC did not place zero weight on such considerations, it considered them to be relatively immaterial in the context of its previous decision for the energy networks.

In 2014, the NZCC also did not consider the possible asymmetric effects of failing to meet net zero targets if a lower WACC percentile was selected. These considerations, which we refer to as the 'decarbonisation framework' in this report, are discussed in section 5.2.

The framework that the NZCC used to link a higher WACC percentile to a lower risk of under-investment

The NZCC also agreed with the mechanism we outlined for the relationship between a higher allowed WACC and a lower risk of under-investment.[13] Oxera's framework explained that companies will make more investments when it is less likely that the net present value (**NPV**) of the project will drop below 0: this is more likely to happen if a regulator aims for a WACC percentile above the mid-point. There is uncertainty about the level of the 'true' WACC, i.e. the risk-adjusted return that is required in the sector. This means, in turn, that the regulated (allowed) WACC can differ from the true WACC. Therefore, if the regulated WACC is below the true WACC, companies will have an incentive to reduce their levels of investment.

The regulated WACC is more likely to be below the true WACC if the regulator targets the 50th percentile of the WACC than if it targets some higher percentile, such as the 67th percentile.[14] This will also be true if one takes a 'trigger' approach to under-investment, whereby under-investment only materialises if the true WACC is above the estimated WACC by some material margin, such as 0.5% (which is a margin that both we and the NZCC have applied in the past[15]). In our 2014 report, we found that the probability of the true WACC being more than 0.5% above the estimated WACC was 32.1% at

[11] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 3.36 and 3.44, available here.
[12] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 5.82–5.83, available here.
[13] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 5.28 and 5.60, available here.
[14] This is because the probability of the true WACC being below the actual WACC is equal to 1 minus the percentile that is targeted (i.e. 50% if the 50th percentile is targeted and 33% if the 67th percentile is targeted).
[15] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.22.3, available here. NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.822, available here.

the 50th percentile, 19.7% at the 65th percentile, and 16.1% at the 70th percentile (we did not estimate the probability at the 67th percentile).[16]

In the NZCC's framework, the under-investment problem can arise at the following stages.

- **The planning stage**—the network will have an incentive to reduce the amount of investment that it proposes to undertake if the allowed WACC for the regulatory period is likely to be below the true WACC that is required by investors. This incentive effect applies to all types of investment.
- **During the regulatory period**—when the regulated company receives limited benefits from investment (i.e. where the NPV of investment is zero or close to zero), and absent any mitigating factors,[17] the company will have an incentive to inefficiently defer investment.
- **After the regulatory period decision is taken**—the under-investment will turn into an enduring under-investment problem if it cannot be resolved at the next review period.

As we noted in our 2014 report, this risk of under-investment can be mitigated by other elements of the regulatory period, such as incentive mechanisms.[18] However, as we explain in section 4.3, there is a limit to how effective this mitigation can be because replacing insufficient remuneration through potentially punitive measures like performance standards is not an effective long-term solution. In general, as we explain later, such mitigation will only be effective to the extent that, if the allowed WACC has been set too low by the regulator, these other mechanisms have been set in such a way that, in expectation, the investors can expect to earn a total return that is commensurate with the required return, i.e. the true WACC.

Other considerations

The NZCC considered two further types of evidence in deciding that a WACC percentile above the mid-point should be used. The first was evidence from regulatory precedents in other jurisdictions and the second was the impact of a higher WACC percentile on other markets.

The NZCC found that international regulators often adopt a WACC estimate above the mid-point by using estimates of individual parameters that are generous in favour of network companies.[19] The NZCC explained that this evidence from regulatory precedents affected its decision to set a WACC above the mid-point.[20] However, the NZCC does not appear to have discussed regulatory precedents in much detail, such that the weight that it placed on these as part of its overall decision, is unclear.

The NZCC also considered the impact of selecting a higher WACC percentile on other markets (i.e. industries that use electricity as an input into their

[16] The precise probability of the true WACC being greater than the estimated WACC by some absolute number of percentage points will depend on the standard error of the WACC. In our 2014 report, we used the standard error of the WACC as estimated by the NZCC. Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', Tables 6.1 and Table 7.3, available here.
[17] By mitigating factors, we refer to regulatory mechanisms that can reward or penalise the company to enforce that a certain level of investment is met.
[18] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', p. 50, available here.
[19] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.84.3, available here.
[20] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.84.3, available here.

production processes). The NZCC considered that there could be an allocative inefficiency throughout the economy, due to the role of electricity prices as an input.[21] The NZCC considered expert evidence from both the Oxera 2014 report and from its adviser, Dr Martin Lally.

First, in relation to this issue, Oxera's evidence considered two possible theories of harm and concluded that the effects of both theories of harm were likely to be immaterial:

- we considered whether a higher WACC could reduce the incentives for downstream businesses that use electricity as an input to undertake investment. We considered whether this could happen as a result of, among other things, their profits being reduced by the higher electricity price. We concluded that this was unlikely to have any material effects because even a 5% increase in electricity prices would affect less than 1%, and in many cases less than 0.1%, of the industrials' cost bases;[22]
- we considered whether a higher WACC would reduce the international competitiveness of New Zealand businesses. Here we found that, even for the most energy-intensive industries, the result of setting the WACC at the 75th percentile would be an increase in end-prices of less than 0.25% if there was full pass-on of the higher electricity costs, and a reduction in profit margins of 0.2% if there was no pass-on.[23]

Second, Dr Lally's evidence commented on the effects of a price increase on allocative efficiency generally, and did not consider an explicit theory of harm.[24] His advice was interpreted by the NZCC as implying that the question of downstream effects was relatively immaterial.[25]

Based on the evidence presented by Dr Lally and ourselves, the NZCC considered that arguments related to the indirect effects of a higher WACC on the competitiveness of New Zealand industry were not material to its decision that a percentile above the mid-point should be used.[26]

In summary, the above explains why the NZCC first concluded that a WACC percentile above the mid-point (50th percentile) of its estimated range was appropriate. It did this to reduce the risk of under-investment leading to poor network reliability, as a WACC set above the mid-point would tend to arise if the allowed WACC were lower than the true WACC required by investors. We turn now to the second step in the NZCC's methodology—why it chose to set the allowed WACC below the 75th percentile of its estimated range.

3.1.2 Why did the NZCC choose to set the WACC below the 75th percentile?

After explaining why it wanted to aim up on the WACC, the NZCC considered the reasons why it would want to aim for a specific percentile above the 50th. However, as we explained above, this part of the NZCC's 2014 Reasons Paper primarily focused on explaining why it had chosen a percentile below the 75th. Below, we therefore summarise the six reasons that we have distilled as to

[21] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.90, available here.
[22] Oxera (2014), 'Input Methodologies: Review of the '75th percentile', pp. 35–7, available here.
[23] Oxera (2014), 'Input Methodologies: Review of the '75th percentile', pp. 37–9, available here.
[24] Lally (2014), 'The Appropriate Percentile for a the WACC Estimate', p. 18, available here.
[25] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.92, available here.
[26] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.94, available here.

why the NZCC assessed that it was appropriate to set an allowed WACC below the 75th percentile, notwithstanding that it had already decided to aim up above the mid-point.

Reason 1: Evidence from investment plans and investor returns

Evidence from investment plans and investor returns implied that targeting the 75th percentile was at least sufficient to encourage the right level of investment

The NZCC considered that, at the 75th percentile, the incentive levels were at least sufficient, and potentially too large, to encourage investment in the energy networks.[27] It concluded this based on two types of evidence: the levels of infrastructure investment undertaken by network companies, and the returns earned by network companies.

First, with respect to the levels of infrastructure investment, the NZCC considered that there did not appear to be risk of significant under-investment in the network:

- the NZCC considered that the levels of investment that Orion (an EDB) had proposed were larger than necessary, and the levels of investment that Transpower had proposed were in line with requirements;[28]
- it found that there had been no evidence of the EDBs running down (i.e. failing to re-invest) their asset bases in the past.[29]

Second, with respect to investors' required returns, the NZCC considered that there was evidence of strong investor interest in New Zealand energy networks. It cited the acquisition of a 42% stake in Powerco alongside favourable commentary on the regulatory environment in New Zealand, as well as EV/RAB multiples above 1 as evidence of this.[30] The NZCC interpreted EV/RAB multiples above 1 as potentially indicating that the allowed return was too large,[31] although it did also acknowledge that this result could arise from a number of other factors, such as outperformance of regulatory benchmarks and higher profitability of the non-regulated parts of a business.[32]

The NZCC stated that it placed a particularly high level of weight on both of these pieces of evidence, stating that these outweighed any theoretical arguments for aiming above the 75th percentile.[33]

[27] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.12, available here.
[28] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.14, available here.
[29] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.16, available here.
[30] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.17, available here.
[31] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.29, available here.
[32] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.35, available here.
[33] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 6.18, available here.

Reason 2: Implications of using a consumer welfare standard

The use of a consumer welfare standard implies that there is less reason to aim up on the WACC than the use of a total welfare standard

The NZCC considered that a consumer welfare standard was the most appropriate way to assess the socio-economic benefits of targeting a particular percentile of the WACC.[34] This was consistent with the approach taken by Oxera in 2014, and was justified on the basis of Section 52A of the Commerce Act.[35]

The main alternative to a consumer welfare standard is a total welfare standard. The relationship between total welfare and consumer welfare can be expressed as:

$$TW = \alpha CS + (1-\alpha)PS$$

- where TW is total welfare;
- CS is consumer surplus (i.e. the level of consumer welfare);
- PS is producer surplus (i.e. the level of producer welfare);
- α is a weight.

If α is equal to 1, then total welfare is equal to consumer welfare, while the more α drops below 1, the greater the level of weight that is placed on producer welfare.[36] In this case, 'producers' are investors in the energy networks.

When a policy, such as the targeting of a particular percentile is introduced, the net socio-economic benefits of this policy are therefore assessed by summing the benefits that the policy delivers to consumers and energy networks, with the two benefits being weighted by α and $(1-\alpha)$. As the increase in the WACC percentile also delivers higher returns to the investors in the energy networks, the consumer welfare approach implies that no consideration is given to the benefits that producers experience from a higher WACC percentile.

Section 52A of the Commerce Act explains that the regulation of goods and services should be in the long-term interests of consumers. In this context, both the NZCC and Oxera considered that determining the percentile to target should be based on the relative costs and benefits that were experienced by consumers, and therefore that a consumer welfare rather than a total welfare standard should be used.[37]

Reason 3: Regulatory mitigants against risk of under-investment

The existence of alternative regulatory tools limits the extent to which the regulator needs to aim up on the WACC

[34] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above pp. 33–35, available here.
[35] Parliamentary Council Office (2022), 'Commerce Act 1986', Section 52A, available here.
[36] For more information, see Oxera (2014), 'Review of expert submissions of the input methodologies', section 3.3, available here.
[37] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', pp. 33–35, available here.

The NZCC considered that, due to the existence of alternative regulatory tools besides the WACC allowance, there was a limited risk of under-investment. While in its 2014 Reasons Paper, the NZCC did not put as much emphasis on the existence of alternative regulatory tools as it did in its 2020 IM Decision for regulated fibre (we discuss this in section 3.2), it did cite this as a reason to aim below the 75th percentile.

For example, the NZCC considered that:

- ex post incentive mechanisms would likely be more effective ways than the WACC allowance of incentivising investment in innovation;[38]
- economic investments can be incentivised through incentive measures that link grid outputs and quality standards to revenue;[39]
- providing allowances for a catastrophic event can be better dealt with through resetting the price paths than through increasing the regulated WACC.[40]

Reason 4: Assessment of biases in WACC estimation

The NZCC assessed that submissions stating that the mid-point estimate of the WACC was biased were incorrect

The NZCC received a number of submissions that stated the mid-point of the WACC that the NZCC calculates is downward-biased, and therefore that aiming up to the 75th percentile was needed to address this.[41]

The NZCC concluded that its estimate of the mid-point of the WACC was not downward-biased, and that if it was downward-biased then the appropriate way to address this would be to correct the mid-point of the WACC directly, rather than to aim up on the WACC.[42] For this reason, the NZCC did not feel that arguments about systematic downward bias in the WACC estimate presented any further reasons (i.e. over and above the reliability framework outlined in section 3.1.1) to aim up on the WACC.

Reason 5: Further increases in WACC percentile not justified

The NZCC did not consider some of the evidence for a higher WACC percentile (i.e. higher than 75th percentile) to be reliable

The NZCC received one quantitative submission, from Frontier Economics on behalf of Transpower, and several qualitative submissions from other stakeholders, that there was a need to target a higher percentile of the WACC. The evidence from Frontier Economics appears to have been the main evidence received by the NZCC and it argued for a WACC set at the 99th

[38] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.72, available here.
[39] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.77, available here.
[40] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 4.35–4.36, available here.
[41] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 4.25, available here.
[42] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 4.26, available here.

percentile if a total welfare approach was taken, and a WACC at the 87th percentile if a consumer welfare approach was taken.[43]

The NZCC considered that the model developed by Frontier Economics, which based on a paper written by Professor Dobbs, was not reliable. This was because Professor Dobbs' model was:[44]

- designed to deal with a regulatory system where a regulator sets the WACC at the start of a regulatory period, and the WACC then changes over time. By contrast, the problem that the NZCC was considering was the effect of mis-estimating the WACC at the start of the regulatory period;
- developed on the basis of a total welfare approach, and the NZCC considered that adjusting it for a consumer welfare approach could not be done robustly;
- designed for the telecoms sector, and therefore less appropriate for energy networks.

The NZCC asked Professor Dobbs to review Frontier's model, and he concluded that 'it [was] unclear how much quantitative significance should be placed on the model's predictions'.[45]

We note that the NZCC also concluded that some of the evidence presented by Oxera potentially over-stated the economic costs of power outages. Specifically, the NZCC stated that our estimate that severe outages could result in annualised costs of NZ$1bn to the New Zealand economy might be over-statements because they were based on studies that considered the impacts of outages in the USA. According to the NZCC, there was evidence of under-investment in electricity distribution in the USA but not in New Zealand, and therefore these estimates might be upward-biased for New Zealand.[46]

Reason 6: Use of cross-checks

Comparisons of the NZCC's WACC estimates at the 67th percentile with other estimates indicated that the NZCC's estimates were reasonable

The NZCC ran a number of cross-checks on the WACC that it calculated based on the 67th percentile and concluded that the point estimate produced by aiming for the 67th percentile was not out of line with other sources, and was therefore reasonable.[47] Specifically the NZCC found that both its mid-point estimate of the WACC and its estimate of the 67th percentile were within the range of WACC estimates provided for Transpower and the EDBs by other independent parties, while the 75th percentile of the WACC was slightly above the estimates from other providers.[48] Due to this, the NZCC considered the

[43] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', B51, available here.
[44] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 6.22, available here.
[45] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 6.23, available here.
[46] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 6.9.1, available here.
[47] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 6.57, available here.
[48] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', D19-D23, Figure D1, available here..

67th percentile to be a more reasonable basis for setting the WACC than the 75th.

3.1.3 Concluding remarks

In summary, the NZCC concluded that it was not appropriate to select a point estimate of the WACC that was higher than the 75th percentile.

Within its two-step approach to determining the point estimate percentile as part of the 2014 Decision, this led the NZCC to a point estimate that was:

- higher than the 50th percentile (section 3.1.1);
- no higher than the 75th percentile (section 3.1.2).

Accordingly, the NZCC selected the 67th percentile as the appropriate point estimate for its allowed WACC, within the estimated range for the WACC.

However, the NZCC revised its decision on the point estimate in a subsequent regulatory period. Specifically, the NZCC adopted a lower point estimate within its allowed WACC range, i.e. the 50th percentile, in its 2020 Decision for regulated fibre. We turn now to a review of this latter Decision.

3.2 Choice of 50th percentile in the 2020 Decision for regulated fibre

In its assessment of the percentile that should be applied for regulated fibre networks in 2020, the NZCC highlighted that there were three main reasons for setting the WACC at the 50th percentile. In addition to these three reasons, we have identified two further reasons that appear to have been instrumental in the NZCC's Decision, since they were discussed in detail at the time.

We outline the three main reasons in section 3.2.1 followed by the remaining two reasons in section 3.2.2.

3.2.1 Explicit reasons for the NZCC's choice of a lower (50th) percentile

The NZCC stated that there were three main reasons why it chose to target the 50th percentile of the WACC distribution for regulated fibre. These reasons were:[49]

- under-investment in the fibre network would be visible and gradual;
- there are other tools that better target under-investment in regulated fibre than the WACC;
- the NZCC can adjust the IMs every seven years, and therefore can always return to a higher percentile if necessary.

These are discussed in turn, below.

Under-investment in regulated fibre is visible and gradual

First, the NZCC explained that the degradation of the telecommunications network was likely to be visible and gradual because this could be observed by the growth in traffic over time.[50] For this reason, it considered there to be less of a need to aim up on the WACC because the visible degradation would allow

[49] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.647, available here.
[50] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.798, available here.

it to resolve the problem relatively quickly using the alternative regulatory tools that we discuss below.[51]

As context for this review, it is important to note that the NZCC's 2020 Decision for regulated fibre drew an explicit contrast between the regulated fibre network and energy networks. Specifically, the NZCC explained that the energy networks were not subject to gradual and visible degradation, and that reinforcing the energy network is harder and slower than reinforcing the regulated fibre network.[52]

Other regulatory tools can be used to better manage under-investment risks

Second, the NZCC considered that if under-investment were to arise,[53] it would have at least four alternative regulatory tools available that it considered superior to an uplift on the WACC.[54] These tools were:[55]

- a quality incentive scheme, by which is meant a scheme that rewards network operators for meeting certain quality-based targets;
- asset management plan reporting, which is where the owner of the fibre network explains how it plans to manage its assets during a regulatory period;
- a volume-based incentive to connect new users to the network;
- quality standards, which are minimum standards for network quality that operators need to meet.

The Electricity Networks Association (ENA) submitted to the NZCC that it considered the use of alternative tools which manifest themselves as penalties to be a coercive way of encouraging investment. The NZCC appeared to agree with this because it explained that, while it was reasonable for pecuniary penalties to exist, 'such schemes are not meant to allow for a WACC that is set too low'.[56] We understand this to mean that the NZCC would not want to introduce any alternative regulatory tools in an asymmetric way—i.e. in a way that reduces the expected returns of regulated fibre networks.

Related to this, we note that the NZCC considered that using the WACC to stimulate investment was unnecessarily expensive because the WACC uplifts the return on all investment, while the purpose of aiming up on the WACC is to stimulate future investment only.[57] It therefore considered that there were not only alternative regulatory tools that it could use, but also that using the WACC was a relatively blunt instrument (similar to the views the NZCC expressed in the 2014 Reasons Paper, discussed in section 3.1).

The seven-year IM cycle allows for regular adjustment of the WACC

As a third and final explicit point, in justifying its decision to set a WACC based on the (lower) 50th percentile, the NZCC noted that it reviews the IMs every

[51] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.798, available here.
[52] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.798, available here.
[53] Which, as noted above, they expected to be able to readily identify.
[54] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', paras 6.835–6.842.
[55] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', paras 6.835–6.842.
[56] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.842.
[57] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.721.

seven years. This allows the NZCC to consider the effects of its previous Decisions and to change them if necessary. This implied that the NZCC might consider an uplift on the WACC in future regulatory periods, if the (outturn) evidence were to substantiate that a higher WACC percentile should have been selected.[58]

3.2.2 Other reasons that underpinned the choice of the 50th percentile

In addition to the three main reasons cited by the NZCC, we have also identified two further reasons that were given elsewhere in the decision:

- the social impact of poor network performance in the regulated fibre sector is relatively minor;
- in any case, the asset health of the regulated fibre network was already very high and there was therefore a low probability that under-investment would lead to negative socio-economic impacts.

In relation to these, first, the NZCC explained that the costs of an outage for end-consumers are relatively minor in the regulated fibre industry, especially when compared to outages in the energy sector.[59] One of the reasons why this impact is relatively small is that outages in regulated fibre networks do not have knock-on effects, as they do not affect the provision of services other than Internet. The NZCC explained that this contrasts with energy outages, which, for example, prevent households from being able to use Internet services as well as any other electrical appliance, meaning that the impact is greater when outages occur in electricity networks.[60]

Additionally, as regards the first reason, the availability of substitutes limits the impact of fibre outages. Specifically, in the event of a fibre outage, consumers can still use mobile services to access the Internet, especially for emergency services like calling and email.[61] The NZCC explained that this contrasts with energy networks, for which there is no substitute in the event of outage.[62]

Finally, in relation to the second reason, the NZCC noted that the asset health of the regulated fibre network is very high, so there are limited risks from under-investment. The NZCC considered that the fibre network in New Zealand was 'at the leading edge of fixed line networks worldwide'.[63] It explained that the regulated fibre network is relatively new, was built ahead of demand (implying that there is excess capacity), and was built to recognised international technical standards.[64] With a new and leading-edge network, the risks and effects of any under-investment would be likely to be limited, as they would still leave the network operating at a high level of quality.

Having reviewed how the predominantly network-reliability-based approach taken by the NZCC has been applied in its 2014 and 2020 Decisions for energy networks (section 3.1) and regulated fibre (section 3.2), respectively, we can now assess the implications for the current regulatory and market context. Accordingly, in section 4, we assess the up-to-date evidence base for

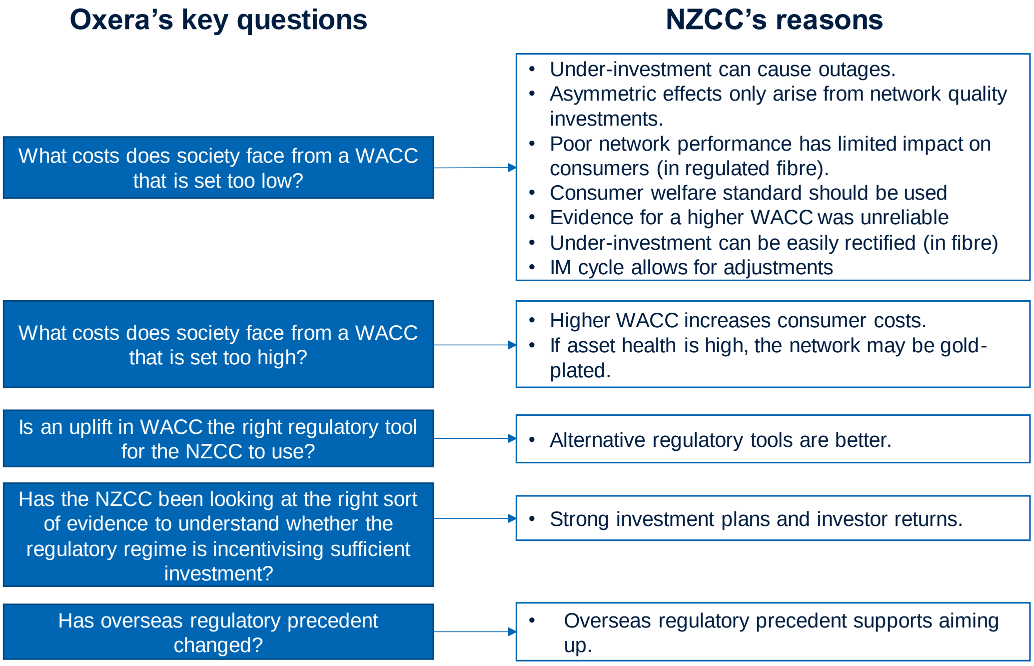
[58] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.647.3.
[59] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.778.
[60] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.779.
[61] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', paras 6.674–6.675 and 6.788.
[62] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.674.
[63] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.746.
[64] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.748.

calibrating the appropriate percentile estimate within the regulated WACC range for energy networks as part of the NZCC's ongoing IM process.

4 The appropriate WACC for the NZCC to set in electricity distribution

We consider that the reasons the NZCC has given for targeting a particular WACC percentile (see section 3), can be summarised into five main questions ('**Oxera's key questions**'), each of which we address in this section. Figure 4.1 provides a visual representation of the mapping from the reasons given by the NZCC to target a particular percentile, against these five key questions.

Figure 4.1 Mapping of reasons given by the NZCC for a WACC percentile and Oxera's key questions



Note: We note that in this figure we have not mapped two of the NZCC reasons to an Oxera key question. These two reasons are: (i) the NZCC's discussion on the downstream effects on other markets from a higher WACC; and (ii) the reasons it gave in relation to the WACC being systematically downward-biased. The reason for not mapping these is because, first, in respect of the issue of potential downstream effects (see section 3.1.1), this was largely resolved in the 2014 Reasons Paper and so we see limited value in revisiting this; second, we do not consider it necessary to discuss the possibility that the NZCC produces a downward-biased estimate of the WACC. At this stage, the NZCC has yet to produce an estimate of the WACC for the 2023 IMs and is consulting on the methodology that it plans to use. In addition, we discuss the comparison of the WACC to other calculations in section 5.3.

Source: Oxera.

This section is structured around the five key Oxera questions, with a different question addressed in each section (i.e. in sections 4.1 to 4.5). These questions group and classify the multitude of factors that the NZCC has historically considered, in setting a WACC percentile. Accordingly, considering the Oxera questions allows us to understand the percentile that the existing NZCC framework (i.e. the network reliability framework) would recommend targeting.

We note that there are two other categories of reasoning that could also justify aiming up on the WACC:

- reasons outside of the network reliability framework. The decarbonisation framework falls into this category and is discussed in section 5.2;
- if the methodology adopted by the regulator fails to set an appropriate level of return. However, in this case the first-best solution would be to fix any potential problems with the WACC methodology.

4.1 Q1. What costs does society face from a WACC that is set too low?

In order to address this first question, which examines the costs that society faces from setting a WACC that is too low relative to the true WACC that is required by investors, we break it down it into the following sub-questions:

- what is the welfare standard used to measure social costs (section 4.1.1)?
- what is the causal mechanism by which a WACC that is lower than required leads to adverse consumer outcomes (section 4.1.2)?
- is it likely that consumers would experience the effects of network under-investment (section 4.1.3)?
- what would these effects of under-investment be (section 4.1.4)?

4.1.1 What welfare standard should be used to measure social costs?

Before answering the question of what costs society faces from a WACC that is set too low, one needs to define how social costs are to be measured. As we explained above, a relevant debate in this context is between measures of total welfare and consumer welfare. We note that the correct welfare standard for the NZCC to use will be governed by its statutory obligations.

As noted earlier, Section 52A of the Commerce Act explains that the purpose of regulated industries is to promote the long-term benefits of consumers.[65] However, Section 52A also explains that this needs to be done by, among other things, ensuring that suppliers (i.e. regulated networks) have sufficient incentives to innovate, invest, and improve their efficiency. Furthermore, in Section 52R, the Act explains the purpose of the IM is to 'promote certainty for suppliers and consumers'.[66] We note also that maintaining the incentives of regulated networks to innovate and invest is necessary to maintain long-term benefits for consumers.

We therefore maintain the view that we expressed in Oxera's 2014 report, that a consumer welfare standard is the appropriate standard to apply, but that some consideration could be given to producer interest.[67] Nonetheless, for the remainder of this report, we take a conservative approach in assuming that any additional returns that accrue to investors as a result of setting the WACC above (rather than at) the mid-point, do not contribute towards social welfare via the producer interest.

4.1.2 What is the process by which a low WACC leads to bad outcomes for consumers?

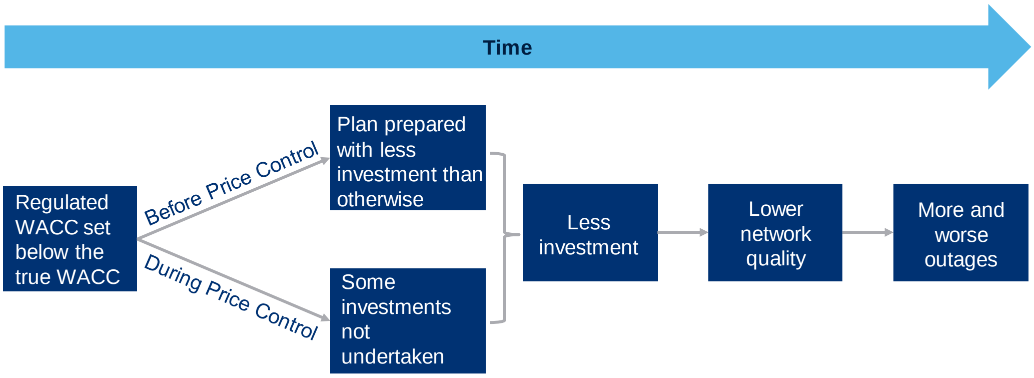
In order to assess the actual impact of a WACC that is set too low, one first needs to define the process by which a particular level of the WACC affects consumer outcomes. This is shown in Figure 4.2 below, which depicts a causal

[65] Parliamentary Council Office (2022), 'Commerce Act 1986', Section 52A, available here.
[66] Parliamentary Council Office (2022), 'Commerce Act 1986', Section 52R, available here.
[67] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', p. 11, available here.

chain from the level of the regulated WACC to consumer outcomes. The figure explains that, in a period where the true WACC rises above the regulated WACC, there will be two possible effects that result in less investment, depending on whether the time period in question is before or during a regulatory period:[68]

- if it is before the expected outcome of a regulatory period, the regulated network will have an incentive to prepare a plan with less investment;
- if it is during a regulatory period, the regulated network will have an incentive to undertake the minimum legally permissible amount of investment. This may also 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 effects.

Figure 4.2 Causal mechanism from the regulated WACC being below the true WACC to bad outcomes for consumers



Source: Oxera.

In both of these cases, the reason why the regulated network has less of an incentive to invest is because it will recover a lower level of its costs through future charges.

Once a level of investment that is below the needs of the network has been realised, it is likely that the network will become lower-quality which, in turn, will cause more and worse outages.[69] Specifically, the NZCC distinguishes between investments in network quality, demand growth, innovation, and economic investments, and only considers the network quality investments to be the source of a potential asymmetric loss, as these are the investments that prevent consumer outages.[70]

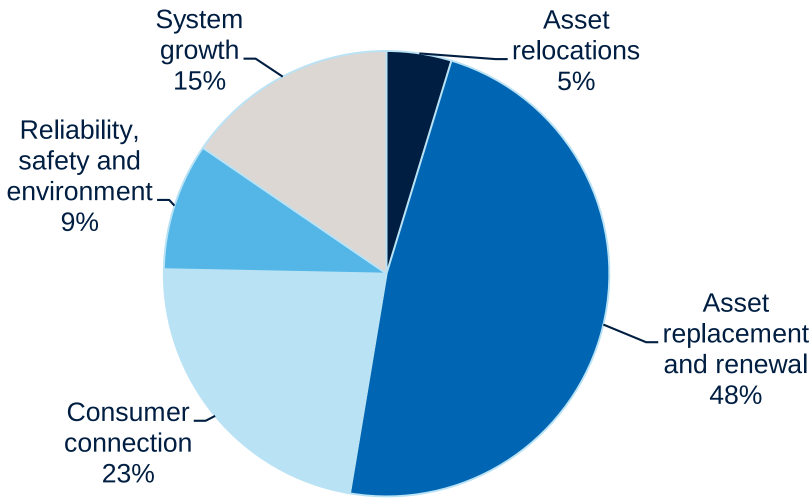
While we agree that network reliability investments are the main investments of relevance, we consider that a large proportion of the investments undertaken by the EDBs have positive effects on network reliability. In Oxera's 2014 report, we explained how investments related to Asset Replacement and Renewal, System Growth, and Reliability, Safety and Environment, would all be likely to contribute to improving network reliability.[71] This is because:

[68] We note that the NZCC agrees with us on both of these mechanisms. See NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', heading above para. 3.27, available here.
[69] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras 5.53–5.83, available here.
[70] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.58, available here.
[71] Oxera (2014), 'Review of expert submissions of the input methodologies', p. 25, available here.

- Asset Replacement and Renewal replaces assets that are older and therefore more likely to cause faults;
- System Growth expands the capacity of the network, without which the demand for network capacity (from generators, storage, and off-takers) would exceed the capacity of the grid and require the EDBs to curtail off-take (i.e. introduce managed outages). The investments that expand the grid in order to facilitate that connection improve network quality, as without them the new connection would tend to increase grid congestion and therefore outages;
- Reliability, Safety, and Environment investments are, to a large extent, directly targeted at improving the reliability and safety of the grid.

The investments across these categories accounted for 77% of EDB CAPEX in 2014.[72] We have updated this analysis for 2021 and Figure 4.3 shows that 73% of CAPEX was still invested in these areas. This means that a large majority of investment was, and is, in areas that have reliability benefits.

Figure 4.3 Breakdown of EDB CAPEX investments by type of investment



Source: Oxera analysis based on data received from the EDBs.

Accordingly, as far as EDB investment is concerned, more than 70% of CAPEX investments are directly identifiable as delivering reliability benefits. Consequently, setting the WACC too low is likely to have material downside effects on network reliability and, conversely, setting the WACC above the mid-point is likely to materially mitigate against this risk.

This is particularly likely to be the case when there is greater electrification of the New Zealand economy. Without adequate investment in the above-mentioned CAPEX categories, there is a risk that the EDBs will not be able to keep pace with the growth of demand for electricity. While network companies should not be incentivised to undertake inefficient levels of infrastructure investing without considering the role of other solutions such as flexibility, a

[72] Oxera (2014), 'Review of expert submissions of the input methodologies', p. 25, available here.

successful decarbonisation strategy relies on them having sufficient CAPEX to stay ahead of a rapidly increasing demand for electricity.

4.1.3 Is it likely that consumers would experience the impacts of network under-investment?

Both the probability and impact of outages are hard to link quantitatively and precisely to a specific WACC percentile. This is because to do so would require:

- an understanding of the precise magnitude of the effect that the WACC has on additional investment. This magnitude would need to take into account the entirety of the regulatory regime (as there are other incentive mechanisms and quality standards that affect investment) over both the short term and the long term;[73]
- an understanding of how the current state of the network affects the likelihood that under-investment will lead to more outages, as if the network has excess capacity or is gold-plated then there is likely to be a 'buffer zone' where some level of under-investment can occur without resulting in more or worse outages.

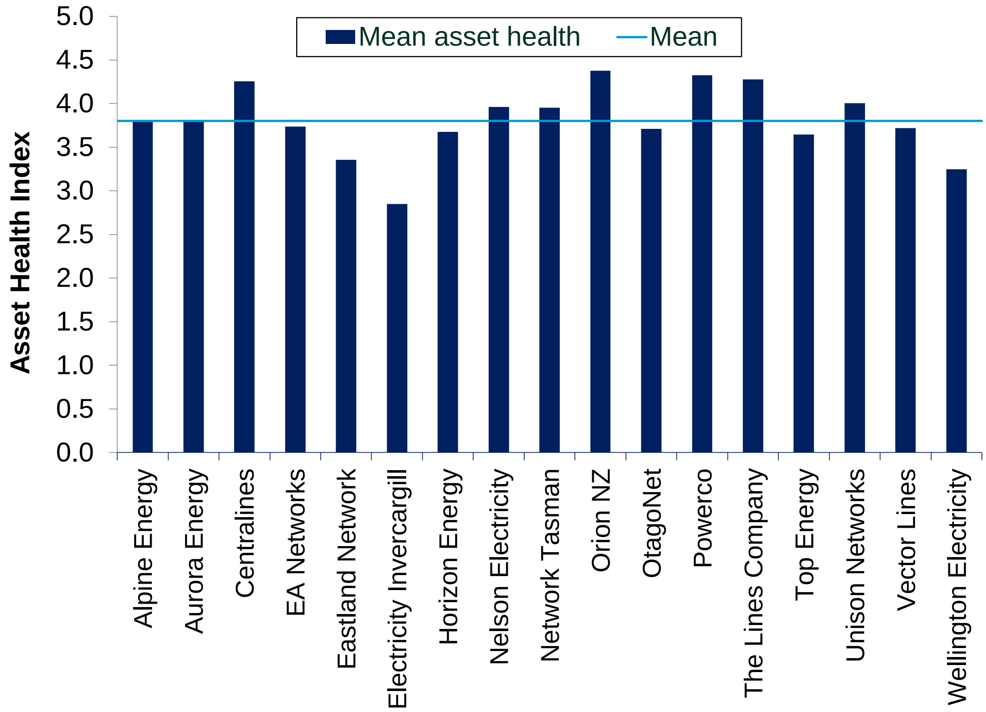
With regard to the latter issue, we have not found evidence of current gold-plating in the New Zealand distribution networks. This indicates that if under-investment does occur, there would be no material buffer zone that allows networks to withstand downward pressure on network reliability. It also indicates that the current regulatory framework—which aims for the 67th percentile—does not appear to have led to over-investment by networks.

Specifically, we analyse whether there is evidence of excess capacity or gold-plating of network assets in New Zealand with reference to the asset health of the EDBs. The quality of the networks can be assessed through the industry standardised asset health index (AHI), which the NZCC publishes for each EDB on an annual basis.[74,75]

Figure 4.4 presents the mean AHI of all assets of each EDB in 2021, and compares it to the industry mean.

[73] The distinction between the short term and the long term may be important because, in the short term, under-investment may be mitigated by using performance guarantees. However, in the long term, if a regulator is relying on punitive measures to incentivise investment without providing sufficient rewards in line with the risks of the sector, investors will tend to divest the relevant assets.
[74] Wellington Electricity (2021), 'Wellington Electricity Asset Management Plan 2021', 1 April, available here.
[75] The AHI grades assets on a scale of 1 to 5. An AHI of grade 1 means that an asset has reached the end of its useful life and must be replaced within one year; grade 2 means that an asset is at material failure risk and should be replaced shortly; grade 3 means that an asset is exposed to increasing failure risk and medium-term replacement is needed; grade 4 is an asset with a reasonable degree of deterioration that requires regular monitoring, expecting replacement in over a decade; and grade 5 is a new asset that has over two decades of lifespan left. See NZCC (2022), 'Performance summaries for electricity distributors – Year to 31 March 2021', 28 April, available here.

Figure 4.4 Average asset health in 2021



Note: Average asset health of EDBs active in New Zealand measured through the asset health index (AHI). The mean asset health is calculated as the mean AHI across each company's asset class in 2021.

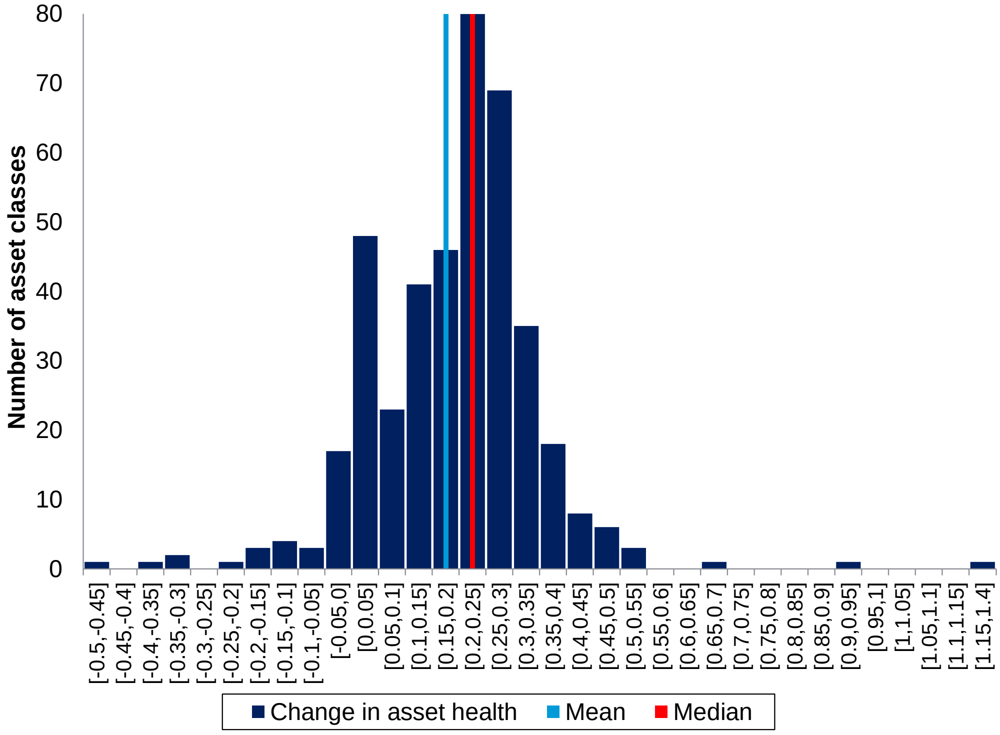
Source: Oxera analysis based on NZCC (2022), 'Performance summaries for electricity distributors – Year to 31 March 2021', available here.

Figure 4.4 shows the mean of the mean AHI, measured at a grade of 3.8, which indicates that the network is in a good state, requiring regular monitoring, but is neither completely new nor in disrepair. This is broadly consistent with the reliability of New Zealand network, which, according to the NZCC, has exhibited 'little change'.[76] The existing regulatory framework, which targets the 67th percentile, therefore appears to have achieved a good balance of outcomes for consumers.

Figure 4.5 provides further insight into the trend of asset health over the last regulatory period by presenting the distribution of the difference in asset health between 2018 and 2021 across asset classes. This figure shows that the change in asset health, measured through the change in AHI (which is shown on the x axis), has on average improved by 18.9%, measured by the mean and 21.4%, measured by the median. Therefore, we observe a positive trend in the quality of the network over this period.[77] We note that, even though the asset health of the network has increased, it has not risen to a level that indicates the installation of predominantly new assets, suggesting that excess network capacity is installed—i.e. the health of the network assets does not indicate gold-plating.

[76] NZCC (2022), 'Trends in local lines company performance', p. 3, available here.
[77] We find that the distribution is centred on the median, but is skewed toward the right, with only 7.77% of asset classes experiencing a negative change, indicating that the improvement in asset health is systemic across the industry.

Figure 4.5 Distribution of change in EDB asset health, 2018–21



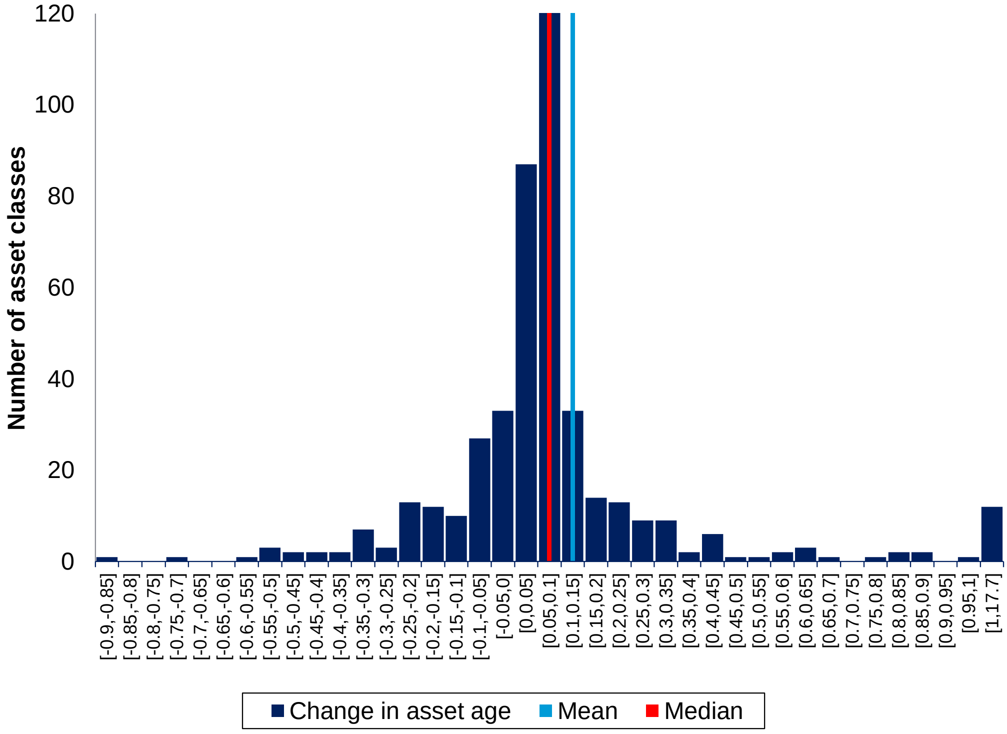
Note: The x axis presents the change in the AHI index between 2018 and 2021. The graph can be interpreted as follows—the tallest bar in the graph shows that approximately 80 asset classes experienced an increase in asset health of between 0.2 and 0.25 points in the AHI index, over the period.

The width of bins on the right side of the distribution has been adjusted for readability.

Source: Oxera analysis based on NZCC (2022), 'Performance summaries for electricity distributors – Year to 31 March 2021', 28 April, available here.

Figure 4.6 below shows the distribution of the difference in mean asset age across asset classes within the same regulatory period. We observe that the average change in the age of an asset class (measured in years, and shown on the x axis) across companies, has on average increased by 12.9% (mean estimate) or 5.3% (median estimate). This evidence indicates that the network has aged slightly during the regulatory period.

Figure 4.6 Distribution of change in asset age, 2018—21



Note: The x axis shows the change in the age of assets between 2018 and 2021, measured in years, with positive numbers reflecting aging assets and negative numbers reflecting asset classes that have more new assets. The graph can be interpreted as follows—the tallest bar in the graph shows that slightly more than 120 asset classes experienced an increase in age of between 0.05 and 0.1 years.

The width of bins on the right side of the distribution has been adjusted for readability.

Source: Oxera analysis based on NZCC (2022), 'Performance summaries for electricity distributors – Year to 31 March 2021', 28 April, available here.

Taken together, this analysis of changes in average asset health and asset age over the current regulatory period does not indicate that there has been inefficient investment in, or gold-plating of, the network in response to the previous decision to aim up in the WACC range. Improved asset health with a slightly older installed asset base is consistent with better monitoring and maintenance of the network, rather than investment in new assets (which may not yet be needed).

4.1.4 Impact of under-investment on consumers

The impact that the under-investment would have on consumers will be equal to the change in the probability and impact of outages that arises as a result of under-investment in the network (i.e. stripping out other causes of outages) multiplied by the impact of those outages. To inform an assessment of this impact, we have updated the research that we undertook in 2014[78] into the economic impacts of outages. The table below shows that network failure can have a negative impact of between 0.26% and 6.1% of GDP each year. Note that in the absence of data being available for New Zealand specifically, this exercise is informed by outage events in other jurisdictions. If equivalent levels

[78] See, for example, Oxera (2014), 'Review of expert submissions of the input methodologies', Table 4.2, available here.

of network failure occurred in New Zealand, this would cost the economy between NZ$0.92bn and NZ$21.7bn annually.

Table 4.1 Summary of studies into economic cost of power outages

Study	Country	Event period (year)	Cost of outage (US$ bn)	GDP in year of study year (US$ bn)[1]	Cost (% of GDP)	NZ GDP in 2021 (NZ$ bn)	Implied cost of outages in NZ (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 over 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 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', available here; LaCommare, K. and Eto, J. (2004), 'Understanding the cost of power interruptions to U.S. electricity consumers', available here; Nexant (2003), 'Economic impact of poor power quality on Industry, Nepal', available here; EPRI (2001), 'The Cost of Power Disturbances to Industrial & digital economy companies', available here; Swaminathan, S. and Sen, R.K. (1997), 'Review of power quality applications of energy storage systems', available here; Targosz, R. and Manson, J. (2007), 'Pan-European lpqi power quality survey', available here; Zachariadis, T., Poullikas, A. (2012), 'The cost of power outages: A case study from Cyprus', available here; EBP (2020), 'Failure to act: Electric infrastructure investment gaps in a rapidly changing environment', available here; Campbell, R.J. (2012), 'Weather-related power outages and electric system resiliency', available here; Executive Office of the President (2013), 'Economic Benefits of Increasing Electric Grid Resilience to Weather Outages', Council of Economic Advisors et al, available here; Reichl, J., Schmidthaler, M. and Friedrich, S. (2013), 'Power Outage Cost Evaluation: Reasoning, Methods and an Application', available here.
Data from World Bank and Statistics New Zealand (2013), 'Regional Gross Domestic Product', March, available here.

None of the studies in Table 4.1 provide a perfect comparator for New Zealand and the full range of impacts is very wide—between NZ$0.5bn and NZ$21bn, as mentioned above. However, excluding the outlier of Cyprus in 2011, the single event studies, and those with a narrow remit (e.g. related to severe weather), result in a tighter range of NZ$0.9bn to NZ$6.4bn.

Furthermore, we consider that the ASCE study is likely to be the most relevant to the New Zealand economy, because it focuses specifically on the costs from under-investment in electricity infrastructure, whereas the other studies are not clear about the cause of the outage impact that they estimate. The cost for the New Zealand economy implied from these studies is between NZ$0.92bn and NZ$1.3bn. We also note that CEPA has produced its own estimate of the impacts of network failure from underinvestment. This estimate is NZ$1.9bn, and is based on updating our 2014 estimate of NZ$1bn for inflation and changes in the VoLL.[79]

While the 2020 study by EBP is a more recent update of the ASCE paper, we place less weight on this than the ASCE paper because it only covers lost output from businesses, meaning that it may understate the full losses (due to, for example, excluding the impacts on households). We therefore consider the estimates of NZ$1bn-NZ$1.9bn from the ASCE 2011 paper to be more reliable for our assessment, and draw insight from the lower bound of this estimate (i.e. NZ$1bn) in our analysis.

We note that in its 2014 Reasons Paper, the NZCC explained that it considered studies from the USA to potentially overstate the impacts of under-investment because there was already an under-investment problem in the USA, whereas no such problem existed in New Zealand.[80] The analysis that we have undertaken in this report is informative, to address this criticism. Specifically, we have shown in section 4.1.3 that the age and asset health of the New Zealand network does not support a hypothesis that the network is all new and in an excellent state of repair; rather, the age and asset health indicators show that the New Zealand networks do require ongoing levels of investment. Therefore, it seems plausible that a relatively small level of under-investment could result in New Zealand moving towards evidence of under-investment as in the USA, making the NZ$1bn figure a realistic estimate of the impacts on New Zealand. In any case, as noted above, this estimate of NZ$1bn is at the lower end of the range in Table 4.1.

There are also two reasons why the NZ$1bn estimate may be an under-estimate of the outage impact:

- if it is not easy or quick to rectify the under-investment, then the effective annualised costs of under-investment will be greater because it could take several years to rectify the under-investment, meaning that 1 year of under-investment could result in more than 1 year of the effects of under-investment.[81] In this context it is important to note that the NZCC does not consider it easy to observe and rectify under-investment in electricity networks,[82] which implies that the annual costs of under-investment in New Zealand could exceed NZ$1bn;
- as the New Zealand economy decarbonises, it may be more dependent on electricity than the studies that we have used assume. If this were to be the

[79] CEPA (2022), 'Review of Cost of Capital 2022/2023', section 4.6, available here.
[80] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 6.9.1, available here.
[81] This can be most easily seen through the following example. Consider an under-investment problem that results in economic costs of NZ$1bn per annum from year 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 between the regulated companies receiving the higher regulated return, making an investment plan, tendering for the new investments, and finally constructing those new investments such that the NZ$1bn impact is reversed. In this example the effective annual costs of the under-investment are NZ$2bn because the regulator reverses the policy that caused under-investment in period t+2, but it is only in period t+4 that the effects of the under-investment are fully reversed.
[82] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', paras 6.779 and 6.798, available here.

case then the impacts of outages would be greater than those assumed in the papers that have been written to date.

Box 4.1 CEPA update: impact of under-investment on consumers

As we described above, CEPA has updated our analysis by adjusting it for changes in New Zealand's GDP growth rate and the VoLL since 2014. CEPA initially conducted this analysis in 2013 price terms and then inflated it to 2022 prices.[83]

As the costs of under-investment estimates by CEPA, at NZ$1.9bn, are higher than the lower-bound costs that we estimated, the benefits of aiming up on the WACC are higher under CEPA's approach than under ours. This can be seen by comparing the benefits in the column for the 0.5% threshold in the CEPA report with the benefits in Table 4.3 below. Due to this, CEPA's approach will tend to support aiming up for a higher percentile than our approach.

We consider that CEPA's approach is reasonable—as our choice of NZ$1bn was a conservative, lower-bound estimate—such that their finding that the benefits of aiming up outweigh the costs at the 70th percentile would support our conclusion that it would be appropriate for the NZCC to continue targeting the 67th percentile, at a minimum.

4.2 Q2. What costs does society face from a WACC uplift?

The costs that society faces from a WACC uplift are the costs of: (i) additional investment that is undertaken, which did not need to be undertaken; and (ii) the cost for the investment that is undertaken being higher as a result of a higher WACC.

While it is not possible to rule out that additional inefficient investment is undertaken if a WACC uplift is included in a regulatory regime, the regulatory framework in New Zealand has several measures in place to limit the extent to which it is possible for the EDBs to over-invest. These measures include the following.

- The existence of information disclosure requirements within the Asset Management Plans of EDBs. In the case of asset replacement, these plans require the EDBs to justify any forecast investment based on an asset health assessment of the asset they are planning to replace. In the case of network reinforcement, the plans need to contain a capacity and demand assessment. If the case for new investment is deemed insufficiently strong, it can be rejected by the NZCC.
- Under a Default Price-Quality Path (DPP), CAPEX is subject to a 'gates procedure', meaning that CAPEX categories need to meet certain criteria before being allowed to proceed.[84] An overall 120% cap on CAPEX also applies.
- Increases in investment (such as those that could be caused by over-investment) are assessed more rigorously, such as through higher levels of scrutiny if an EDB moves from a DPP to a Customised Price-Quality Path (CPP) or through re-openers for significant investments.

[83] CEPA (2022), 'Review of Cost of Capital 2022/2023', p.41, available here.
[84] We understand from the EDBs that gates operate at the level of CAPEX categories, not at a project level.

- The revenue cap prevents the EDBs from collecting more revenue than is needed to fund their allowable investment levels. If the EDB engages in unnecessary investment, it will increase its costs without increasing its revenues, which will tend to reduce its level of profits. Under the Incremental Rolling Incentive Scheme (IRIS), this overspend has to be borne by the EDBs (as well as customers) beyond the end of the regulatory period. This means that over-investment is likely to have a material negative impact on EDB returns.

In addition, as noted in section 4.1.3, we have not seen evidence that the EDBs have engaged in unnecessary investments over the course of the most recent regulatory period.

Consequently, the main cost of a WACC uplift is the fact that consumers pay higher prices for their electricity. We have calculated these prices on a per MWh and economy-wide basis in Table 4.2 below. The calculation took the RAB of Transpower and the EDBs,[85] and multiplied it by the uplift to the WACC at different percentiles of the WACC distribution, using the standard deviation of the WACC that was used in the 2016 IMs (1.01%). In addition, the table shows:

- the approximate annualised impact of under-investment (NZ$1bn based on the estimates discussed in section 4.1);
- the probabilities of the true WACC being more than 0.5% and 1% below the regulated WACC, respectively. We have included these estimates because, under the NZCC's framework, under-investment is only likely to happen if the true WACC falls below the regulated WACC by a 'material' amount, which is assumed to be at least 0.5%.[86]

Table 4.2 Consumer cost impact of a higher WACC percentile

Percentile	WACC impact	Cost (NZ$m)	Cost per MWh (NZ$/MWh)	Annualised impact of under-investment (NZ$m)	Probability of true WACC being more than 0.5% below regulated WACC	Probability of true WACC being more than 1% below regulated WACC
50%	0.00%	0.00	0.00	1,000	31.0%	16.1%
55%	0.13%	23.01	0.58	1,000	26.7%	13.2%
60%	0.26%	46.38	1.16	1,000	22.7%	10.7%
65%	0.39%	70.54	1.76	1,000	18.9%	8.5%
70%	0.53%	96.01	2.40	1,000	15.4%	6.5%
75%	0.68%	123.49	3.09	1,000	12.1%	4.8%
80%	0.85%	154.08	3.85	1,000	9.1%	3.3%
85%	1.05%	189.75	4.74	1,000	6.3%	2.1%
90%	1.29%	234.63	5.87	1,000	3.8%	1.2%
95%	1.66%	301.14	7.53	1,000	1.6%	0.4%

Note: All cost estimates are relative to the costs that would be incurred at the 50th percentile of the WACC.

[85] The RAB of Transpower is taken from its 2016 value of NZ$4.6bn, while the RAB of the EDBs is taken from their 2021 value of NZ$13.5bn. NZCC (2021), 'Electricity Distribution Statistics Year to March 2021', available here.
[86] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', para. 5.22.3, available here.

Source: NZCC (2016), 'Input methodologies review decisions', 20 December, p. 186, available here; NZCC (2022), 'Total electricity distribution Year to 31 March 2021', 28 April, available here; NZCC(2014), 'CC19. Transmission Transpower ID Disclosures 2015-16_Rev3', 28 February, available here; Ministry of business innovation & employment (2022), 'Energy in New Zealand 22', August, available here.

The optimal WACC percentile will be determined by the percentile that maximises consumer welfare. Consumer welfare is defined as the difference between the change in the impact of power outages as a result of a higher WACC (i.e. lower duration and frequency of outages) less the additional costs that the higher WACC imposes on customers (i.e. the pass-through of network costs into electricity prices). Therefore, the WACC percentile that maximises this difference is the optimal percentile.

Table 4.3 below shows the social benefit enjoyed by New Zealand consumers. This social benefit is calculated as follows:

- first, we calculate the change in the probability of under-investment relative to the 50th percentile by calculating the change in the probability that the true WACC is more than 0.5% below the regulated WACC (see the second column of the table);
- this change in probability is then multiplied by the annual impact of under-investment (of NZ$1bn) to produce a monetary estimate of the reduced impact of under-investment (see the third column);
- this is then compared to the additional cost faced by consumers (which is copied into the fourth column of the table below from Table 4.2) in order to produce the social benefit of targeting the particular percentile (see the fifth column).

The analysis indicates that the optimal percentile is somewhere between the 75th and the 80th, as these are the percentiles where the social benefit is highest.

Table 4.3 Social benefit at different percentiles

Percentile	Change in probability of under-investment	Reduced impact of under-investment (NZ$bn)	Additional cost faced by consumers (NZ$bn)	Social benefit (NZ$bn)
50%	0.00%	0.00	0.00	0
55%	4.29%	42.89	23.01	20
60%	8.32%	83.17	46.38	37
65%	12.10%	120.95	70.54	50
70%	15.63%	156.29	96.01	60
75%	18.92%	189.19	123.49	66
80%	21.96%	219.62	154.08	66
85%	24.75%	247.46	189.75	58
90%	27.25%	272.47	234.63	38
95%	29.41%	294.10	301.14	-7

Source: Oxera analysis based on Table 4.2.

We note that this analysis relies on a number of assumptions that could, in principle, be adjusted in ways that either increase or decrease the optimal

WACC percentile.[87] The analysis that we present in Table 4.3 should therefore be interpreted as indicative of the order of magnitude percentile that the NZCC should target.

For this reason, we consider that an appropriate conclusion to draw is that, as the social benefits appear to be highest in the region of the 65th to the 85th percentiles, the optimal WACC is likely to be in this range. We note that this is similar to the recommendation we made in one of our 2014 reports, where we described the 80th percentile as a 'prudent' approach, but whose cost would be 'potentially excessive'.[88] In those reports, we ultimately concluded that a percentile between the 60th and the 70th was most appropriate, in part due to the fact that under-investment can also be mitigated through other regulatory measures.[89] We turn to this issue in the next sub-section.

Box 4.2 CEPA update: costs of aiming up on the WACC

CEPA has also updated the costs that society faces from a WACC uplift. The costs that CEPA has calculated are very similar to our estimates, and this can be seen by comparing the estimates we presented in Table 4.3 above to the estimates that CEPA presents in Table 4.8 of their report.[90]

The analysis that we presented on the costs that society faces, above, did not include any assessment of: (i) the deadweight loss arising from changes in the quantity of energy demanded at higher prices; (ii) the indirect financial effects of higher energy prices (i.e. the impact of higher electricity prices on downstream companies). It is helpful to note that CEPA has updated our 2014 analysis and confirms that both of these effects remain small,[91] which is consistent with our approach of not including these in the present analysis.

4.3 Q3. Is an uplift on the WACC the right regulatory tool for the NZCC to use?

Regulators have many different tools available to them to prevent under-investment in the network. Examples include performance guarantees and incentive schemes that reward regulated companies if they outperform selected reliability metric(s). Some of these tools could be used instead of, or in combination with, an uplift to the WACC in order to prevent or mitigate under-investment. However, given that the prevailing methodology in New Zealand uses aiming up on the WACC, any change that is now introduced would tend to undermine regulatory stability, and any change would need to be introduced on a forward-looking, NPV-neutral basis.

[87] A non-exhaustive list of these assumptions is that:
- there is no additional inefficient investment as a result of a higher WACC percentile. We have explained that we do not consider it likely that this would happen due to various regulatory safeguards, and that at the 67th percentile there does not appear to be evidence of this happening, but if a very high percentile such as the 80th were adopted, the risk of this happening could be increased (as the EDBs would have greater incentives to over-invest). This would reduce the optimal percentile that the NZCC should target;
- the NZ$1bn investment could be under- or over-stated, in which case the optimal WACC percentile would be lower and higher, respectively, than implied by Table 4.3;
- as explained earlier, it is likely to be the case that under-investment cannot be quickly resolved, in which case the annual costs of under-investment would be in excess of the NZ$1bn that we have assumed. This would increase the percentile that the NZCC should target.

[88] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach' pp. 6 and 72, available here.
[89] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach' p. 72, available here.
[90] CEPA (2022), 'Review of Cost of Capital 2022/2023', Table 4.8, available here.
[91] CEPA (2022), 'Review of Cost of Capital 2022/2023', p.37, section 4.5, available here.

Stable regulatory regimes provide benefits to consumers because they reduce the regulatory risk that investors need to be compensated for. If regulation becomes more stable and investors are not compensated for this, there is a risk that they will divest. This would lead to higher required returns for debt and equity holders in regulated networks, and consequently higher consumer prices. We note that regime stability was an important consideration to which we also gave weight 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'.[92] This highlighted the regulatory risk of the NZCC choosing a particular WACC percentile at the time, only to change it in future periods.

It is possible that in the short run, effective reductions in remuneration such as the replacement of monetary rewards (e.g. aiming up in the WACC range) with penalties (e.g. use of stricter performance guarantees with higher fines for failure) would not lead to investors divesting. This is because investors may temporarily remain invested while they discuss regulatory changes with a regulator. However, in the long run this is likely to reduce incentives to invest and/or increase in incentives to divest, and could consequently lead to an increase in the cost of capital.

In this context, we note that in its 2020 Decision on regulated fibre, the NZCC considered that to mitigate the risk of under-investment in regulated fibre, it would be able to place 'greater reliance on quality standards and enforcement'.[93] Furthermore, the NZCC commented that:[94]

> We agree that more targeted tools are potentially available. At this stage we do not consider that such tools are needed but over time, to the extent concerns on under-investment prove substantive, **a WACC uplift appears a comparatively expensive way to address these concerns** for end-users [emphasis added]

However, in response to criticism of this approach from the ENA,[95] the NZCC provided reassurance that that it did not intend to make unilateral downward adjustments to the returns of regulated companies, as it explained that it did not consider that quality standards allow for the WACC (or more generally the expected return) to be set too low.[96] We consider this clarification important, because even if regulatory risk were not present, it would be important for the NZCC to introduce any changes on an NPV-neutral basis, if the existing regime does not show signs of systematic over-compensation. We note that regulatory stability helps to maintain investment incentives, especially in the context of long-lived network assets.

4.4 Q4. Has the NZCC been looking at the right evidence base to understand whether the regulatory regime is incentivising sufficient investment?

As discussed above, the regulatory regime should aim to incentivise sufficient but not excessive investment. A reasonable level of investment aims to reduce the risk of outages without unduly increasing the costs to consumers.

[92] NZCC (2014), 'Input Methodologies: Review of the '75th percentile' approach', p. 6, available here.
[93] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.715, available here.
[94] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.837, available here.
[95] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.840, available here.
[96] NZCC (2020), 'Fibre Input Methodologies: Main final decisions – reasons paper', para. 6.842, available here.

We note that, in the past, the NZCC has considered evidence in relation to the EV/RAB ratios of regulated network companies, to assess whether the regulatory regime is promoting sufficient levels of investment. As this ratio does not describe the quality of the network—its reliability and underlying asset health—it is not informative in assessing whether sufficient levels of investment have occurred.

EV/RAB ratios are also not informative in assessing whether there is an excessive return that is earned by investors, such that they have incentives to over-invest in network assets. We do not consider the EV/RAB ratio to be a good measure of over-compensation, because other factors can explain the ratio being above 1, including:

- the winner's curse—a transaction-winning bid is that with the highest valuation, which is underpinned by more optimistic assumptions than other bids and therefore might be above the intrinsic asset value;[97]
- a control premium—if a majority stake has been acquired, investors may be willing to pay a premium for it;
- the 'stickiness' of investors' valuation expectations—investors tend to refer to past transactions to form their expectations about future valuation which may suggest an expected exit EV/RAB ratio, i.e. the terminal value, of above 1; the terminal value explains a significant proportion of the EV/RAB ratio being above 1;
- financial restructuring—there is the potential to restructure the financing of the business and create value for the shareholders;
- revenue and/or RAB adjustments as reconciliations from the preceding regulatory period;
- environmental, social and governance (ESG) factors and market sentiment;
- company-specific outperformance which does not apply to other companies in the industry;
- expectations over future RAB growth, because the RAB is a backward-looking measure while EV is a forward-looking measure;[98]
- the value of non-regulated business activities, which is additional to the value generated by the RAB. If a regulated business also engages in non-regulated activities then the value placed on the non-regulated activities will upward-bias the EV/RAB ratio;
- accrued dividends, which are likely to be embedded into the market capitalisation of a company but not the RAB, and would therefore lead to an EV/RAB ratio above 1x even when there is no over-compensation.

Also, importantly, our understanding is that the NZCC does not consider the EDBs to be over-compensated, as they have stated that profitability across the EDBs has been below the NZCC's estimates of reasonable returns.[99]

[97] See, for example, Andrade G., Mitchell M., and Stafford E. (2001), 'New Evidence and Perspectives on Mergers', *Journal of Economic Perspectives*, spring, **15**:2.
[98] Therefore, any expectations over future RAB growth will be reflected in a higher EV (as the share price of the company will increase with a higher absolute level of profit) but not in a higher RAB (until the RAB growth transpires).
[99] NZCC (2022), 'Part 4 Input Methodologies Review: Process and Issues paper', para. 5.18, available here.

Overall, we consider that the NZCC should consider evidence related to network investment—such as business plans, the age and asset health of assets—when assessing whether the regulatory regime is providing sufficient incentives to invest. In setting the allowed return, evidence of EV/RAB is not directly informative in this regard.

4.5 Q5. Has overseas regulatory precedent changed?

Notwithstanding that there are differences between regulatory regimes in New Zealand and other jurisdictions, we observe that in our 2014 reports, and in its past decisions, the NZCC has assessed international regulatory precedents in relation to the WACC percentile that is selected within an estimated range. We have undertaken a review of recent regulatory precedents in informing our assessment in this report. Our findings are summarised below, with more details in Appendix A1).

- In Oxera's 2014 report, we explained that **UK** regulators tended to aim up on the WACC, and typically chose the 73rd percentile of the WACC ranges that they considered.[100] Since then, Ofgem, the GB energy regulator has changed from aiming up to 'aiming straight' (i.e. choosing the mid-point of the WACC).
- We have also observed that the mid-point of the WACC range was selected in the recent energy decisions in **Australia** (by the AER[101]), the **Netherlands** (by the ACM[102]), **Germany** (by BNetzA[103]), and in **Italy** (by ARERA[104]).
- In **France**, however, the energy regulator (CRE) selected a WACC point estimate that is higher than the mid-point, in its recent decision.[105]
- However, we note that this generalised move towards aiming straight within the calibration of the allowed WACC has tended to be accompanied by other measures that have reduced (but not eliminated) the ability for the regulated WACC to deviate from the true WACC. In the UK, for example, Ofgem has indexed movements in the risk-free rate.
- In addition, the fact that the NZCC has not found any evidence of over-compensation suggests that there is no reason to adjust the regulatory framework in a manner that reduces the ex ante returns of energy networks.
- Also, the regulators that are cited in this review of international precedents have not used the NZCC's network reliability framework to present analysis that supports their decision to select the mid-point (50th percentile) of the WACC range. Therefore, their choice of WACC percentile is not directly comparable to the NZCC's, because it is made in a different context (e.g. they do not apply the network reliability framework to calibrate the allowed WACC).

[100] Oxera (2014), 'Input Methodologies: Review of the '75th percentile' approach', Table 3.2, available here. As a point of detail, note that this 73rd percentile represents a percentile of a range of point estimates, rather than a percentile of a distribution around a WACC estimate.
[101] AER (2021), 'Final Decision: AusNet Services Distribution Determination 2021 to 2026', available here.
[102] ACM (2021), 'The WACC for the Dutch Electricity TSO and Electricity and Gas DSOs', available here.
[103] Bundesnetzagentur, (2021), 'BK4-21-055', available here.
[104] 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', available here.
[105] 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)', available here.

Box 4.3 CEPA update: overseas regulatory precedent

CEPA also finds that regulatory precedent has moved away from 'aiming up' towards 'aiming straight'. However, we note that CEPA also references some non-energy precedents for aiming up, such as the UK water and telecommunications sectors.[106] CEPA also finds that IPART, an Australian regulator, uses a methodology that appears to suggest that a WACC uplift would be appropriate in times of macroeconomic uncertainty.[107] In addition, CEPA does not reference the French precedent for aiming up that we refer to above. Therefore, combining our report and CEPA's report together results in more precedents for aiming up than taking either of the reports individually.

CEPA does not comment on the fact that the regulators that they have found now 'aim straight' are not regulators that formally use the NZCC's network reliability framework. We consider this to be an important distinction in the approach that the NZCC takes to setting its regulatory package relative to other regulators, and consider that this limits the direct read-across of the other regulators' decisions to the NZCC's.

4.6 Concluding remarks

In summary, we find that society is likely to face a substantial negative impact from outages if the electricity network suffers from under-investment. An uplift to the WACC can prevent this from happening, and the costs to consumers of applying it are relatively low. When the reduction in the cost of outages that is caused by an uplift to the WACC is traded off against the costs to consumers, we find that a WACC percentile somewhere between the 65th and the 85th is likely to reflect the highest social benefit.

While we consider that other regulatory tools can also mitigate against the cost of outages, the use of these tools needs to be traded off against (i) additional regulatory risk caused by changing the regulatory framework; and (ii) the need to make any regulatory changes NPV-neutral, especially in the context of a regulatory regime that does not have any evidence of over-compensation. Ultimately, the regulatory regime needs to provide a return that is sufficient for regulated companies to be funded by investors, and these alternative tools cannot necessarily compensate for an allowed return that is set too low.

Some of the evidence that the NZCC has previously considered to assess whether sufficient (or excessive) investment is being incentivised by the regulatory regime has focused more on the financial returns of the EDBs (e.g. the EV/RAB ratios) than on the incentives to invest (i.e. assessments of asset health, investment plans, etc.). We consider it more appropriate for the NZCC to consider measures that directly assess investment, such as business plans and the asset health of the network, rather than measures of investor returns which do not directly speak to the levels of investment being undertaken by the EDBs. In addition, we consider that the use of the EV/RAB ratio to measure investor returns is inappropriate as it can return a ratio in excess of 1 for reasons other than over-compensation.

In recent decisions, overseas regulators have tended to aim straight on the WACC, but have not done this universally. However, we consider the evidence from regulatory precedent to be of limited relevance to New Zealand, where the NZCC finds that the networks are not being over-compensated (and

[106] CEPA (2022), 'Review of Cost of Capital 2022/2023', section 4.3, available here.
[107] Ibid.

therefore limited a priori need to move away from the status quo of aiming up). Also, the choice by international regulators of the WACC percentile is not directly comparable to the NZCC's, because it is made in a different context (e.g. they do not apply the network reliability framework to calibrate the allowed WACC).

Box 4.4 CEPA update: concluding remarks

We consider that CEPA broadly comes to the same conclusion that we do. CEPA explains that the evidence for aiming up in the network reliability framework—as applied to the New Zealand energy sector—is stronger than it was in 2014, while observing that the international regulatory precedent has moved towards aiming straight.[108] CEPA was not asked to comment on whether they consider it appropriate to aim straight or aim up, but its main findings are similar to ours.

[108] CEPA (2022), 'Review of Cost of Capital 2022/2023', pp.4-5, available here.

5 Expansion of the NZCC framework and the impact that this may have on the WACC percentile that should be targeted

Section 4 discussed the reasons to aim up on the WACC within the context of the NZCC's framework. This section expands on that through three additional considerations that have not been taken into account by the NZCC to date.

The first consideration, discussed in section 5.1, is the extent to which further evidence has emerged regarding the optimal WACC percentile that a regulator should aim for, since the publication of our last report in 2014. The second consideration, discussed in section 5.2, explains why the need to decarbonise the economy and achieve net zero by 2050 strengthens the case for aiming up on the WACC. The third and final consideration, discussed in section 5.3, explains how the NZCC should more fully take into account another feature of parametric uncertainty (i.e. its estimation of standard errors) in the WACC estimate.

5.1 New academic evidence on the WACC percentile that regulators should aim for

We have reviewed new academic research, by Romeijnders and Mulder (2022), who studied the relationship between WACC uplifts and consumer welfare under a theoretical model.[109] They found that, under their model, the optimal solution was typically (but not always) to raise the regulated WACC above the historical WACC (i.e. target a percentile above the 50th). More details about their methodology and findings are summarised in Appendix A2.

The paper provides valuable insight on how the optimal regulated WACC should be set based on different assumptions about market conditions. Specifically, the authors find that the relationship between the WACC mark-up and the standard deviation of the WACC exhibits an inverted u-shape relationship, whereby the recommended uplift on the WACC increases with the standard deviation when the standard deviation is low, and decreases with the WACC when the standard deviation is high.

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.[110] We have done this in Table 5.1 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[111] 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.

[109] Romeijnders, W. and Mulder M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.
[110] 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.
[111] NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', para. 580, available here.

Table 5.1 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 WACC, measured by standard deviation	Percentage of asset base replaced in one year	Persistence[1]	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 persistence is the autocorrelation factor of the model and measures how close the previous period's value of 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.

We consider the salient points for the NZCC from Table 5.1 to be that:

- at high levels of persistence in the WACC (i.e. situations where under-investment could occur for multiple years), the optimal WACC percentile is always above the 67th;[112]
- at lower levels of persistence (i.e. situations where it is less likely that under-investment could occur for multiple years), and where the standard deviation is similar to the standard deviation calculated by the NZCC,[113] the suggested percentile is between 55% and 72%, thereby encompassing the 67th percentile used by the NZCC;[114]
- the most relevant rows to consider are likely to be those that have a standard deviation of between 1% and 1.5%, and persistence of 0.92 or 0.5. These rows are most relevant because the NZCC currently has an estimate of the standard error that is approximately 1%,[115] but the change that we suggest in section 5.3 would increase this. Furthermore, as the persistence

[112] This can be seen from the optimal WACC percentile in the rows that have a persistence parameter of 0.92. However, it is important to note that a persistence parameter of 0.92, which was the authors' estimate for the WACC in the Netherlands, may not reflect the level of persistence in the WACC in New Zealand.
[113] 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%. NZCC (2016), 'Input Methodologies Review Decisions. Topic paper 4: Cost of capital issues', para. 580, available here.
[114] 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
[115] NZCC (2016), 'Input Methodologies Review Decisions. Topic paper 4: Cost of capital issues', para. 580, available here.

parameter of 0.92 is estimated using actual market data from the Netherlands, it seems relatively unlikely that a persistence parameter of 0 would reflect the levels of persistence in New Zealand. These rows suggest a mean percentile of 77%, which is materially higher than the NZCC's current percentile.

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

- no investment is undertaken when the regulated WACC is below the true WACC, which increases the WACC percentile that it targets relative to a situation where some investment still takes place;
- 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.

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.

5.2 Aiming up in the context of the decarbonisation framework

As explained in section 3, the NZCC's framework considers that the primary form of under-investment that leads to an asymmetric loss is under-investment in network quality. This asymmetry largely arises from the fact that end-users place much more value on an uninterrupted electricity supply than they do on the additional costs that they pay from a WACC uplift. Under this framework, the higher the proportion of EDB investment that improves network quality, the greater the case for increasing the WACC percentile.

Under the NZCC's current framework any asymmetric loss arising from the need to decarbonise is not considered. However, since the framework was first introduced, New Zealand has committed itself to a 2050 net zero goal,[116] and the NZCC has stated that it may take into account New Zealand's climate change commitments in its ongoing review of the IMs.[117] Taking these commitments into account would tend to imply that the NZCC should target a higher percentile of the WACC than that which has been considered by the NZCC previously, or by us in the earlier parts of this report.

Decarbonisation tends to increase the asymmetry of the loss function for at least two reasons.

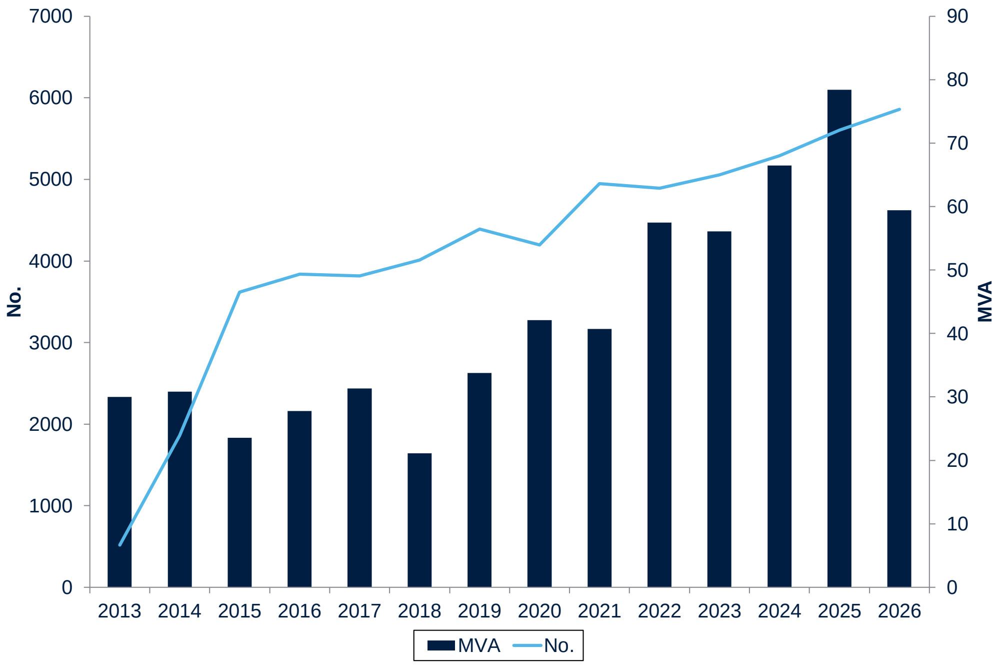
First, the need to connect new LCTs creates a further social benefit to any particular WACC uplift, without creating an additional countervailing cost. The need to deliver future decarbonisation investments requires that returns are sufficient for investment in infrastructure that facilitates new connections. As part of the energy transition, there will be a substantial increased demand for new connections, as a large number of functions that are currently not electrified will become electrified. These functions include, for example, electrification of heating and transport, and the electrification of various

[116] New Zealand Government (2022), 'Aotearoa sets course to net-zero with first three emissions budgets', available here.
[117] NZCC (2022), 'Note of clarification – our Part 4 Input Methodologies Review 2023 Framework paper', available here.

industrial processes. It is widely recognised that quick connection of LCTs is critical to the energy transition, with the New Zealand Electricity Authority commenting that investment in LCTs will need to rise to levels 'much faster than experienced in living memory'.[118]

Much of the increased demand for electrification will tend to be distribution-connected, affecting the EDBs, rather than transmission-connected (e.g. increased levels of embedded generation). Figure 5.1 below shows that, over 2022–26, there will be an average annual increase of 3.5% in the number, and 10.2% in the capacity of connections of distributed generation.

Figure 5.1 Historical and future annual connections of distributed generation to the New Zealand distribution network



Note: Forecast figures for Alpine Energy, Aurora, Eastland Network and Vector were provided 'cumulative' and have been amended to 'in year'.

Source: Oxera analysis based on client's data (Commerce Commission, EDB Information Disclosure Requirements, Schedule 9e: Report on network demand).

Accordingly, to successfully decarbonise the New Zealand economy, the EDBs will need to have sufficient capital and incentives to:

- connect new users, batteries, and generators to the grid. If EDBs have insufficient incentives to expand the network, there will not be enough capacity to connect these parties;[119]
- invest in transformational technologies (e.g. digitalisation, data, LV visibility, connectivity, two-way power flows, flexibility markets). These new technologies may be more risky than traditional network investments, such that there is a higher risk of disincentivising (riskier) investments if the WACC is set too low.

[118] Electricity Authority (2022), 'Price discovery under 100% renewable electricity supply. Issues discussion paper', para 3.5, available here.
[119] Alternatively, if the cost of increased connection charges is borne directly by new connectors rather than as part of network charges, this may also discourage LCT growth.

Second, as the New Zealand economy electrifies, the impacts of any outages will be more significant than they have been in the past. This could happen if, for example, manufacturing processes that currently use natural gas switch to electricity, or if more domestic heating is electrified. Related to this, if there is not enough spare capacity in the network to manage peak demand (which could happen if the EDBs do not have sufficient incentives to invest in the network), there could also be more outages.

Both of the above points provide a rationale to aim up for a higher percentile, relative to a network reliability framework that does not account for the social costs and benefits that are affected by the delivery of net zero.

5.3 How the NZCC should consider uncertainty in the WACC estimate

It is important for the NZCC to accurately estimate the uncertainty in the WACC estimate. This is because the standard error of the WACC determines the percentage point uplift that the EDBs will receive during a regulatory period.

Currently the NZCC calculates the standard error of the WACC by considering the standard error of three parameters: the Tax-adjusted Market Risk Premium (TAMRP), debt premium, and asset beta, and using these to calculate the standard error of the WACC.[120] This approach assumes that all other components of the WACC (i.e. the risk-free rate, debt issuance costs, leverage, and tax rates) have no uncertainty associated with them. In addition, it assumes that all the uncertainty with the three parameters is captured in their standard errors. As the standard errors of three parameters are estimated directly from the methods that the NZCC uses to estimate the WACC,[121] this means that the only uncertainty that the NZCC considers is the uncertainty that is contained within the models it uses. We refer to this as 'within-model' uncertainty and compare this to 'between-model' uncertainty, which is the uncertainty associated with choosing one particular approach to estimating a parameter at the expense of another.

It is unclear why the NZCC only considered the standard errors of three parameters when setting the WACC, thereby implicitly assuming that the other parameters were known with certainty. The assumption that other parameters can be known with certainty only seems reasonable for the tax rates, as these are fixed parameters that are determined by the New Zealand Government. However, this is not the case with the notional leverage, the risk-free rate, and debt issuance costs for the following reasons.

- The NZCC could be wrong about the optimal level of leverage that the EDBs should have. This might be more likely in New Zealand than in other countries because the approach that the NZCC takes to estimating the leverage uses a considerably larger number of comparators than most other countries, many of which are US-based and may therefore be materially different from the New Zealand EDBs.[122] Indeed, in his paper on estimating the WACC of energy networks, the NZCC's adviser, Dr Lally, explained that

[120] Further information on the NZCC's approach can be found in NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', pp. 149–157, available here.
[121] There is a minimum standard error that the debt premium needs to meet, and if the calculated standard error is below this level then the minimum level will be used instead. In addition, the NZCC does not appear to have explained how it calculated the standard error of the TAMRP. NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', pp. 149–157. available here.
[122] NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', 20 December, paras 275–285, Attachment A, available here.

there would be likely to be 'significant uncertainty' around the leverage of regulated networks.[123]

- The risk-free rate is a parameter that is likely to have a standard error because different measures of the risk-free rate (i.e. different high-quality bonds) will have different yields. Indeed, when writing his report on the approach that should be used for estimating the WACC of energy networks, Dr Lally assumed that the risk-free rate would have a standard error,[124] although he also considered that the standard error would be likely to be quite small.[125]
- Debt issuance costs may also vary between companies, which would also lead to these having a standard error. However, given that debt issuance costs are relatively low (0.2% in the last series of IMs[126]), it may be the case that their standard error would be relatively immaterial.

While we consider that best practice in estimating the standard error of the WACC would be to consider the standard error of all of its components, we acknowledge that this may not be practical or proportionate if the standard errors of some parameters are relatively low. This could justify the exclusion of the standard error for debt issuance costs and the risk-free rate, but it would not justify the exclusion of the standard error of leverage. The standard error of leverage is likely to be material due to the large and diverse set of comparators that the NZCC uses to estimate it, which is likely to result in companies with very different leverages being used for the estimate.[127] This variation in leverage would be captured in the standard error of the estimate, and therefore including this in the standard error of the WACC would give a more complete picture of the uncertainty in the estimated WACC range.

The NZCC does however compare its estimates of the mid-point of the WACC against independent WACC estimates from professional services firms, investment banks, and brokerages.[128] However the NZCC also performs this exact same comparison with the 67th percentile of the WACC range that it calculates. As it is likely that the independent WACC estimates are estimates of the mid-point, the NZCC should only sense-check its estimates of the mid-point of the WACC against these. It is inappropriate to sense-check a different percentile because percentiles above the 50th should, by definition, be higher and percentiles below the 50th should, by definition, be lower.

Even though the NZCC compares its estimates of the mid-point of the WACC to independent third parties, it does not compare the estimates that it could generate through applying alternative methodologies. To use the terminology introduced earlier, the NZCC only considers the within-model variation of some of the components of the WACC, but it does not consider the between-model variation of the components of the WACC at all. This contrasts with the approaches taken by other regulators, which consider a range of parameter values in order to assess which ones are the most realistic. To the extent that

[123] Lally, M. (2008), 'The Weighted Average Cost of Capital for Gas Pipeline Businesses', p. 91, available here.
[124] Lally, M. (2008), 'The Weighted Average Cost of Capital for Gas Pipeline Businesses', fn. 9, available here.
[125] Lally, M. (2008), 'The Weighted Average Cost of Capital for Gas Pipeline Businesses', fn. 9, available here.
[126] NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', para. 201, available here.
[127] NZCC (2016), 'Input Methodologies review decisions. Topic paper 4: Cost of capital issues', 20 December, Table 29, available here.
[128] NZCC (2014), 'Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services', paras D21–D27, Figure D1, available here.

considering alternative sources of evidence would widen the WACC range, not doing so will tend to lead to an under-estimate of the allowed point estimate within the range.

6 Conclusion

This report has assessed the percentile that the NZCC should target from the perspective of both the network reliability framework that the NZCC has considered (see section 4) and the extensions to the network reliability framework (see section 5).

We find that the network reliability framework supports targeting a percentile between the 65th and 85th percentiles of the WACC distribution, based on our assessment of the socio-economic benefits of aiming up on the WACC percentileer,. This conclusion is consistent with new academic evidence from Romeijnders and Mulder (2002)—the most relevant results of which support a WACC percentile of 77%. We do not over-rely on the Romeijnders and Mulder framework, as we identify how its results are sensitive to the modelling assumptions made by the authors. However, we consider it helpful in informing a choice of percentile that is higher than the mid-point of the WACC range.

Within the NZCC's existing framework, we note that the existence of other regulatory tools mitigates the risk, at least in the short term, of substantial under-investment. In addition, the current regulatory period, which targets the 67th percentile of the WACC, appears to be delivering good outcomes for consumers—albeit with returns that are potentially slightly too low for the EDBs as per the NZCC's assessment. These points tend to support the lower end of the 65th to 85th percentile range.[129] On the other hand, the increased asymmetry of the loss function from the decarbonisation framework we have introduced would tend to support the upper end of the 65th to 85th percentile range. On balance, across all of the evidence considered in this report, a percentile between the 65th and the 75th is appropriate. As the 70th percentile is in the middle of this range, this provides a focal point for the NZCC's decision on the appropriate percentile as part of the upcoming IM review. Giving weight to the need to maintain regulatory stability, this supports the retention of at least the 67th WACC percentile.

We note that regulatory precedent shows that overseas regulators have tended to aim straight in recent decisions, although CRE has aimed up on the WACC in its most recent decisions. However, this regulatory precedent is of limited direct read-across, as it comes from countries that do not explicitly undertake analysis related to applying the network reliability framework in setting the WACC, as the NZCC has done. In addition, in many of these countries, aiming straight has tended to be accompanied by measures that have reduced (but not eliminated) the ability for the regulated WACC to deviate from the true WACC, such as the use of indexation of the cost of equity and/or cost of debt allowances.

[129] Selecting too high a percentile could unnecessarily increase the incentives for gold-plating in relation to network investments. We consider this to rule out targeting a WACC percentile above the 80th, as we find that targeting the 85th percentile of the WACC results in consumers experiencing an increase in electricity bills that is approximately twice as high as what they experience at the 70th percentile.

A1 Regulatory precedent on aiming up

Table 6.1 Regulatory precedent on aiming up

Name of regulator	Does the regulator aim up?	Rationale for decision/ further details
Ofgem (UK)	No, but three smaller companies receive an infrequent issuer premium on their cost of debt	• Takes the mid-point of the parameters used to estimate the cost of equity and does not add any premia such as convenience premia. • Calculated cost of debt using the yields on 10-year utility bonds, uplifted for debt issuance costs and, in the case of three companies, a 6bps infrequent issuer premium.
AER (Australia)	No	• Based on cross-checks from EV/RAB multiples, financeability tests and other scenario testing, the AER considered the overall rate of return, under a method that aims straight, to be reasonable.
ARERA (Italy)	No, but a convenience premium is added to the RFR	• Several premia are added to the RFR. • Two of them (an uncertainty premium and a forward premium) appear to be introduced to reflect the fact that the WACC is not indexed. As the WACC is indexed in New Zealand, this does not reflect an attempt to aim up relative to the approach taken by the NZCC. • However, a convenience yield is also added to the RFR.
CRE (France)	Yes, although it does not explicitly discuss this	• For the TSO, CRE granted a WACC of 4.6% from a range of 3.87%-5.03%. • For the EDB (DSO), a different remuneration methodology, which is based on the same parameters of the WACC, is used. • The relevant rates, 'marge sur actif' and 'rémunération des capitaux propres régulés' were determined respectively at 2.5% from a range of 2.4%-2.5% and 2.3% from a range of 2.1%-2.5%.
BNetzA (Germany)	No but a convenience premium is added to the RFR	• A convenience yield is added to the RFR to reflect the fact that there is a divergence between government bond yields and corporate bond yields.

Name of regulator	Does the regulator aim up?	Rationale for decision/ further details
ACM (Netherlands)	No	• ACM does not uplift any of the parameters used to calculate the WACC

Source: Ofgem (2022), 'RIIO-ED2 Draft Determinations Finance Annex, available here; Ofgem (2021), 'Ofgem response to CMA cost of capital working paper', available here; AER (2021), 'Final Decision: AusNet Services Distribution Determination 2021 to 2026', available here; 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', available here; 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), available here; 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)', available here; Bundesnetzagentur (2021), 'BK4-21-055', available here; ACM (2021), 'The WACC for the Dutch Electricity TSO and Electricity and Gas DSOs', available here.

A2 Summary of methodology used by Romeijnders and Mulder (2022)

The approach taken by Romeijnders and Mulder was to take a stylised model that simulates investments undertaken by an electricity grid operator that is subject to price-cap regulation. The grid operator replaces a certain percentage (10% in the base case of the model) of the infrastructure in each year if the regulated WACC (which is set at the start of each 5-year regulatory period) is set above the true WACC, and performs no investment if the regulated WACC is set below the true WACC. Subsequently, the model estimates the expected quantity of lost load in a given year, based on the age of the infrastructure (which is a function of the operator's investment decisions). The lost load is valued at the Value of Lost Load (VoLL). The model also estimates the additional costs that consumers have to pay for electricity as a result of different percentiles of the WACC being chosen. In this way, the authors can trade off the impact that the investment effects of the higher WACC have on lost load and customers' bills, in order to see what size of uplift the regulator should aim for.

In order to increase the robustness of their results, the authors performed multiple sensitivity analyses on the uncertainty of the true WACC, by varying its standard deviation, the VoLL per MW/h, the expected quantity (in MWh) of lost load, the social discount rate, the percentage of assets that can be replaced by investment in a given year, and the persistence of the WACC (i.e. the extent to which the true WACC in one period is similar to the true WACC in the previous period[130]).

Consequently, the paper provides a very similar, but not identical, framework for considering the effects of a higher WACC percentile to the NZCC. It is a similar framework because it considers the effects from a consumer welfare perspective of the true WACC being below the regulated WACC, and it also assumes that the true WACC is not known to the regulator. The main way in which this framework extends the NZCC's framework is that the authors assume that the WACC is persistent from one period to the next. This extension is important because it means that if the regulator mis-estimates the WACC at the start of the regulatory period, it is likely that the direction of its mis-estimate will be the same in the next year of the regulatory period. However, as explained above, the authors also run a sensitivity analysis on the persistence of the WACC, meaning that we can observe how sensitive their results are to it.

[130] The paper assumes that the WACC on the capital market follows a first-order autoregressive process, the AR(1) model estimates the predicted value of WACC in period t through the sum of the long-term expected value of WACC, the error term and the difference of the expected value of WACC subtracted from the predicted WACC of period t-1 multiplied by the persistence term. The persistence measures the uncertainty of WACC on capital markets: the higher the persistence, the closer the predicted WACC value will be from the previous period's, and the more predictable the WACC is, the lower the uncertainty around WACC during the regulatory period is.

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