Stranding risk
depreciation vs uplift

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August 2021

Table of Contents

List of Figures

List of Tables

1 Introduction and overview

1. We have been engaged by the Vector to provide our opinion as economists on remedies to address the stranding of investment in regulated gas distribution businesses.

2. Stranding occurs when businesses can no longer expect to recover previously sunk investments in providing regulated services. In the absence of measures to address stranding risk, and provide for an expectation of cost recovery, investors will be discouraged from making investments to support the provision of the specific regulated service and regulated services more generally. The likelihood and magnitude of stranding for a regulated business is influenced by the cost recovery path determined by regulators. This cost recovery path is determined by the rate at which capital is returned to investors (i.e., deprecation).

3. In this report we model the relationship between the rate that capital is returned to investors, the expected cost of future asset stranding and the compensation required for expected asset stranding.

4. We show the following:

   a. An acceleration in the rate of deprecation will reduce the likelihood and expected cost of stranding and, therefore, reduce the level of compensation required for that stranding.

   b. Measures to address stranding risk such as an *ex ante* stranding uplift (self-insurance cost) and accelerated depreciation can be shown to be mathematically equivalent.

   c. To date, models used by regulators to compensate for stranding risks are rudimentary and do not realistically model the circumstances of regulated gas distribution businesses.

   d. We develop a more realistic model and apply it to Vector's and New Zealand Gas Pipeline Business circumstances. While the model is based on illustrative assumptions about the path for future gas demand (based on New Zealand Climate Change Commission scenarios), its outputs do suggest a strong case for immediate action by the New Zealand Commerce Commission (NZCC).

   e. The model also shows the trade-off between accelerated depreciation and the required *ex ante* uplift to compensate for expected stranding costs. Specifically, the faster the accelerated depreciation the lower the *ex ante* uplift.

   f. In our view, the best policy response is to use accelerated deprecation as the primary tool to deal with stranding risk.

i. Accelerating depreciation now may be a sufficiently powerful to avoid an expectation of future stranding and, therefore, obviate any need for an *ex ante* stranding uplift.

ii. Even if this is not the case, accelerated deprecation should be relied on as the primary tool for dealing with stranding risk. Application of an *ex ante* uplift should only be relied on if accelerated depreciation cannot fully eliminate stranding risk.

g. If the window of opportunity to address stranding risk is missed, regulators may have no capacity to address the effects of stranding risk. If that is the case, then it is likely that at some future date there will be no chance to re-direct the recovery pathway.

2 Stranding risk

5. In this section we discuss some economic considerations relating to approaches to address the risk of stranding.

2.1 What is stranding risk?

6. Whenever costs are incurred in advance of receiving revenues there is a risk that such expenditures will not be recovered. The inability to recover past expenditures, including a normal return, results in those costs being stranded. A common reason that costs may be stranded is because of unexpected reductions in demand for the product. The reduction in demand may be for a range of reasons including unexpected advancement in competing technologies, changing consumer preferences or interventions by government to restrict demand.

7. In a regulated setting, prices are typically held below the willingness to pay of consumers.[1] Regulators also smooth the recovery of costs. They do this by adopting a depreciation profile that achieves a path of prices that is considered to be desirable and which, ideally, aims to promote economic efficiency.[2]

8. In the absence of any probability of stranding, the regulated firm may be indifferent between the regulator's choice of depreciation profile. This indifference to the profile of depreciation is commonly referred to as the Invariance Proposition.[3] It says that if the depreciation profile is determined such that the present value of future income streams is zero in each period over the life of the asset (discounted at the allowed rate of return) investors will be assured cost recovery (at least in expectation). Hence, they will be indifferent between depreciation profiles selected by the regulator.

9. However, once we introduce a positive probability of stranding, the Invariance Proposition no longer holds. The regulated firm will no longer be indifferent between

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1 In unregulated settings, a firm will only incur costs if they expected to at least earn a normal return. The risk of stranded costs in this setting is borne by the firm. The compensation for assuming this risk is in the upside returns in circumstances that stranding does not occur. In a competitive market this upside is constrained by the potential for entry – which is in turn informed by "the market's" perceptions of stranding risks.

2 This would entail setting prices such that they minimise dead-weight loss. In effect, this would be an intertemporal application of the well-known Ramsey pricing problem. Prices, or the level of depreciation of the asset, would be set in each period to maximise use of the service over the life of the asset. This would require recovering a greater proportion of costs in periods where demand was relatively less sensitive to higher prices (the inverse elasticity rule) See Baumol, W. J. (1971). Optimal Depreciation Policy: Pricing the Products of Durable Assets. The Bell Journal of Economics and Management Science, 2(2), 638

3 Schmalensee, Richard, 1989. "An Expository Note on Depreciation and Profitability under Rate-of-Return Regulation," Journal of Regulatory Economics, Springer, vol. 1(3), pages 293-98, September.

the regulator's choice of depreciation profiles if some of those profiles backload depreciation into periods such that the allowed prices will be above consumer's willingness to pay (i.e., cause stranding to occur).

10. In practice, the likelihood and the degree of stranding may not be known with certainty. There will be some states of the world in which stranding will occur and in other states of the world stranding might not occur. Hence the terminology of stranding "risk".

11. Without explicit allowance for the possible states of the world in which stranding might occur, investors face an asymmetry. Investors face the potential for there to be a downside without any commensurate potential for upside.[4] This asymmetry means a key principle of regulation is no longer adhered to – that of giving investors an expectation, or a fair bet, that they will be able to recover the cost of investing in assets to provide regulated services.

2.2 What creates stranding risk?

12. In a regulatory regime where a regulated business could choose their own deprecation profile, but still be subject to an NPV=0 long term cost recovery constraint, the business would have an incentive and ability to adjust its price path to reduce the risk or size of potential stranding. Firms could tilt the recovery of costs to earlier periods such that higher prices today would be in lieu of materially lower prices in the future (given the impact of discounting within an NPV=0 constraint). Stranding is made less likely because materially lower future prices are less likely to be above consumers' willingness to pay.

13. It is, therefore, the regulator's choice of depreciation profile that determines the size of stranding risks. A regulator that adopts a heavily backloaded depreciation will create or increase the risk of stranding, whilst a regulator that adopts a more frontloaded deprecation profile will reduce the risk of stranding, other things equal.

2.3 Why address stranding risk?

14. This section discusses the reasons for addressing stranding risk.

15. The two primary grounds for addressing stranding risk relate to providing surety for future investment. The first ground is economic efficiency. Denying the opportunity to recover costs risks raising perceived cost of doing business above the competitive

4 The nature of regulation is that it caps the potential upside to be a normal rate of return.

level leading to a lower than optimal allocation of investment in the provisions of services.[5]

16. If stranding occurs due to government fiat, this may be viewed by financial markets as a form of opportunism. Participants in financial markets would incur greater transaction costs in investing in regulated sectors exposed to the potential for stranding. This could create distortions in decision making to the detriment of economic efficiency.

17. The second ground for addressing stranding risk is to ensure regulation is consistent with an implied compact between current and future consumers. In this framework, the regulator acts as an arbitrator of a fair deal between current and future consumers. In the absence of long-term agreements with consumers, or exit fees, consumers that continue to use services when demand falls are exposed to price increases. This involves a burden shift from consumers that no longer use the regulated service to consumer that continue to do so.

18. If demand falls to a significant extent the higher prices charged to consumers who continue to acquire services may be insufficient to achieve cost recovery. This would ultimately result in price spiral with the price increases resulting from falling demand perpetuating further reductions in demand, ultimately resulting in asset stranding.

19. This was the AER's logic for accelerating depreciation in the face of potential falls in future demand.[6]

> *"As consumers make the switch to renewable energy under the ACT Government's climate change strategy it's expected there will be less demand for gas in the ACT," Ms Savage said.*
>
> *"This means any remaining consumers who can't or don't yet choose renewable energy services are at risk of future bill increases because less homes and businesses can share the cost of maintaining gas network services.*
>
> *"To minimise future price increases, particularly for vulnerable consumers that might not be able to afford to switch, the AER's decision allows Evoenergy to accelerate the depreciation of new gas pipeline assets in NSW and the ACT.*

5 Brennan, T. J., & Boyd, J. (1997). Journal of Regulatory Economics, 11(1), 41–54

6 AER, press release *AER allows revenue to support gas consumers in transition to renewable, 30 April 2021.*

"Faster depreciation means that some of the costs for gas network services can be recovered from more consumers today, compared to a smaller number of consumers in the future

20. Setting faster regulatory deprecation to minimise stranding risks is a means to determine a fair deal between consumer and investors, as well as between current and future consumers.

3 Modelling stranding risk

3.1 Overview

21. This section explores the modelling of stranding risk and, to the extent that stranding risk cannot be eliminated, how to model the necessary *ex ante* compensation for that residual stranding risk.

22. We have already noted that Schmalensee (1989) demonstrated the Invariance Proposition which states that, in the absence of stranding risk, investors are indifferent about the time profile over which they recover their investments.

23. However, it is also recognised in that, in the presence of stranding risk, this is no longer true. Crew and Kleindorfer show that accelerated capital recovery may be necessary to eliminate or reduce the expected cost of stranding:[7]

> *… under conditions of competition and technological progress, front-loading of capital recovery is essential if the regulated firm is to remain viable. In addition, if the introduction of accelerated capital recovery is delayed by regulators, they may effectively vitiate any opportunity of the firm to recover its invested capital. The breathing space, or period of time, that the regulators can delay introducing the application of efficient capital recovery without ultimately compromising the firm's ability to recover its invested capital is called the "Window of Opportunity" (WOO).*

24. This passage highlights a critical relationship, and trade-off, between:

- The rate at which capital is returned to investors;
- The expected cost of stranding of future stranding; and
- The necessary compensation 'stranding uplift' now if the expected cost of future stranding cannot be eliminated.

25. Holding other things equal, the slower the rate that capital is returned to investors the higher the expected cost of future asset stranding and the higher the compensation required for that asset stranding.

26. In the rest of this section, this relationship is explored within two different modelling frameworks.

7 Crew, Michael A & Kleindorfer, Paul R, 1992. "Economic Depreciation and the Regulated Firm under Competition and Technological Change," Journal of Regulatory Economics, Springer, vol. 4(1), pages 51 - 61.

3.1.1 The NZCC modelling framework applied to Chorus

27. In section 3.2, we apply the modelling framework that theNZCC used to estimate a stranding uplift to compensate Chorus for stranding risk. This stranding uplift was applied as a percentage of the RAB and, in this sense, it can be thought of as a "WACC uplift". However, the correct way to conceive of this is as an increase in the "promised return" absent stranding in order to make the "expected return" equal to the WACC. That is, the "WACC uplift" does not result in an increase in expected returns above WACC – it merely raises expected returns to be equal to WACC (where they would otherwise be below the WACC absent the uplift due to stranding risk).

28. With plausible assumptions about potential asset stranding by 2050, this modelling suggests a very high stranding uplift for stranding (greater than 5%).

29. The modelled stranding uplift can be reduced by applying accelerated depreciation. However, even with extremely high levels of accelerated depreciation the need for a stranding uplift cannot be eliminated within this modelling framework. For example, even if compensation for capital costs was initially quadrupled (such that capital cost compensation fell to effectively zero by 2040) a 1.45% stranding uplift would still be required.

30. This is because, implicit in the modelling framework applied by the NZCC, there is an assumption that the probability of stranding by 2050 is simply the accumulation of a continuous constant risk of stranding per unit of time between now and then. This means that, even if 100% past capital investment was to be returned at the end of one year, the investors would still be exposed to material asset stranding risk within that year. Therefore, the only accelerated depreciation that can remove stranding risk altogether is instantaneous return of past investments (i.e., in the first second of the next regulatory period).

3.1.2 Modelling the path of future gas demand

31. In section 3.3 we adopt an alternative model that does not assume a constant continuous constant risk of stranding per unit of time. Instead, we assume a time path of for the demand (willingness to pay) for gas transport and a time path for the recovery of costs (past investments plus ongoing costs). So long as the latter is below the former, the business can recover its costs. However, if the former drops (or has a positive probability of dropping) below the latter, then there is an expected cost of stranding (revenues falling below costs).

32. The model assumes that the regulated business will continue to operate the business so long as revenues exceed 'stay-in-business' costs. This is true even when revenues fall below regulated building block costs (inclusive of the cost of sunk investments). However, once aggregate customer willingness to pay falls below stay-in-business costs, the services will cease to be supplied. The total stranding cost is modelled as the sum of the following in present value terms:

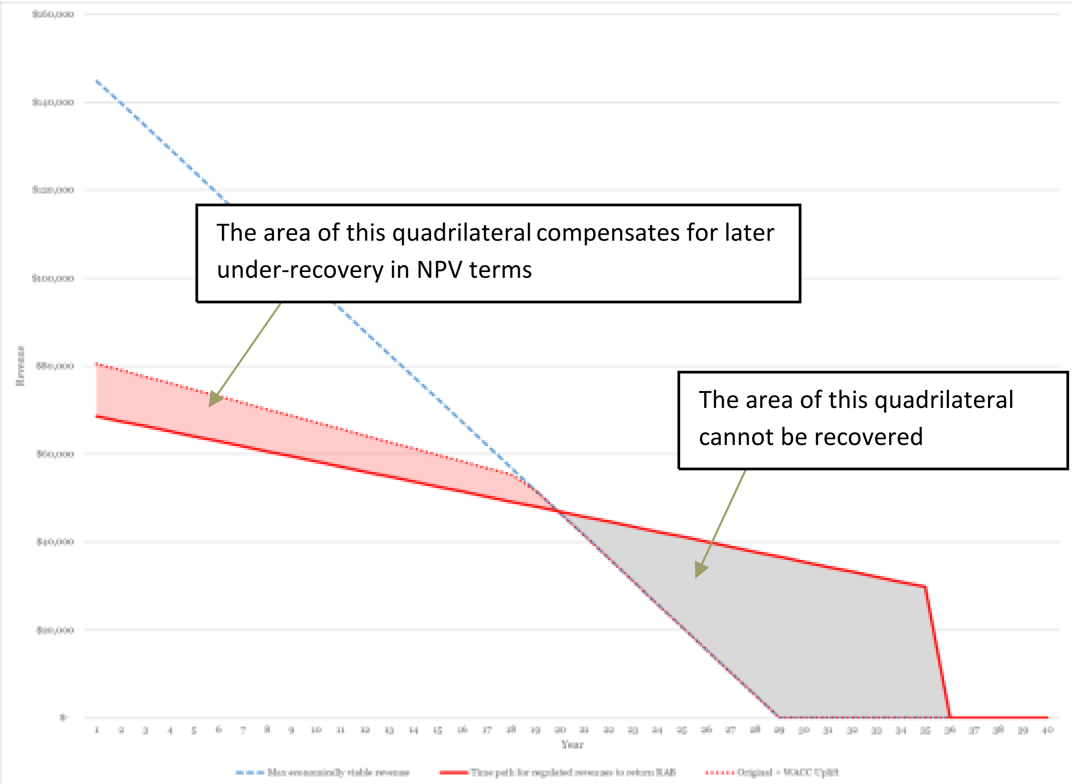
- The difference between building block costs and revenues while the business continues to operate at revenues less than building block costs; plus
- The value of the unrecovered RAB at the time the network is closed (when revenues fall below stay-in-business costs).

33. The stranding uplift is calculated to generate the same present value of revenues above/below building block costs prior/after customers' willingness to pay falls below building block costs. This is illustrated in Figure 3-1 below, where, for simplicity, we have assumed the only costs are the recovery of previously sunk costs (zero operating and capital expenditures) and that the regulator has set a path for full recovery of those sunk costs over 35 years.

34. However, in this illustration the maximum viable contribution to sunk costs is given by the blue line and this cuts below the regulator's path for cost recovery from year 20 onwards. Between years 20 and 28 the business can earn some revenues towards its sunk investments. However, from beyond year 28 revenues make zero contribution to sunk costs. This means that the loss to the business is given by the area of the quadrilateral at the bottom right of Figure 3-1. This is the difference between building block costs and revenues from year 20 onwards.

35. To compensate for this loss there needs to be an uplift in regulated revenues above building block costs prior to year 20 (shown by the dotted red line). This uplift needs to be calibrated so that the area under the upper left-hand quadrilateral (bounded by the dotted and unbroken red lines) is equal in present value terms to the bottom right quadrilateral. Because of the effects of compounding, the upper left quadrilateral is smaller than the bottom right quadrilateral.

Figure 3-1: CEG framework for modelling stranding risk



Source: CEG illustration

36. We use this basic model to generate some more complex modelling in section 3.3 below. Under this model it is, at least in some circumstances, possible to accelerate depreciation sufficiently to eliminate the need for any stranding uplift.

3.2 The NZCC method applied to Chorus

37. In this section we apply the NZCC approach to estimating an uplift to the WACC for exposure to stranding risk for Chorus. The NZCC approach relied on a modelling framework developed by Dixit and Pindyck.[8] In doing so, the NZCC made the following implicit and explicit assumptions:

    a. That cash-flows above avoidable costs are a perpetuity (this could be associated with zero capital expenditure or capital expenditure equal to depreciation such that the RAB is in a steady state).

    b. An assumption about the probability of a certain percentage of RAB being stranded over the next N years. For Chorus, the NZCC thought it was reasonable

[8] Dixit and Pindyck "Investment under Uncertainty" (1994), Princeton University Press, pages 200 to 207

to assume slightly less than a 5-10% probability that 10-20% of the RAB would be stranded at some point (i.e., cumulatively) over the next 10 years.[9]

c. Assume that the stranding risk in b. results from a process where there is a constant per annum stranding risk.

d. Back solve from a. b. and c. what an implied annual risk of stranding is and, therefore, what annual compensation is required. This is how the NZCC arrived at 10bp ex ante uplift. In effect, the NZCC has assumed, based on a. b. and c., that there is an effective 0.1% risk of 100% asset stranding in each year (which is also equivalent to an A% risk of B% stranding in each year – where A×B=0.1% (e.g., a 1% chance of 10% stranding each year).

38. For gas distribution businesses there is, arguably, a much more material risk of stranding by 2050. For example, the New Zealand Climate Change Commission has recommended to the New Zealand Government that it pursue policies aimed at achieving zero natural gas distribution to residential and commercial customers by 2050.[10] These policies include banning new gas connections.

39. In this context, it is plausible to assume a high probability that any unrecovered assets in 2050 will be stranded. In what follows, we use the NZCC modelling framework to estimate the stranding uplift if, by 2050, there is an 80% probability that 100% of the asset is stranded. If we do this, then there is a 5.75% per annum required uplift for stranding risks.

40. We illustrate this model visually in Figure 3-2 below. The red dotted line is the cumulative risk of asset stranding assuming 5.75% annual risk of asset stranding. This line is plotted relative to the right-hand axis. It can be seen that 5.75% annual stranding risk compounds to a cumulative stranding risk of 25% after 5 years and 80% after 28 years (i.e., by 2050).

41. The solid black line in the illustration (plotted against the left-hand axis) is the value of a perpetuity. We have chosen the level of this perpetuity at $4.41 which can be thought of as a 4.41% real WACC applied to a constant real regulated asset base of $100.[11] The dotted black line represents the perpetuity plus the stranding uplift of 5.75%

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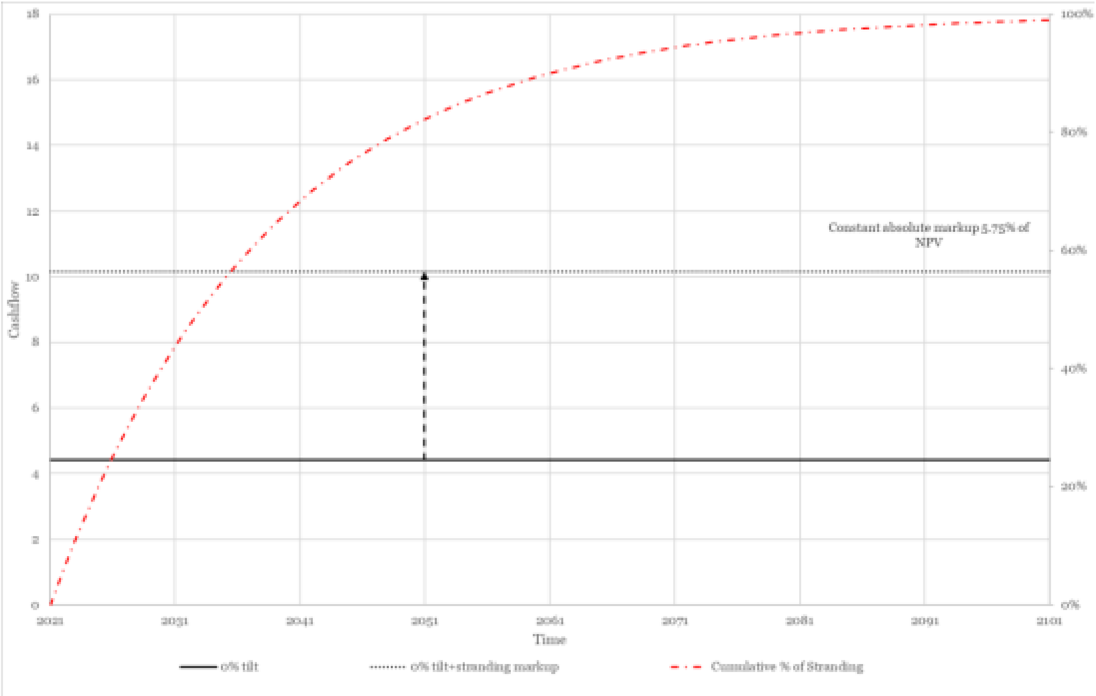
9 NZCC Fibre input methodologies: Main final decisions – reasons paper, 13 October 2020, p. 599. The Commission actually determined this as the midpoint but chose a level of compensation associated with a lower level of stranding risk in order to, in its view, better serve the relevant legislative objectives it is required to have regard to.

10 New Zealand Climate Change Commission, Scenarios dataset for the Commission's 2021 Final Advice (output from ENZ model), 9-Jun-21.

11 Consistent with the Commission's modelling for Chorus this is a perpetuity which implies either zero real depreciation with zero capex or capex equal to depreciation (i.e., a steady state RAB).

Figure 3-2: NZCC methodology



Source: CEG Analysis

42. A 5.75% stranding uplift is greater than the real WACC itself and, in our view, is likely to overstate the true required uplift for stranding risk – even if there is an 80% probability of 100% asset stranding by 2050. This is because:

    - The implicit assumption of constant annual stranding risk is extreme and tends to overestimate the potential for cash-flows to be impaired in early years;
    - The assumption of a perpetuity of cash-flows assumes no preventative action is taken to avoid/reduce stranding by 2050. It implies that there is no acceleration of deprecation (or reduction in new investment relative to depreciation).

43. Assuming a constant annual stranding risk is akin to assuming that regulated gas businesses are just as likely to be unable to recover their regulated revenues in 2022 as in 2050 (and in every year in between). This assumption makes sense if one is modelling the expected costs from a random event, such as an earthquake, but makes less sense when the source of stranding relates to the inability to recover regulated revenues at some future point in time. This type of stranding risk cannot be easily dealt with in the Dixit and Pindyck framework and that is why we explore a different framework in section 3.3 below.

44. However, it relatively simple to model accelerated depreciation in the Dixit and Pindyck framework by simply assuming the cash-flows in question are a tilted perpetuity rather than a constant perpetuity. A perpetuity with a tilted revenue

profile has revenues rising/falling annually by the relevant tilt (-5% tilt implies prices are falling by 5% annually).

45. In order to have a constant NPV, a perpetuity with a -5% (-30%) tilt must start with initial revenues that are roughly double (10-fold) higher than a constant perpetuity. This means that a perpetuity with a negative tilt has accelerated depreciation relative to a constant perpetuity (zero tilt).

Table 1: Stranding uplift with different tilted perpetuities

Tilt	Stranding uplift required (assuming 80% risk of 100% stranding by 2050)
0%	5.75%
-5%	3.85%
-30%	1.45%

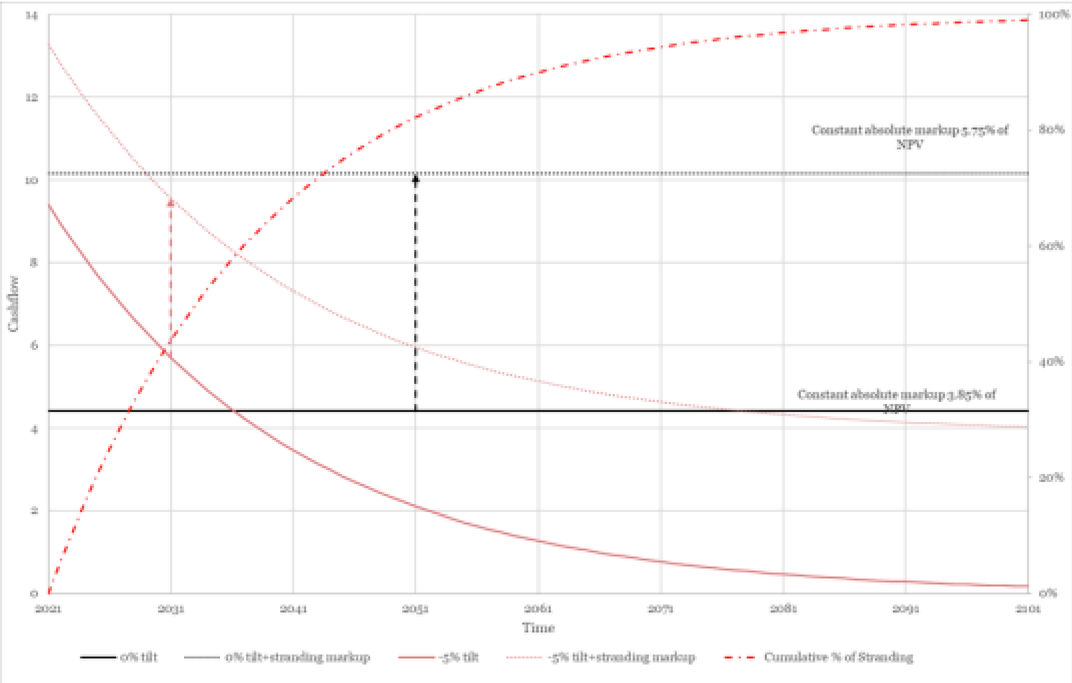
Source: CEG analysis

46. Even with extreme accelerated depreciation associated with a -30% tilt (a 10-fold increase in prices immediately to allow a 30% reduction in prices per annum) the required stranding uplift is still 1.45%.

47. As foreshadowed, this is because, under the Dixit and Pindyck's modelling assumptions, the probability of stranding by 2050 is just the accumulation of continuous constant risk of stranding per unit of time between now and then. In this model, the only way to eliminate stranding risk is for the regulator to allow immediate and instantaneous return of past investments. Any delayed recovery of investment creates stranding risk because stranding risk is assumed to be the same from one month to the next (indeed, from one minute to the next).

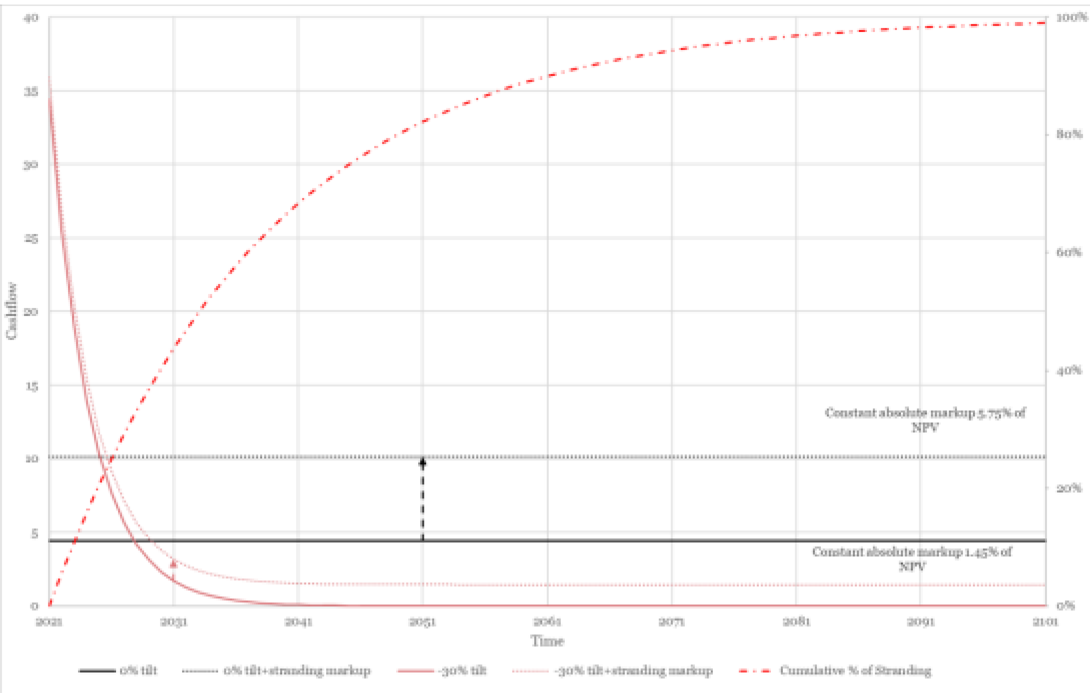
48. Figure 3-3 and Figure 3-4 below illustrate the -5% and -30% tilts graphically.

Figure 3-3: NZCC methodology – adapted to apply a -5% tilted perpetuity



Source: CEG Analysis

Figure 3-4: NZCC methodology – adapted to apply a -30% tilted perpetuity



Source: CEG Analysis

3.3 Alternative approach to modelling asset stranding risk

49. Rather than assuming a constant annual probability of stranding. We introduce the concept of the maximum economically viable profit that can be obtained from the market. This can be thought of as customers' aggregate willingness to pay for gas pipeline services less the 'stay-in-business' operating expenditures of those businesses. This is the maximum amount that customers are willing to contribute to compensation for past sunk investments (above and beyond the compensation required for ongoing costs of providing the service).

3.3.1 Base case scenario

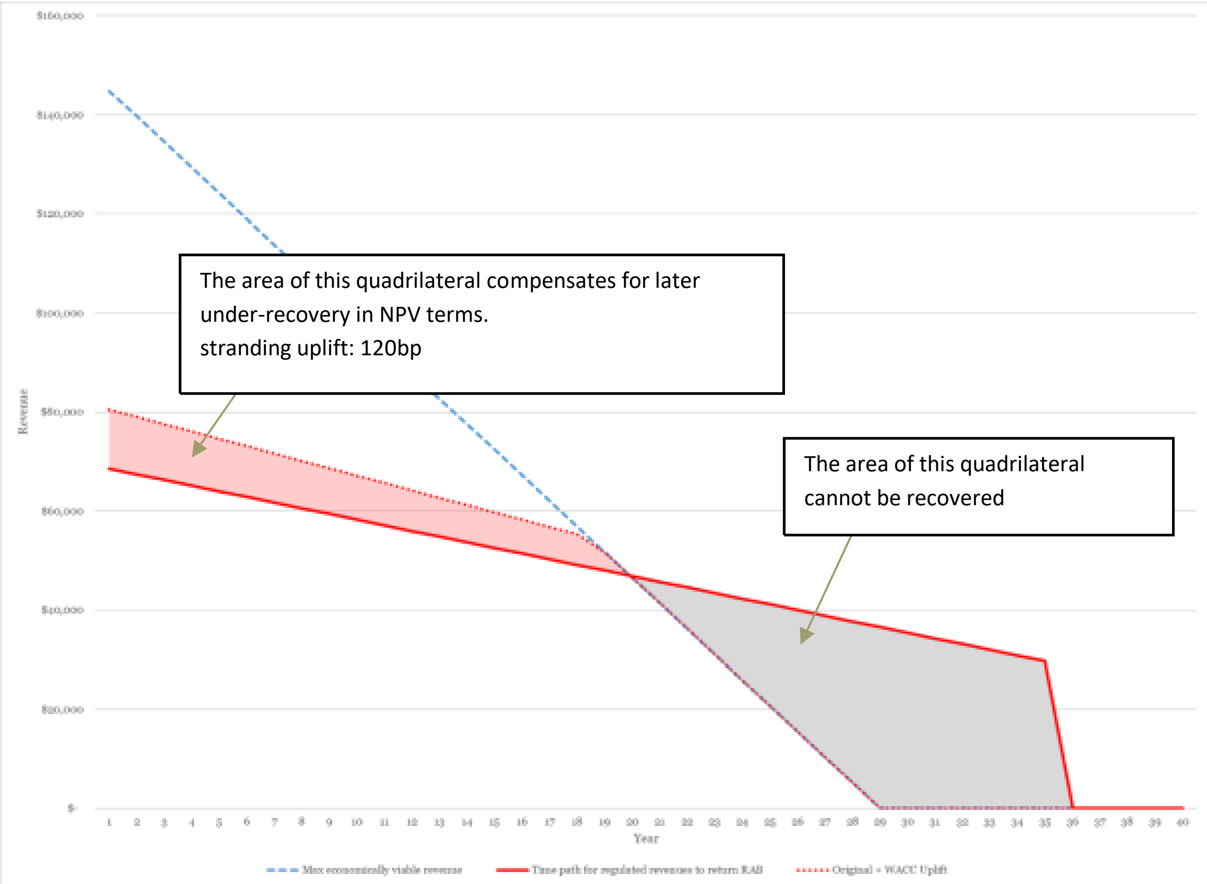
50. Figure 3-5 is the same as Figure 3-1 set out above. The solid red line illustrates the regulator's time path for recovery of sunk investments. The underlying assumption is that, at the beginning of year 1 there is $1,000,000 of unrecovered RAB and the real WACC is 4% (it is assumed that the RAB is inflation indexed so that all values in Figure 3-5 are in real "year 1" terms). It is also assumed that the regulator is depreciating the sunk RAB in a straight line over a 35 year remaining life with straight line depreciation. These assumptions imply the solid red line (building block costs) starts at $68,571 in year 1[12] for the return on, plus depreciation of, the sunk capital base in year one and falls to zero by the end of year 35 (beginning of year 36).

51. The dotted blue illustrates the path of customers' aggregate willingness to pay for the sunk investments. This line can be thought of as customers' willingness to pay 'as if' there is no opex or capex, or, more realistically, the blue line represents the maximum willingness of customers to pay for the recovery of sunk costs after all other variable costs are paid for. In this illustration, customers' initial aggregate willingness to compensate for sunk costs is $145,000 per annum – being roughly double the building block costs associated with sunk assets. However, this is assumed to fall, in a straight line, to zero 28 years later (28 years from 2022 is consistent with a possible 2050 policy target of reducing natural gas consumption by residential and commercial customers to zero).

52. The combination of the regulatory and market constraint on the recovery of sunk costs means that the ability of the regulated business to recover those costs is given by the minimum of the solid red line and the dotted blue line.

12 $40,000 in return on capital and $28,571 in straight line depreciation

Figure 3-5: Stranding uplift with 35-year remaining life for sunk assets



Source: CEG Analysis

53. If regulatory compensation is set to follow the solid red line, then there will come a point, in year 20, when customers are unwilling to pay the full building block costs – i.e., there is at least partial stranding of sunk investments at that point. If the regulator did not accelerate depreciation to remove this expected stranding cost (from year 20 onwards) it would need to add a stranding uplift of 120bp in the years prior to year 20 in order to compensate (in present value terms) for the stranding post year 20. This is the value that makes the top left quadrilateral have the same present value as the bottom right quadrilateral.

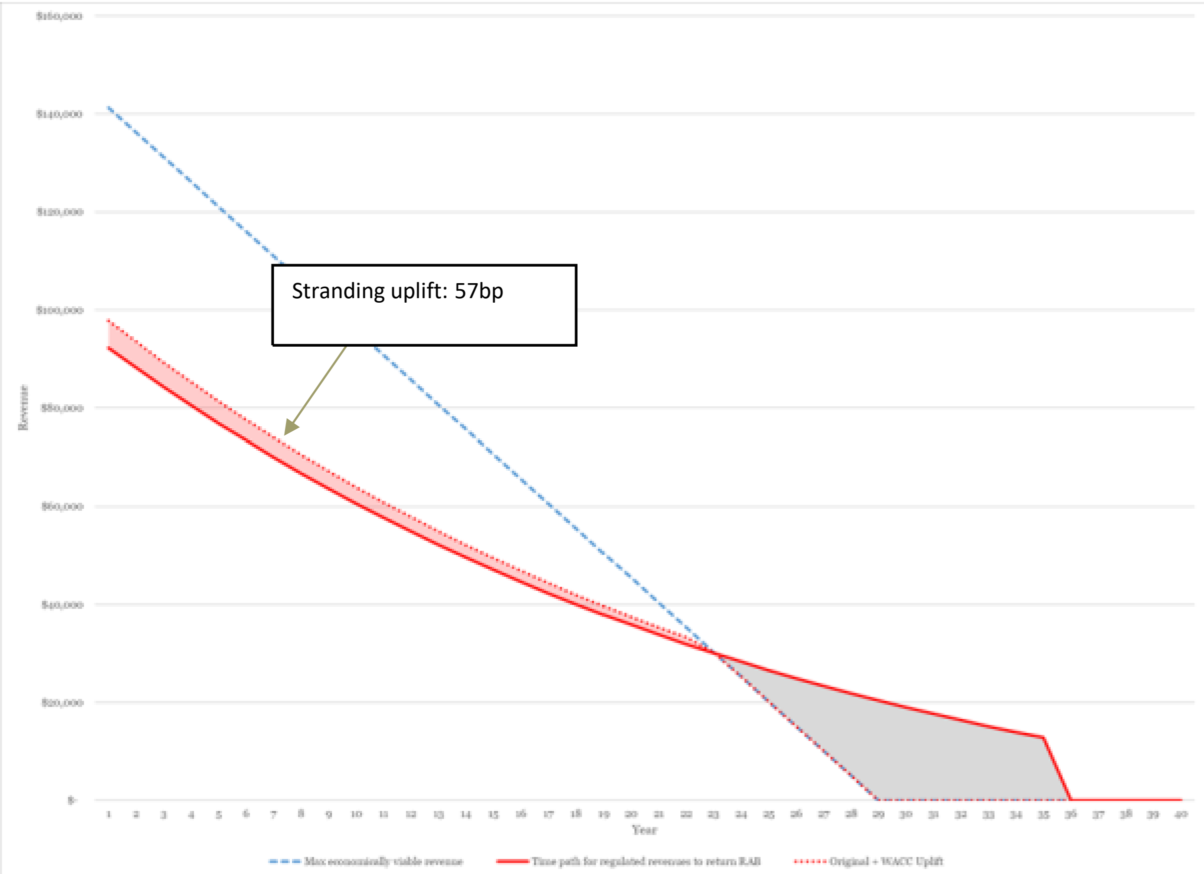
54. It should be clear from this presentation that, where the dotted blue line is known with certainty, the "stranding uplift" is, in essence, a form of "accelerated depreciation" by another name.

3.3.2 Accelerating cost recovery reduces the required stranding uplift

55. If the RAB is no longer indexed for inflation, then this accelerates cost recovery (higher return on assets now in return for a lower future RAB is a form of accelerated depreciation). Consequently, the solid red line is higher initially and lower in future.

This reduces the later stranding cost (the extent to which the solid red line is above the dotted blue line) and, therefore, reduces the required stranding uplift.

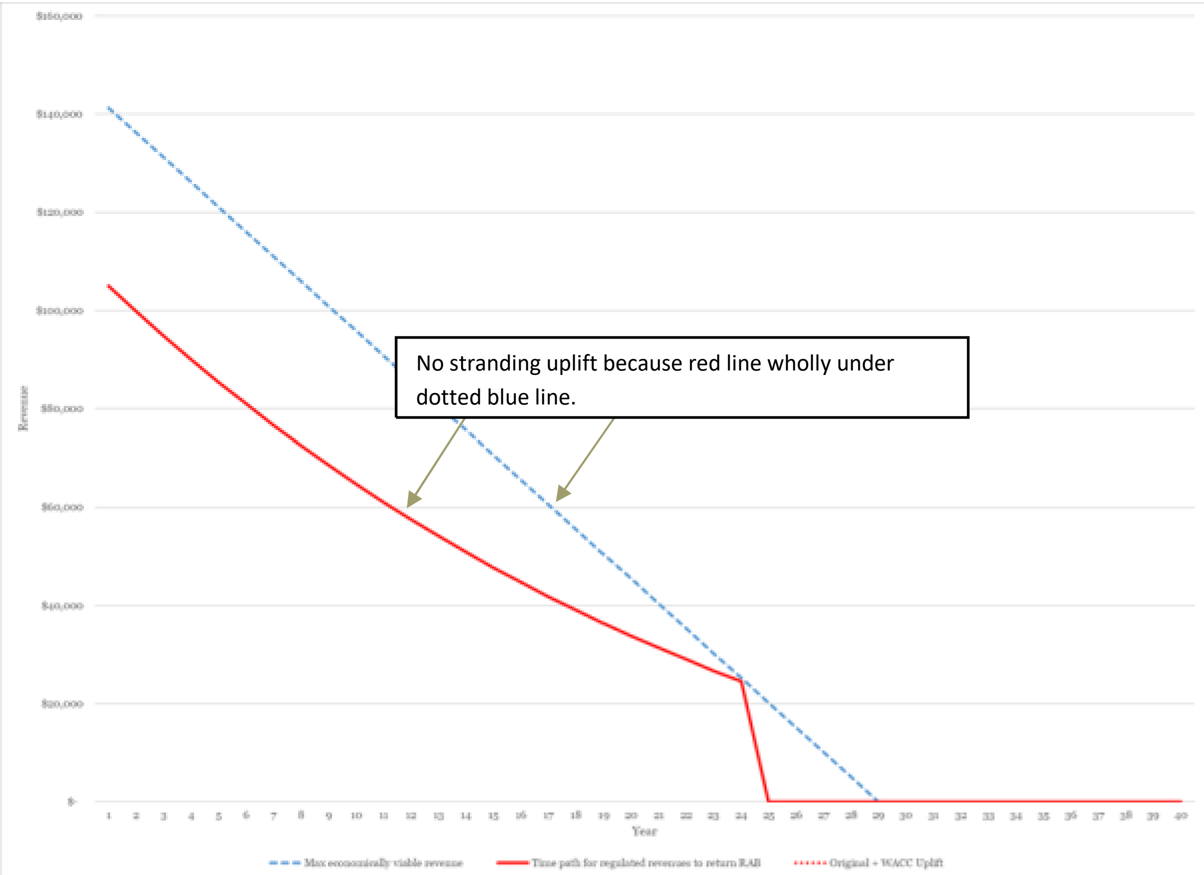
Figure 3-6: Removing indexation reduces stranding uplift from 120 to 57bp



CEG analysis, assumes 2.5% inflation.

56. Removing indexation and accelerating depreciation to depreciate the sunk assets over 24 years (down from 35) eliminates uplift. That is, together, these reforms bring the solid red line wholly under the dotter blue line in all periods.

Figure 3-7: Removing indexation and reducing asset lives from 35 to 24 years eliminates uplift for stranding



CEG analysis, assumes 2.5% inflation.

57. If depreciation was accelerated from 35 years to 24 years but inflation indexation continued to be applied, then the stranding uplift required to compensate for future stranding cost would be 25bp. This scenario is illustrated in Figure 3-8 below.

Figure 3-8: Stranding uplift with 24 year remaining life for sunk assets

Source: CEG Analysis

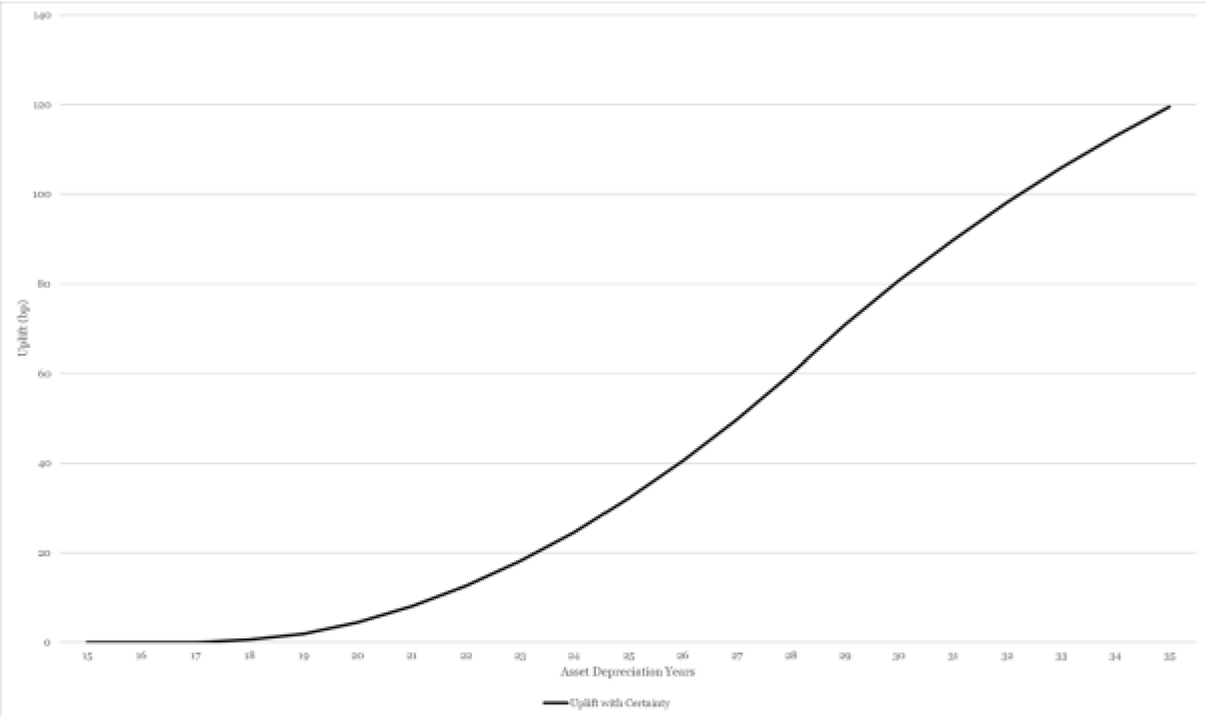
58. In the rest of this section, we show modelling assuming that the RAB continues to be indexed for inflation. Naturally, and as illustrated above, for any given rate of depreciation, if the RAB ceased to be indexed for inflation the required stranding uplift would be lower.

59. Figure 3-9 below illustrates the general relationship between the rate of accelerated depreciation and the required stranding uplift (assuming that indexation of the RAB continues). The vertical axis is the required stranding uplift, and the horizontal axis is the remaining life over which the outstanding RAB is depreciated. A low value on the horizontal axis indicates high levels of accelerated depreciation. The underlying assumptions in Figure 3-9 are the same as in Figure 3-5 to Figure 3-8 with the only factor varying being the rate of accelerated depreciation.

60. The stranding uplift at zero with high rates of accelerated depreciation having the effect of making the time-path of regulatory compensation fall wholly below the time-path for customers' willingness to pay (given the underlying assumptions of Figure 3-5 to Figure 3-8). However, as the time horizon over which the RAB is depreciated is increased, the required stranding uplift rises - indicating that the time-path for regulatory compensation crosses above the willingness of customers to pay at some

point in the future. The longer the time horizon over which the RAB is depreciated the earlier that point is and the greater the value of the depreciated RAB that is subject to stranding at that point.

Figure 3-9: Modelled stranding uplift as accelerated depreciation varies (assuming indexation of the RAB continues)



Source: CEG Analysis

61. In the scenario being modelled there is always some stranding uplift that can fully compensate for stranding risks. This is because, in this scenario, the present value of customers' willingness to pay (the present value of the area under dotted blue line in earlier figures) is greater than the value of the sunk RAB at the beginning of year 1 (which is also the present value of the area under solid red line). Provided this is true, there is always some combination of depreciation rate and stranding uplift that can fully recover the value of sunk investments.

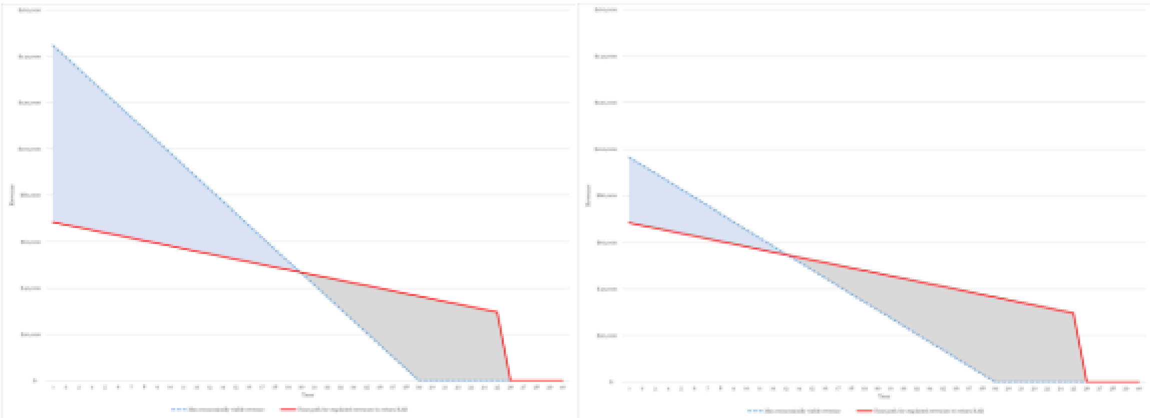
3.3.3 Stranding can be unavoidable (unable to be compensated)

62. It may not always be possible to avoid asset stranding by accelerating depreciation. Specifically, if there is limited "headroom" between the dotted blue (customer willingness to pay) and the solid red (regulatory compensation) lines – even in early years – then accelerating depreciation may simply push regulatory compensation above customers' willingness to pay earlier. In this situation it is impossible to compensate fully for expected future stranding by either:

- Accelerating depreciation;
- Providing a stranding uplift; or
- Any combination of the above.

63. This situation is illustrated in Figure 3-10 below. In Figure 3-10 the reed lines in both panels have the same regulatory compensation path as Figure 3-5**Error! Reference source not found.** but, in the right hand panel, the aggregate customer willingness to pay (dotted blue line) is lower (starting value of $97,000 instead of $145,000) and now falls under the path for regulatory compensation in the 13th year rather than the 20th year).

Figure 3-10: Asset stranding is unavoidable



Source: CEG Analysis

64. In this scenario, asset stranding is unavoidable (has already happened). Even if regulation were completely removed the (formerly) regulated business would be unable to fully recover the value of its sunk assets.

65. This is because, in the right-hand panel, the blue shaded area has smaller NPV than the grey shaded panel. The value of asset stranding is given by the present value of the difference between the solid red and dotted blue lines. The value of asset stranding cannot be eliminated, only reduced, by changing the tilt (rate of depreciation) of the solid red line.

66. In this situation, even if regulation was removed, the regulated business would be unable to recover the value of their sunk investment. The only affect a regulator can have on the value of asset stranding is to increase it. This will be the case if the regulator forces compensation below the dotted blue line in the early years. If this is done the value of asset stranding is increased by the difference between regulated compensation and customers' willingness to pay in those years that regulated compensation is below customers' willingness to pay.

3.3.4 Stranding that is preventable now will be unavoidable in the future if depreciation is not accelerated

67. Avoidable asset stranding may turn into unavoidable asset stranding if a regulator delays taking action to accelerate depreciation. This can be illustrated by reference to Figure 3-5 and Figure 3-10 above. In Figure 3-5 the path for regulatory compensation is set such that it passes above customers' willingness to pay in future decades. This problem is remedied in Figure 3-7 by immediately, in 2022, removing inflation indexation and accelerating depreciation to raise regulatory compensation now and lower it in the future – such that it never passes above customers' maximum willingness to pay.

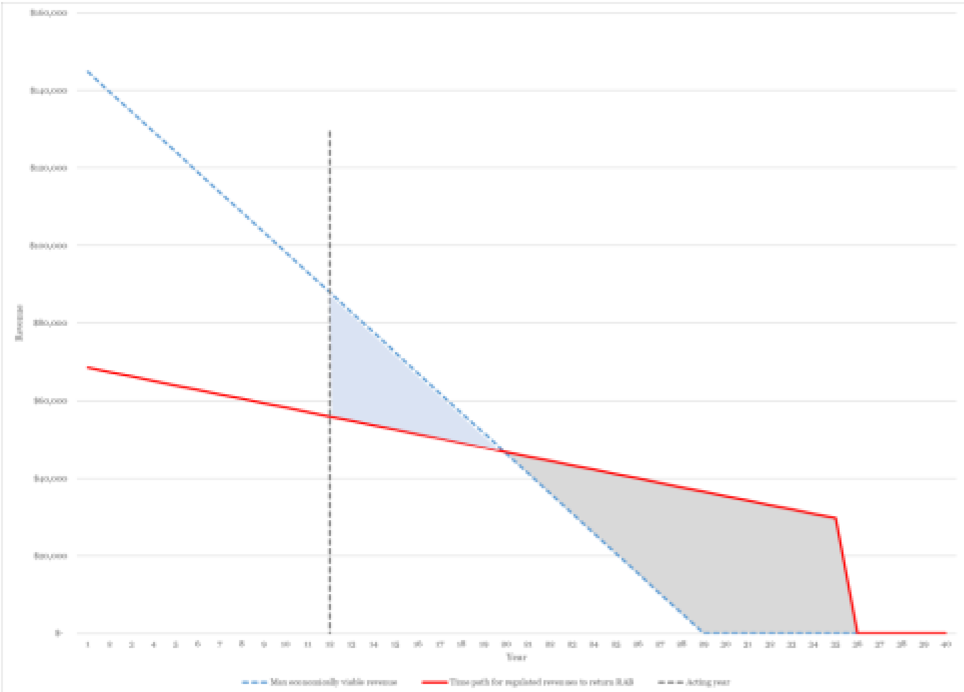
68. However, if the regulator delays providing accelerated depreciation immediately avoiding stranding risk may not be possible in future years. Figure 3-7 and Figure 3-11 share the same underlying assumptions about the initial level of sunk costs and the path of customer willingness to pay. The difference is that, in Figure 3-7, the regulator immediately implements accelerated recovery of sunk costs (ceases indexation and reduces asset lives) to eliminate stranding risk.

69. Figure 3-11 shows what happens if the regulator delays the decision to accelerate cost recovery for 12 years. By that time:

- the value of sunk assets unrecovered in year 12 is greater than the sum of present value of customers' willingness to pay in all subsequent years;
- this means that, even if depreciation is accelerated (or a stranding uplift applied) to allow the maximum possible cost recovery (given by the height of the dotted blue line at year 12 years).

70. Geometrically, the present value of the area in the light blue triangle is the maximum additional value that can be derived from higher regulated revenues relative to staying on the default time path for compensation (the solid red line). However, because the light blue triangle is smaller (in present value terms) than the grey quadrilateral this will not fully compensate for the unrecovered costs associated with the default time path.

Figure 3-11: Regulatory delay in accelerating depreciation makes stranding unavoidable



Source: CEG Analysis

3.3.5 Introducing uncertainty into the model

71. In the above illustrative modelling, we have proceeded as if there was a single known time path for customers' aggregate willingness to pay.[13] However, in reality there is material uncertainty around the path that willingness to pay may take.

72. Even if we had an accurate estimate of the most likely (average) time path for customers' willingness to pay, solely relying on that single (average) time path in the modelling would be problematic. This is illustrated in Figure 3-12 below; in which the darker dotted blue line can be viewed as the average path and the two lighter blue lines around it can be viewed as the worst case and best-case scenarios.

[13] Or, more exactly, willingness to pay above and beyond that need to cover ongoing operating costs of providing the service.

Figure 3-12: Modelling stranding compensation with uncertainty

Source: CEG Analysis

73. In this example, comparing the solid red line solely with dark blue (average) path for willingness to pay will result in a conclusion that asset stranding risk has been eliminated (the stranding uplift can be set to zero). This is because the solid red line lies wholly beneath dark blue dotted line.

74. However, this approach ignores the fact that, under the worst-case scenario, some of the allowed revenue will not be recovered. This means that there is some, non-zero, probability of asset stranding. Consequently, either:

- Depreciation would need to be accelerated even further so that, even in the worst-case scenario, the solid red line is below the dotted blue line; or
- A positive stranding uplift would need to be estimated based on the expected value of asset stranding (being the area of the solid red line above the light blue dotted line multiplied by the probability of this sort of "worst case" scenario occurring).

75. This illustrates the fact that the correct estimate of the appropriate stranding uplift is heavily dependent on two difficult to know values:

- The expected path of customer willingness to pay; and

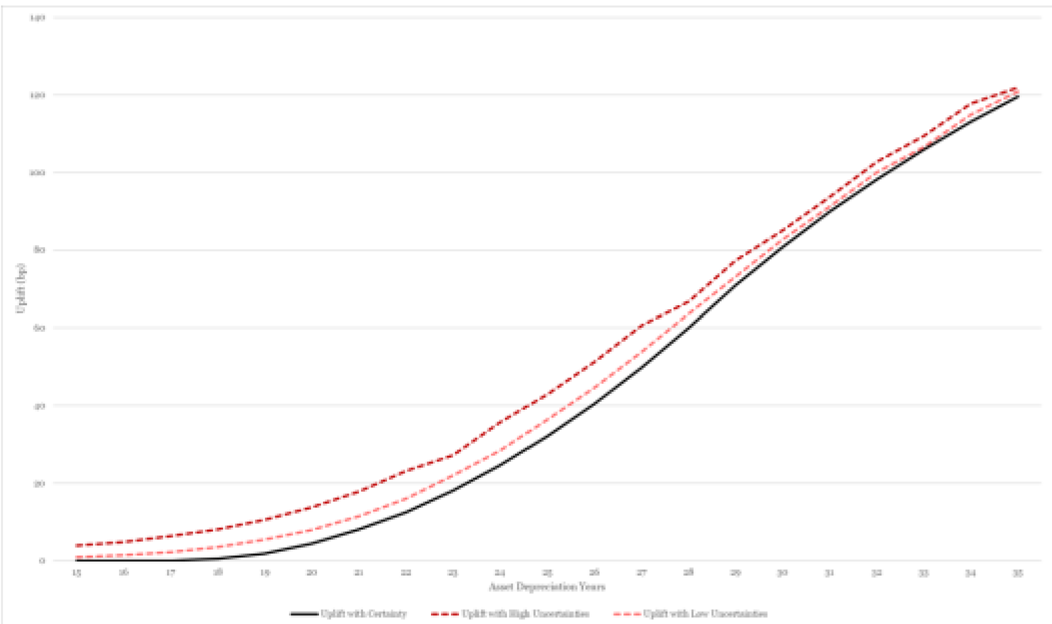
- The distribution of (uncertainty around) the expected path of customer willingness to pay.

76. Figure 3-13 demonstrates this. In both Figure 3-13 and Figure 3-9 the solid black line is the same and shows the relationship between the required stranding uplift and the time horizon over which the RAB is depreciated. However, in Figure 3-13 we also show the additional impact of uncertainty on the required stranding uplift – in the form of the dotted pink and dotted red lines. The dotted pink and the dotted red lines each show the impact of different levels of uncertainty. In all cases we assume a base case where the most likely outcome is a linear trend towards customers having a zero willingness to contribute towards sunk costs (i.e., above and beyond operating costs) by 2050 (28 years).

77. The two uncertainty scenarios we model assume a uniform distribution of possible outcomes around that most likely case:

- Low uncertainty scenario – the best/worst case is that willingness to pay falls to zero by 2047//2053 (± 3 years from 2050). This uncertainty gives rise to the need for a higher uplift (relative to the zero-uncertainty black line) illustrated by the dotted pink line; and
- High uncertainty - the best/worst case is that willingness to pay falls to zero by 2045//2055 (± 5 years from 2050). This higher uncertainty gives rise to the need for a higher uplift (relative to the low uncertainty dotted pink line) illustrated by the dotted red line.

Figure 3-13: Modelled stranding uplift with and without uncertainty



Source: CEG Analysis

4 Application of stranding model to NZ GDBs

78. In the previous section we set out a simplified generic model to illustrate how we consider stranding risk should be modelled. In this section we adapt that generic model to the specific circumstances of New Zealand gas distribution business (GDBs). In doing so we introduce some additional complexity by specifically modelling assumptions about operating costs and stay-in-business capital expenditure. We also adopt the New Zealand Climate Change Commission's "demonstration path" as the base case for the rate of decline in customers' willingness to pay for gas distribution services.

79. We have attempted to make the modelling more realistic of the actual circumstances faced by New Zealand GDBs. Nonetheless, the model and its outputs should still be considered illustrative. We do not claim that all input assumptions to the model are accurate (especially those around the path of future customer willingness to pay). The modelling results presented are not a prediction of what will happen.

80. However, we do consider that the model itself is an accurate framework to estimate stranding costs for New Zealand GDBs. However, we recognise the key challenge for the model is to understand the time profile for customer's willingness to pay. That is, with the most accurate assumptions the model will provide correspondingly accurate estimates of the magnitude of stranding risks under different rates of accelerated depreciation. We consider that this framework for analysing stranding risk is, in the circumstances faced by New Zealand GDBs, superior to the model applied by the New Zealand Commerce Commission to Chorus.

4.1 Base case assumptions

81. Our base case assumption for maximum customer willingness to pay is that the maximum revenue that can be recovered at each point in time is given by:

- Initially, (in Year 2022), 2-times the most recent regulated revenue earned by Vector;
- In subsequent years we assume that commercially viable revenues fall proportionally with (follows the same path as) the Climate Change Commission's (CCC) forecasted residential and commercial gas demand under its "demonstration path" modelling scenario.[14] In this scenario, gas demand for residential and commercial customers falls to zero by 2050.

[14] New Zealand Climate Change Commission, Scenarios dataset for the Commission's 2021 Final Advice (output from ENZ model), 9-Jun-21.

82. That is, we assume maximum commercially viable revenue today is double regulated revenue (without accelerated depreciation or stranding uplift) and then we assume that this follows the same path as the CCC's estimated path for gas usage. We do not claim that either of these assumptions are necessarily the most realistic, but we do consider that they are, at least, plausible.

83. To derive a base case for the path of real regulated revenues we make the following assumptions. These assumptions assume that New Zealand GDBs take action to limit the cost of asset stranding (primarily by not incurring growth related operating expenditure or capital expenditure) but that the Commission takes only limited action in the form of accelerating the depreciation for new capex (i.e., does not accelerate depreciation for the existing RAB or stop indexing the RAB for inflation).

- We have combined all NZ GDBs' RAB and expenditures and modelled them as a single regulated entity;
- **WACC.** We apply a real WACC of 4.4%. In doing so, we explicitly assume that the nominal **RAB continues to be indexed for inflation**.
- **Opex**. We assume that the starting value for operating expenditures is $42.5m which is based on operating expenditure reported in GDBs' information disclosure schedules (see Appendix A for more detail). We assume that this operating expenditure is fixed in real terms into the future although it is possible to implement scenarios where it falls with gas customers/volumes.
- **Capex.** We assume 'stay-in-business' annual capex is only $25.0m in constant real terms. In doing so we have attempted to remove system growth and customer connection capex (see Appendix A for detail).
- **RAB.** Our opening RAB for 2022 is $1.06bn see Appendix A for details);
- **Regulatory depreciation.** We model regulatory depreciation based on straight line depreciation of the opening RAB in 2022 over the weighted average remaining asset life of 30 years (see Appendix A for derivation). In doing so, we assume the average remaining life of assets falls by one year each year until all assets are fully depreciated in 2052 (30 years)). We note that this assumes a faster rate of depreciation than implied by the Commerce Commission's current practice[15] and is, in this sense, conservative. For stay-in-business capital expenditure we assume that this is depreciated to the same end point as the opening RAB (2052). In some scenarios we accelerate depreciation of the opening RAB. If the opening RAB is fully depreciated before the model predicts the network will network ceases to operate, then subsequent capex is

15 Current practice is to recalibrate average remaining asset lives at each reset. This means that, in a world with low growth capex as short lived assets fall out of the asset register (are fully depreciated) and are not replaced, the average remaining life of assets would tend to give increasing weight to long lived assets. Consequently, the average remaining life of assets will not fall by one year every year – and it may even increase as time goes on.

treated as opex. This means that the rate of depreciation of each year's stay-in-business capex increases over time (always with the same fixed end point) or is treated as opex. Again, this is faster depreciation than the Commission's current practice.

- We have not attempted to model tax costs – effectively setting the tax building block to zero.

4.2 Model results

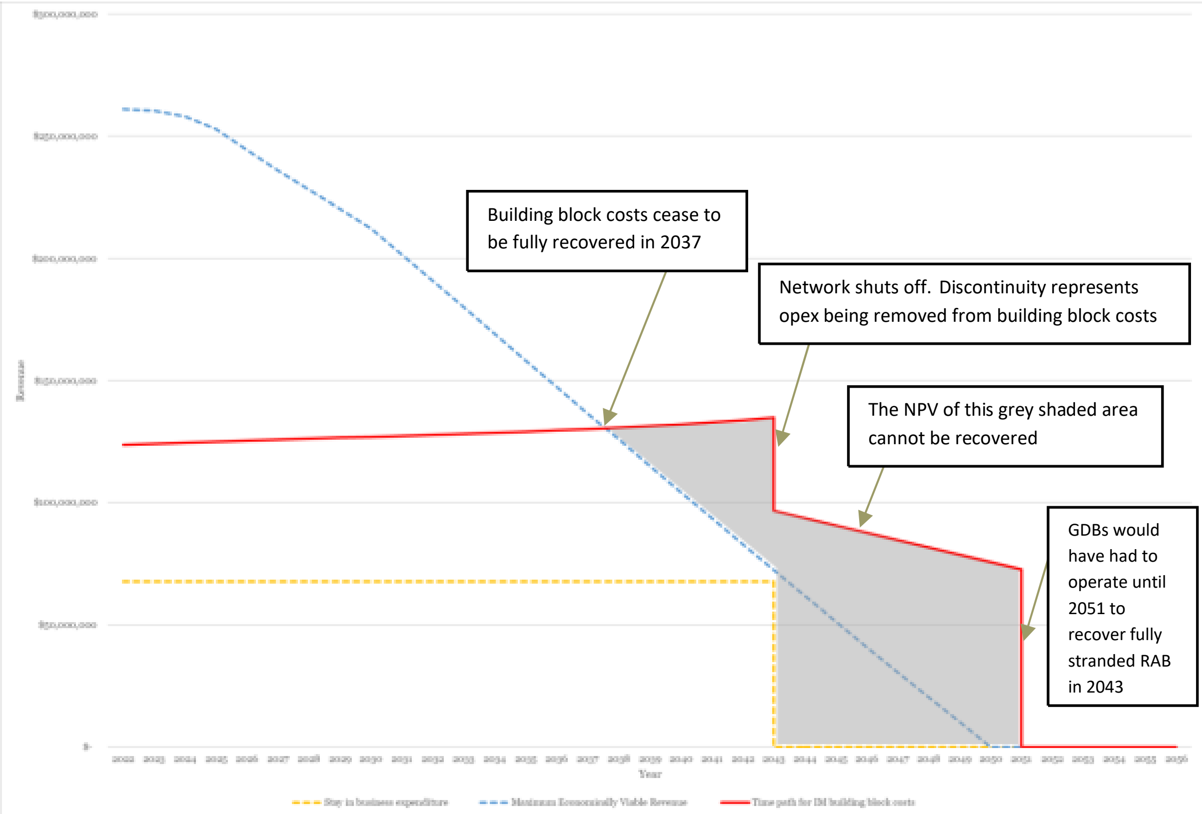
84. Figure 4-1 introduces a dotted yellow line which represents stay-in-business expenditure (opex and capex). The year in which the dotted yellow line cuts the dotted blue line is the year in which customers' aggregate willingness to pay for gas distribution falls below the ongoing costs of making the network available. At this point the network ceases to operate and the outstanding value of the RAB is stranded. In the base case this occurs in 2043.

85. In Figure 4-1 the solid red line is now the total building block costs (unlike in the previous section when the solid red line just related to the building block costs associated with the sunk investments in year 1). The solid red line is rising between 2022 and 2043 because stay-in-business capex continuing to be capitalised and depreciated over shorter and shorter periods. The solid red line has two discontinuities. The first is in 2043 when (in the base case) the network ceases to operate. At that point opex ceases to be incurred and the solid red line drops by the value of opex.

86. The then value of the RAB is fully stranded on that date. However, to show this value graphically in a consistent manner we spread that cost out over time 'as if' the building block costs (return on and of capital) for the unrecovered RAB continued to be calculated. This explains why the solid red line continues in existence from 2043 to 2051. It represents the path of compensation that would have had to have been provided to fully recover the outstanding RAB at the time the network ceased to operate. The final discontinuity is in 2051 – by which time the RAB would have been fully recovered if revenues had followed the solid red line.

87. Our assumptions imply that aggregate customer willingness to pay falls below building block costs in 2037. The business continues to operate for the next 6 years because, while revenues are lower than building block costs, they are higher than avoidable costs (i.e., there is still some contribution to the recovery of sunk investment). Beyond 2043 this is not true and the network ceases to operate.

Figure 4-1: Stranding under the base case



CEG analysis

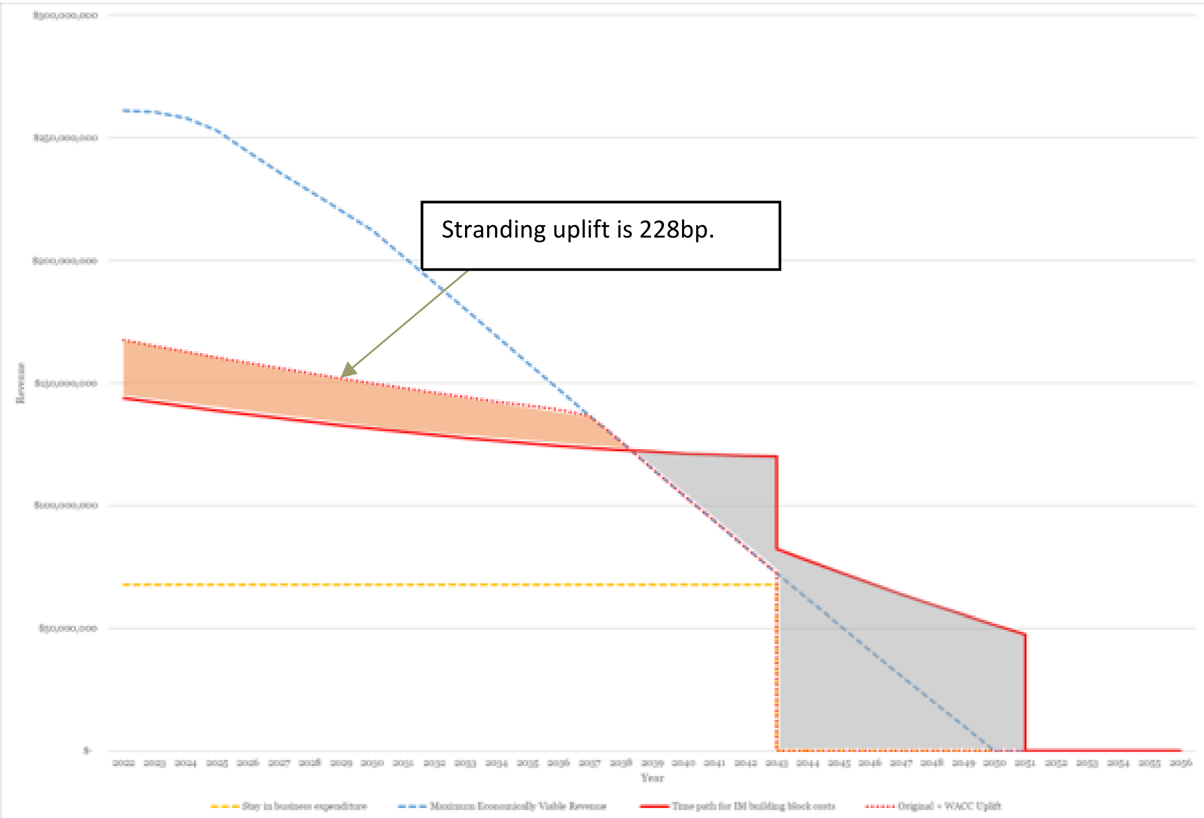
88. Given the under-recovery of building block costs post 2037, New Zealand GDBs would need additional compensation prior to 2037 if they were to have an expectation of recovering their full costs (including the opening RAB in 2022). If this compensation is expressed as a constant percentage of the RAB (i.e., a "stranding uplift") then the required uplift would be 288bp in the base case. This is indicated as the dotted red line in Figure 4-2. Without any uplift to regulated revenues in 2022, revenues are modelled at $123.7m and the required uplift increases this to $154.3m.

Figure 4-2: Stranding uplift under the base case (depreciation to zero RAB over 30 years)

CEG Analysis

89. We now model two separate reforms that the NZCC could implement to bring forward cash-flows and reduce stranding risk (and therefore the need for a stranding uplift). First, we examine the impact of ceasing to implement indexation of the RAB for inflation (Figure 4-3). This reduces the required uplift from 288bp to 228bp (i.e., a reduction of 60bp).

Figure 4-3: Stranding uplift with no inflation indexation of the RAB

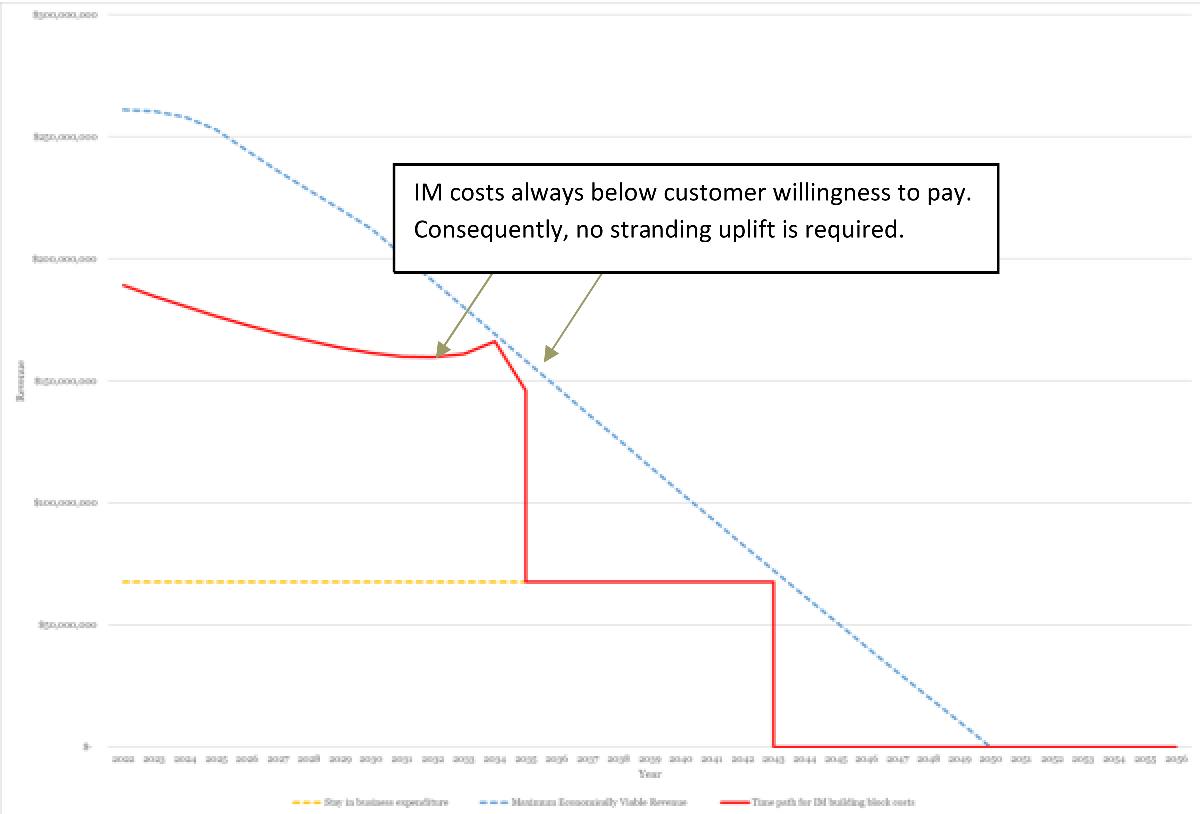


CEG Analysis. Note, the solid red line falls at a slower rate over time because of the effect of 'stay-in-business' capex being depreciated over a shorter and shorter period (being the time to 2051).

90. We then combine this reform with accelerated depreciation (targeting full depreciation of the RAB by 2035 (i.e., 13 years) shown in Figure 4-4. . These two reforms eliminate the need for any uplift (at least in the scenario where there is no uncertainty around the future path of customer willingness to pay). (Note that beyond 2035 stay-in-business capex is fully depreciated in the year it is incurred (i.e., treated as opex) in order to ensure a zero RAB is maintained beyond 2035.).

91. Targeting a zero RAB in 2035 but continuing to index the RAB would require a 15bp uplift for stranding (this result is not illustrated).

Figure 4-4: Stranding uplift with depreciation accelerated to target zero from 2035 onwards



CEG Analysis

92. The following table illustrates the impact on initial year revenues of each of the reform options/combinations illustrated above. As can be seen from the above figures, higher revenues in the initial year are associated with lower revenues in later years (and lower expected stranding costs).

Table 2: Impact on starting revenues

Figure	Scenario	
Figure 4-1	No compensation for stranding risk	$123.7m
Figure 4-2	Keep indexation and 30 year asset life (provide stranding uplift)	$154.3m
Figure 4-3	Stop indexation, retain 30-year asset life (provide stranding uplift)	$167.5
Figure 4-4	Stop indexation, reduce asset life to 13 years (no uplift needed)	$189.1

Source: CEG analysis

5 Policy implications

93. The analysis in this report suggests that material change in regulatory approach by the New Zealand Commerce Commission may be required for New Zealand GDBs to have an expectation of recovering the value of their sunk investments.

94. There are two paths that this change can take, and these are not mutually exclusive. Where there is a potential for future asset impairment due to future customers being unwilling to pay the costs of the service (including any then unrecovered RAB) then, in order for there to be an NPV=0 expectation, this must be compensated by one, or both, of the following:

- Accelerated depreciation so that costs are recovered earlier, and the asset impairment is avoided (or its probability reduced); and/or
- *Ex ante* compensation (above and beyond building block costs) with an expected present value equal to the expected present value of the lost compensation due to future impairment.

95. Conceptually, both approaches (in concert or separately) can deliver an expectation of full cost recovery now (NPV=0). However, the *ex ante* compensation method, by its very nature, is designed to provide an NPV≠0 at some point in the future (whenever future events turn out better/worse than the forecast on which *ex ante* compensation was estimated).

96. Of these two approaches, accelerated depreciation is the least informationally intensive. Implementing, accelerated depreciation only requires an estimate of the current and near-term level of demand for the regulated service (i.e., the headroom available now to accelerate cost recovery in order to reduce the probability of future stranding).

97. Moreover, under accelerated deprecation every dollar of additional revenue now is a dollar of lower attempted cost recovery from later customers in present value terms. This means that neither customers nor Vector are not forced into 'taking a bet' on the path for future demand. In this sense, accelerated depreciation is a 'no regrets' policy for both networks and customers.

98. The only difference between accelerated depreciation and a stranding uplift is that the latter involves exposing customers and networks to risk associated with the future state of the world. That is, every stranding uplift is based on a forecast of (bet on) when the network revenues will become constrained by demand rather than regulation. This is uncertain so the forecast is for the actuarially expected date of this event. If the actual date of this event is earlier/later than the forecast on which the uplift was estimated, then customers will pay less/more than the network's costs of providing theme the service.

99. In effect, a stranding uplift involves the regulator putting in place a "bet" between customers and networks where:

- Customers lose the bet if the stranding event occurs later than forecast at the time the uplift was estimated (or simply does not occur due to, for example, clean hydrogen replaces natural gas). This is because customers must go on paying the WACC uplift based on the original terms of the bet; or
- Customers win the bet if the stranding event occurs earlier than the forecast at the time the uplift was estimated. This is because, even with the uplift, they end up paying less for the network than the true cost (noting that the uplift was calibrated based on a longer expected period of the network being able to recover the uplift).

100. Thinking of the uplift as the price of a bet the regulator forces on customers and networks provides for some powerful insights. For one, the uplift cannot be sensibly revisited in future periods as more information comes in because that would be inconsistent with the original terms of the bet. It would be akin to bookmakers changing the odds for pre-race bets during the course of the race.[16]

101. By contrast, accelerated depreciation does not involve putting in place a bet between customers and networks. Accelerated deprecation is a no regrets policy aimed at ensuing an NPV=0 outcome. If no stranding occurs customers benefit by having much lower prices than they otherwise would. Similarly, if new information becomes available the pace of accelerated depreciation can be increased or reduced as appropriate without altering the terms of a pre-existing "bet".

102. It is also the case that, in order for an *ex ante* uplift to be a 'fair bet', an estimation of the probability distribution around the future path of demand is required – with this probability distribution playing a critical role in determining the level of *ex ante* compensation required. This information is highly uncertain, and this makes it very difficult for the regulator to estimate the terms of a fair bet.

103. For this reason, accelerated depreciation is the simplest and the most reliable method for attempting to achieve NPV=0 in the face of the potential for future asset impairment. This does not necessarily mean that zero *ex ante* compensation will be required if accelerated depreciation is allowed. However, it does mean that accelerated depreciation should be regarded as the primary policy tool and *ex ante* compensation as the secondary policy tool.

16 In fact, if the regulator were to set an uplift now with the intention of removing it/clawing it back in the future if stranding does not occur then this is effectively equivalent to providing accelerated depreciation

6 Consequences of inaction

104. The modelling in this report, even though only illustrative at a high level, suggests that, if the Commerce Commission does not take significant action now, there is a significant risk that networks will face the real prospect of stranding risk increasing in the medium to longer term.

105. Network businesses will be compromised with their asset management strategies. Long term planning and investment are put on hold because and management perceive that the firm will not make it in the long term.

106. The disastrous nature of the potential transaction costs associated with managing stranding risk is precisely why management does everything in their power to prevent this occurring within their control.

107. If regulatory inaction does lead to financial stress it is important to recognise that it will cause costs associated with managing this risk for the firm and suboptimal investment decisions. This may take the form of hoarding cash by foregoing what would otherwise be sensible investments or running down existing assets.

Appendix A Sources for assumptions of RAB and expenditures

108. Below are the assumptions for the model we used, based on the "GDB Information Disclosure Requirements 2020":

- RAB and Remaining Asset (Schedule 4):
  - RAB $1,060.3m (30 years)
    - The most recent RAB in the GDB information disclosure is based on 2020.
    - We added up the RAB for Powerco ($387.5m), FG ($174.4m) and Vector ($434.3m), and indexed them by the inflation to be the 2022 opening RAB (implicitly assuming capex equalled depreciation in 2021).
  - Remaining Asset – 30 years.
    - We took the weighted average remaining asset life between Powerco (30 years), FG (33 years) and Vector (33 years) which was 31.8 in 2020 and adjusted it down to 30 year for 2022 (implicitly assuming a close to zero effective life for capex).
- Capital Expenditure (Schedule 11a): $25m
  - We estimate net capex minus growth and expansion using either Sep/Jun 2022 for Powerco ($8.2m), FG ($5.5m) and Vector ($11.4m).
- Operational Expenditure (Schedule 11b): $42.5m
  - We added up the operational expenditure forecast in constant prices to be the Opex.
  - We used either Sep/Jun 2022 for Powerco ($18.7m), FG ($10.0m) and Vector ($13.9m) to be the 2022 Opex.