Review of Draft Decisions Paper on Starting Price on 2010-15 Default Price-Quality Path For Electricity Distribution

A report for Vector

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1. Introduction and summary

1. Vector has asked CEG to review the Commerce Commission's July 2011 draft decision in relation *to 2010-15 Default Price-Quality Path for Electricity Distribution* and associated spreadsheets.

2. Almost all of my recommendations for change to the Commission's model stem from the fact that the Commission's model:

   - departs from the Input Methodologies in relation to the timing assumptions; but
   - does not make the necessary consequential changes necessary to properly implement this change.

3. This reflects the fact that the Input Methodologies involve a tightly interconnected set of rules. A change to one vital rule, being the assumed timing of cash flows, has a number of other consequential changes that need to be implemented in order for the final result to be internally consistent. In this regard, there are three important areas where the model needs to be amended.

4. The first is in relation to the calculation of depreciation. In the presence of inflation the Commission's new timing assumption means that the current model fails to depreciate assets over their useful life. The effect of the model is that the real value of initial investment to the EDB is never fully returned to the EDB – even many years after the asset has been fully depreciated and disposed of.

5. This would not be the case if the Commission had followed the timing assumptions in the Input Methodologies. To the extent that the Commission continues to depart from the Input Methodologies by modelling mid year revenues it must increase the value of depreciation returned to the EDB's each year by half a year's inflation. Relative to the Commission's model this increases the real value of depreciation provided to investors in each year but reduces the increase in the RAB due to inflation by a corresponding amount.

6. The second proposed amendment relates to the assumption that tax payments occur at the end of the year while revenues and operating costs are incurred in the middle of the year. The Commission acknowledges that this assumption is incorrect and that implementing it will tend to under-compensate EDBs for the cost of tax. However, it justifies doing so on the basis that it has made another assumption elsewhere (that revenues are earned in the middle of the year) which it also believes to be wrong. The Commission's hope is that the two incorrect assumptions will 'cancel out' in some sense.

> *However, this assumption ignores the fact that—due to seasonal factors—revenues are likely to be higher in the first half of the year than in the second half of the year. This provides a slight timing benefit in favour of EDBs. To offset this effect, and to improve the accuracy of our modelling overall, we have modelled tax costs as falling at the year-end (rather than throughout the year as would be likely in practice).* (Para 2.29 of the Draft Decision)

7. I consider that this justification is unreasonable. Specifically, it is arbitrary to make one wrong assumption on the grounds that doing so offsets a different wrong assumption. This is especially the case as no evidence is brought to bear that the two effects are of equal magnitude (or even that the first effect exists). In my view, to the extent that the Commission believes an assumption is wrong it should, to the extent possible, correct that assumption directly.

8. Moreover, the Commission implements this solution without recognising that a change in the pattern of cash flows must invariably change the appropriate WACC applied to those cash flows. This error arises from the Commission's application of a single discount rate (the WACC) to measure the benefits to the EDB of (hypothetically) delaying tax payments. It is not correct to use the WACC to measure the impact of moving one element of the cash flows relative to another (eg, expenditures relative to revenues).

9. Correct application of discounted cash flow modelling requires that the present value of each item of the cash flow be assessed using a discount rate that reflects the risks inherent in that item. The WACC is a complex average of the individual discount rates and is specific to a given structure of those cash flows. If one changes the relative timing of high and low risk items then one also changes the WACC. The Commission's approach to modelling delayed tax payments fails to recognise this fact.

10. The effect of this is that the Commission overestimates the benefits to an EDB of the (assumed) delay in tax payments relative to revenues. Specifically, the benefits to an EDB of being prepaid for their tax bill (receiving revenues 6 months earlier than tax is assumed to be payable) should be measured at the risk free rate or, at most, the 6 month interest rate that the New Zealand IRD would give an EDB for early payment of their tax bill (should such the IRD offer such a facility). It should not be estimated at the EDB's WACC. The EDB's WACC reflects the risks associated with profits (net cash flows) and this will invariably be higher than the risks associated with either revenues or expenditures individually.

11. The third required amendment relates to the Commission's current model adopting internally inconsistent financing assumptions. In particular, the model assumes that revenues earned in the middle of the year lower financing costs because it allows debt/equity financiers to be paid interest/dividends earlier than if revenues were only received at the end of the year. However, the structure of the model is such that, despite revenues being lowered to reflect this lower modelled finance costs, interest

payments that feed into the tax deduction calculation are not similarly lowered (these are still calculated 'as if' they are made in a lump sum at the end of the year). This is internally inconsistent.

12. Put simply, the Commission's modelling uses:

    a. an assumption of mid year revenues when estimating the compensation for financing costs. The effect of this is to lower the absolute value of revenues allowed; but

    b. an assumption of end of year revenues when estimating the amount of interest deductibility that is generated from financing costs. The effect of this is to lower the amount of compensation for tax and therefore the absolute value of revenues allowed.

13. The following sections describe each of these problems and the proposed solutions in more detail.

2. Use of inflation forecast in modelling of depreciation

14. In a regulatory cost model, depreciation represents the return of capital to investors. That is, over the course of an asset's useful life the fall in the value of that asset is captured as a 'cost' to the investors and revenues are increased to compensate for the fall in value. By the end of the asset's useful life the value of the investment in that asset should have been fully returned to investors in the form of higher revenues – and the value of the asset should have been fully removed from the regulatory asset base (RAB) on which investors receive a return.

15. In the presence of inflation, depreciation returned to investors must be increased to reflect the fact that nominal dollars have lower value. For example, consider an asset costing $100 in 2010 being depreciated on a straight line basis over its useful life of 10 years. In order to return the full $100 invested over 10 years, depreciation in each year must be maintained at $10 in real 2010 terms. However, in the presence of inflation this means that nominal depreciation must be increased above $10.

16. For example, if inflation is 10% pa then the amount of capital returned to investors, if returned at the end of the first year, must be $11 (=$10*(1.10)) – this is $1 dollar above $10 because there has been a 10% decline in the purchasing power of nominal dollars since the original $100 investment. In the second year depreciation of $12.1 must be returned to the investor – this is $2.1 dollars above $10 because there has been a 21% ($(1+10\%)^2$-1) decline in the purchasing power of nominal dollars since the original $100 investment.

2.1. IM versus Commission model

17. In order to understand how the Input Methodologies delivered compensation for inflation on depreciation one must recognise the role of two elements of the input methodologies. Specifically:

- The Input Methodologies calculate depreciation according to a particular formula giving rise to a depreciation value (let this be "D_t^{IM}"). This amount is returned to investors in the form of higher revenues in the year in question; and
- The Input Methodologies provides a full year of inflation compensation on that amount in the form of a revaluation of the asset.

18. By contrast, even if the Commission used the same formula as the Input Methodologies to determine "D_t^{IM}" (which it does not as is discussed below), the

Commission would provide less than "D_t^{IM}" to investors in the form of higher revenues. This is because the timing assumption adopted by the Commission departs from the Input Methodologies.

19. As a consequence of this departure from the Input methodologies, the Commission's model reduces the compensation for all elements of the building block by a half year's inflation. The effect of this is that the actual compensation for depreciation provided in revenues is equal to:

CC model nominal compensation for deprn $D_t^{CC\,model} = \frac{D_t^{IM}}{(1+inflation)^{0.5}}$[1]

20. It can be demonstrated that the effect of the Commission's timing assumption, in combination with the Input Methodologies calculation of depreciation (D_t^{IM}) would be that the Commission's model returns less in real depreciation than the actual value of the asset. I perform this demonstration in Appendix A.

2.2. Proposed solution

21. In order to ensure that assets are depreciated over their useful economic lives it is necessary that the real value of depreciation (opening RAB divided by residual life) must be scaled up for inflation. In Appendix A it is demonstrated that this approach corrects the Commission model's under-compensation for depreciation when revenues are modelled as falling in the middle of the year.

22. In order to apply this adjustment within the Commission's cost model one would alter the contents of depreciation cells D63 to H63 (opening asset base divided by residual asset lifetime) such that the values in these cells are multiplied by $(1+CPI)^{0.5}$. This assumes that the Commission maintains its assumption that revenues are received in the middle of the year. Where CPI for the relevant year is found in row 36 (D36 to

[1] The Commission's model determines annual building block costs as if compensation occurs at the end of the year (as per the Input Methodologies) but then reduces this amount to reflect the Commission's assumption (not reflected in the Input Methodologies) that revenues are recovered in the middle of the year. The effect of this is that the actual compensation for depreciation provided in revenues is equal to:

Commission model nominal compensation for deprn $= \frac{D_t}{(1+WACC)^{0.5}}$

Depreciation is divided by $(1+WACC)^{0.5}$ in the Commission's model in order to reflect the investors' assumed risk adjusted time value of money associated with receiving compensation for depreciation 6 months (0.5 years) early. The WACC includes compensation for a real risk free rate, inflation and a risk premium. Focussing only on the inflation component of the WACC (assuming the other components have been estimated correctly), the Commission's model provides the nominal compensation for as per equation (5) above.

H36). This ensures that the real amount of depreciation is not underestimated due to the impact of inflation.

3. Assuming tax is only payable at the end of the year

23. The second proposed amendment relates to the Commission's assumption that tax payments occur at the end of the year while revenues and operating costs are received/incurred in the middle of the year. In my view the assumption that tax is paid at the end of the year is unreasonable. Moreover, even if one accepted this assumption as reasonable, the Commission has made a material error in implementing this assumption in its discounted cash flow analysis.

3.1. Reasonableness of the assumption that tax is paid at the end of the year

24. The Commission recognises that, in reality, tax payments are spread over the year and that the same justification for assuming operating costs and revenues occur in the middle of the year applies equally to tax payments. The Commission nonetheless justifies this approach assuming that tax is paid at the end of the year on the grounds that it believes that revenues are earned, on average, earlier than the middle of the year. Thus the Commission hopes that one wrong assumption will offset another. This rationale is set out in the following quote:

> *We have changed the calculation of present values for revenues because revenues are received throughout the year, not at the year-end (which is the basis on which present values were calculated in the Update Paper). This has been modelled by assuming that the timing of revenues is equivalent to the revenues being received in the middle of the year. Operating expenditure has also been modelled as occurring at mid-year. This should reduce much of the modelling bias towards EDBs. However, this assumption ignores the fact that—due to seasonal factors—revenues are likely to be higher in the first half of the year than in the second half of the year. This provides a slight timing benefit in favour of EDBs. To offset this effect, and to improve the accuracy of our modelling overall, we have modelled tax costs as falling at the year-end (rather than throughout the year as would be likely in practice).* (Para 2.29 of the Draft Decision)

25. I consider that this justification is unreasonable. Specifically, it is arbitrary to make one wrong assumption on the grounds that doing so offsets a different wrong assumption. This is especially the case as no evidence is brought to bear that the two effects are of equal magnitude. In my view, to the extent that the Commission believes an assumption is wrong it should, to the extent possible, correct that assumption directly – not by making a wrong assumption it believes has an offsetting effect elsewhere in the model.

26. Moreover, for the reasons set out below, assuming that tax is paid at a different time to the receipt of revenues creates material complications to the correct modelling of total costs. Complications that the Commission's current model fails to recognise and, as a result, the model materially underestimates EDB's true costs.

3.2. Incorrect implementation of end of year tax payable assumption

27. Let us imagine that tax actually was payable at the end of the year while other cash flow items (revenues, operating costs and interest payments) occurred, on average, in the middle of the year. What present value advantage would an EDB receive from this arrangement relative a world where taxes were also payable, on average, in the middle of the year?

28. The answer is a straightforward matter of finance theory. The advantage received by delaying tax payable for six months will be equal to:

$$True\ benefit\ from\ 6\ month\ tax\ delay = Tax\ Payable - \frac{Tax\ Payable}{(1+R_{Tax\ Payable})^{0.5}} \qquad (1)$$

29. That is, the advantage to the EDB is equal to the difference between paying tax in the middle of the year (Tax Payable) less the discounted value of paying the same amount 0.5 years later - where the discount rate used reflects the risks associated with the Tax Payable liability over those 6 months. In reality there are no risks avoided by delaying Tax Payable by six months[2] and, therefore, the correct discount rate to use in equation (1) is the six month risk free rate measured from the middle of the year in question to the end of that year.

30. By comparison, the Commission's model assumes the advantage to an EDB from a six month delay in tax payable is given by discounting at the WACC as per the following formula:

$$CC\ model\ benefit\ from\ 6\ month\ tax\ delay = Tax\ Payable - \frac{Tax\ Payable}{(1+WACC)^{0.5}} \qquad (2)$$

[2] Tax Payable is, according to the logic of the model, determined in the middle of the year when revenues are received and expenses are incurred. By the middle of the year the amount of tax to be paid is known with certainty. There is no advantage to the EDB from delaying this payment other than the pure time value of money (ie, there is no additional risk reduction from delaying the payment). Of course, this only true 'on average' in that by the middle of the year there will still be, on average, 3 months of uncertainty on the amount of revenue and costs to be incurred over the second half of the year. However, by the same token, by the middle of the year there will already have been, on average, 3 months of certainty about tax payable on the first 6 months of operations.

31. The WACC is 8.77% in the Commission's model while the six month risk free rate is likely to be less than 3%.[3] This is a material difference and accounts for the significant reduction in compensation the Commission's model provides for tax costs relative to a model that reflects the reality that tax is payable in the middle of the year.

32. In effect, the Commission is assuming that the risks associated with tax element of the cash flow over that six months are the same as the risks associated with EDBs profits (net cash flows) on average. This assumption is wrong and involves what has been described as a "common mistake".

> *The DCF valuation contains a common mistake. It discounted the discretionary spending in year 3 at the same 12% risk-adjusted rate that had already been applied to the project's cash flows. That rate is almost certainly too high because such expenditures are rarely subject to the same operating and product-market forces that make the project's cash flows risky.* [4]

33. The common mistake in the above quote relates to an example where a practitioner estimates the WACC and then uses that same WACC to discount variations in individual elements of the expenditure profile – where those individual elements do not have the same risks inherent in the projects net cash flows (which the WACC is designed to discount). This is precisely the error that the Commission's model makes. The Commission's model assumes that it can use the WACC to measure the impact of a variation in the timing of tax payable – when the risk profile for that variation in tax payable is not the same as for the WACC.

34. In effect, the Commission's model is based on the underlying assumption that whatever compensation for tax is provided to the EDB in the middle of the year is invested at WACC for the next six months in order to fund the tax payable at the end of the year. This is a source of funds entirely external to the model. That is, the Commission assumes that the EDB will use the excess revenue it allows (in the middle of the year) to make investments outside the regulated business and use the return on that investment to help pay for tax costs.

35. This involves an implicit assumption that owners of the EDB's would be indifferent to receiving:

    a. compensation equal to Tax Payable at the end of the year; or

[3] At the time of writing one year government bond rates are reported by the New Zealand Reserve Bank to be 2.62% and 3 month bank debt is reported to be 2.71% (http://www.rbnz.govt.nz/statistics/exandint/b2/)

[4] Luehrman, Timothy "Investment Opportunities as Real Options: Getting Started on the Numbers", in Harvard Business Review, July-August 1998, page 12.

b. compensation equal $\frac{Tax\ Payable}{\sqrt{1+WACC}}$ in the middle of the year which is then invested in an external enterprise that has the same risk (WACC) as the EDB such that it is expected to deliver principle and return in six months equal to Tax Payable. .

36. However, this cannot be correct. In the second scenario the EDB must take on investment risk in order to have an expectation of being able to have the funds available to meet its tax obligations (ie, in order to expect to earn WACC on an external investment the EDB must take on risk). This is investment risk above and beyond that allowed for and compensated in the Commission's model. The EDB would clearly prefer option a. to option b.

37. The discount rate at which the EDB would be indifferent between receiving the full amount of compensation for tax when it was due and receiving an amount 6 months earlier is the risk free rate. This is the only rate at which the EDB can be certain that, if it invests the compensation provided by the Commission, it will have enough proceeds in 6 months time to pay its tax bill.[5]

Key conclusion

By assuming that the WACC can be used to measure the benefit of delayed tax payments the Commerce Commission is assuming that delaying $1 of tax liability for 6 months (after that tax liability is incurred) dramatically reduces the EDB's exposure to risk over that period.

This is not correct, after tax liabilities have been determined they are certain and therefore riskless. Delaying payment of a predetermined tax liabilities amounts to an interest free loan from the Government where that loan is charged at the risk free rate. The discount rate used to measure the benefit to the EDB should be the risk free rate and not the WACC.

In fact, the Commerce Commission is assuming that delaying a certain payment gives rise to a reduction in risk is of precisely the same magnitude as the EDB is exposed to in waiting 6 months to receive (an expected but not certain) dollar in profits.

38. An example can be used to demonstrate the nature and severity of the error in assuming that a six month delay in tax payable should be valued at the WACC. Let there be a zero NPV project with the following cash flow characteristics:

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1. [5] That is, $R_{Tax\ Payable}$ from equation 1 should be equal to the risk free rate.

- Initial investment of $100;
- Expected revenue of $210 in one period's time where the revenue specific discount rate is 6.00%;
- Expected expenditure in one period's time of -100% where the expenditure specific discount rate is 4.64%;
- Expected net cash flows in 1 period's time of $110. Where the cash flow specific discount rate (WACC=IRR) is determined by the above assumptions and is 10%.

39. Under these assumptions the NPV for the project can be estimated by applying the WACC to the net cash flows or by applying the revenue/expenditure specific discount rates directly to revenue/expenditure. This is demonstrated in Table 1 below which shows that the net present value of expenditures evaluated at 4.64% discount rate is negative $186.90. This is the same magnitude as the net present value of revenues evaluated at a 6% discount rate which is positive $186.90. Consequently, the net present value of the project is zero (NPV revenues plus NPV expenditures = $186.90-$186.90=0).

Table 1: Scenario 1 – all cash flows complete in first period

	Beginning of 1st period	End of 1st period	End of 2nd period	Discount rate	NPV
Expenditure	-100	-100	0	4.64%	-$186.90
Revenue	0	210	0	6.00%	$186.90
Net cash flow	-100	110	0	10.00%	-$0.00
			WACC/IRR on net cash flow	10.00%	

40. Alternatively, one could have estimate the NPV of the cash flows directly using the cash flow specific discount rate of 10% (=WACC/IRR) and one would also have estimated a NPV for the project equal to zero. However, in doing so one should keep in mind that the discount rate for the cash flows is defined by the discount rates of the constituent parts of the cash flow and their timing. If the timing of any individual cash flows change then it would be an error to use the same WACC from the above table to measure the impact of this. This is the source of error in the Commission model.

41. To see why imagine the same example except with $10 of the expenditures delayed by one period from the end of the 1st period to the end of the 2nd period. However, let the amount of that cash flow be escalated by the expenditure specific risk adjusted discount rate of 4.64% (ie, the project swaps a liability for $10 in one period's time for a liability of $10.464 in two periods time).

42. By definition this will leave the NPV of expenditures unchanged. Nothing has changed to alter the NPV of revenues and, consequently, the NPV of the project is also unchanged at zero. However, the WACC/IRR for the project has increased from 10% to 10.53%. This is the single discount rate applied to the net cash flows that is consistent with a zero NPV for the project.

43. This is illustrated in the below table.

Table 2: Scenario 2 – as per scenario 1 but with one period delay in some expenditures

	Beginning of 1st period	End of 1st period	End of 2nd period	Discount rate	NPV
Expenditure	-100	-90	-10.464	4.64%	-$186.90
Revenue	0	210	0	6.00%	$186.90
Net cash flow	-100	110	-10.464	10.53%	-$0.00
			WACC/IRR on net cash flow	10.53%	

44. By construction there is no benefit to the project from the delay in expenditure because the delayed expenditure has increased by an amount commensurate with the appropriate expenditure specific discount rate of 4.64%. This is also reflected by an increase in the WACC on net cash flows – which must increase in order to correctly determine the NPV of the project remains at zero.

45. This example demonstrates that the WACC of a project is a complex function of the discount rates specific to its individual cash flow items. One cannot alter the timing of the individual cash flow items and continue to use the same WACC to discount all new cash flows.

46. To illustrate the error in the Commission's model let each period be 6 months and let the delayed expenditure amount of -$10.464 be equal to the tax payable. The Commission's model would use the WACC to convert the -$10.464 delayed expenditure at the end of period 2 into an "equivalent" cost at the end of the first period. This would result in an estimated cost of expenditure measured at the end of the first period of:

Commission model estimate of 'equivalent' expenditure at the end of the first period

$$= -90.0 - \frac{10.464}{(1 + WACC)} = -90.0 - 9.5 = -99.5$$

47. This is clearly the wrong answer as, by construction, the equivalent risk adjusted expenditure at the end of the first period is the same as in scenario 1 (ie, -$100).

48. The Commission's model would then proceed on this basis to reduce the revenues received at the end of the first period (6 months) by $0.5 (from $210 to 209.5). This is because the Commission's model would have (incorrectly) underestimated the true contribution of the delayed expenditure of $10.464 to the NPV of expenditures measured at the end of the first six months.

3.3. Proposed solution

49. For the reasons expressed in section 3.1 I do not consider that the Commission's modelling assumption that tax is paid at the end of the year is reasonable. Moreover, correctly implementing this assumption would, for the reasons set out in section 3.2 above (also section 4 below), have a much smaller impact on allowable revenues than that modelled by the Commission.

50. For these reasons I consider that the best solution is for the Commission to assume that all cash flows occur at the same time as per the Input Methodologies. This solution avoids the need for the Commission to estimate 6 month cash flow specific discount rates for tax payable and to incorporate these into its model.

4. Inconsistent financing assumptions

51. The third proposed amendment relates to the Commission's current model adopting internally inconsistent financing assumptions. To the extent that the Commission continues to model revenues as occurring in the middle of the year the Commission must alter the structure of its model such that financing costs are also assumed to be paid in the middle of the year.

52. Relative to a model based on revenues being earned at the end of the year, the intention and effect of modelling revenues in the middle of the year is to lower the cost of, and compensation for, financing. Put simply, the earlier revenues are received the lower are financing costs. However, the manner in which the Commission has implemented this assumption is that the model:

    a. Reduces revenues to reflect lower financing costs; but

    b. Fails to reduce modelled interest tax deductions associated with lower financing costs.

53. Put simply, the Commission's modelling uses:

    a. an assumption of mid year revenues when estimating the compensation for financing costs. The effect of this is to lower the absolute value of revenues allowed; but

    b. an assumption of end of year revenues when estimating the amount of interest deductibility that is generated. The effect of this is to lower the amount of compensation for tax and therefore the absolute value of revenues allowed.

54. An example can be used to illustrate the effect of this modelling inconsistency. Imagine that an investor borrows \$100 at the beginning of the year to invest in an asset that he expects to pay off \$120 in one year's time. Let the annualised rate of interest be 10%. In this scenario the investor must maintain the \$100 debt for the entire year until he receives his expected revenue pay off. This means that his debt costs will be \$100*10% = \$10. This will give the investor \$10 in interest deductions for tax purposes.

55. However, now let the payoff be expected to occur in the middle of the year. Now the investor only needs to finance his investment for half a year. The interest costs he will incur on the investment are now $\$100*(1+10\%)^{0.5}= \$4.89$. This is less than half the interest deductions that he would accrue if he had to finance his investment for an entire year.

56. In order to correct this inconsistency the Commission's model can

    i. Continue to assume that revenues 'as if' they occur in the middle of the year but model financing costs (interest and dividends) as if they are paid in the middle of the year (when revenues are received). These payments will reflect post/pre payment of interest for the first/second half of the year respectively.

    ii. Assume that all cash-flows (revenues and expenditures) occur at the end of the year. This requires the simplest amendment to the model as it requires no change to the modelling of interest costs (which are currently modelled on the assumption that interest is paid at the end of the year in a lump sum). This is the approach used in the Input Methodologies. It is also, in my experience, the standard assumption in regulatory cost models and is the approach used in the Australian Energy Regulator's PTRM model.

4.1. Assuming all cash flows (including tax) are in the middle of the year

57. Assuming that all cash-flows occur in the middle of the year ensures internal consistency in the model. As the model currently stands the costs of financing the RAB are reduced by the assumption that revenues occur half way through the year but interest deductions for tax purposes are calculated on the basis that enough debt must be maintained to finance the RAB 'as if' revenues are only received at the end of the year.

58. If revenues are earned in the middle of the year then an EDB will pay its interest costs in the middle of the year (or, equivalently, pay down the value of outstanding debt). Under either scenario its interest deductions for tax purposes will be lower than those in the Commission's model.

59. The reason for the oversight in the Commission's model is that it attempts to adjust all financing costs from the end of the year to the middle of the year in a single cell (cell C101). However, this fails to recognise that interest and term credit spreads (which feed into tax deductions) must also fall if financing costs fall. The solution below involves altering financing costs in rows 67, 68 and 70 directly rather than attempting to implement an adjustment in cell C101 (which by its nature cannot capture the annual change in interest and term spread payments).

60. In order to implement this change to the model the following detailed amendments must be made:

    i. Cell D67 needs to be expressed as "WACC*D66/(1+WACC)^0.5". The relevant change to this cell is the division by (1+WACC)^0.5. The effect of this change is to convert financing costs from the end to the middle of the year. This formula must then be filled across to H67;

ii. Cell C68 needs to be expressed as "C28/(1+Debt)^0.5". This converts the credit spread payment from the end to the middle of the year. Changing this cell alone has the effect of flowing through to the rest of the cells D68 to H68;

iii. Cell D70 needs to be expressed as "=Debt*Leverage*D66/(1+Debt)^0.5". The relevant change to this cell is the division by (1+Debt)^0.5. The effect of this change is to convert interest payments from the end to the middle of the year. This formula must then be filled across to H70;

iv. Cell C89 needs to be expressed as "=C81+(C88*Tax-C78*Tax)*(1+$C$93)+C23". Similarly, cell D89 needs to be expressed as "=D81+(D88*Tax-D78*Tax)*(1+$C$93)" and this formula filled across to H89. The effect of these changes is to escalate the tax advantages associated with deferred tax from the middle of the year (where they now fall) to the end of the year (as is appropriate in this row which is measuring closing deferred tax;

v. Cell C94 needs to be expressed as "=D63-D64" and this formula filled across to H94. The effect of this is to remove financing costs from those costs that fall at the end of the year – noting that changes i to iii above have the effect of shifting these to the middle of the year;

vi. Cell D96 needs to be expressed as "=D59+D67+D68" and this formula filled across to H96. The effect of this is to add financing costs as costs that fall in the middle of the year;

vii. Cell C100 needs to be expressed as "=NPV(WACC,F99:H99)*(1+C93)". The effect of this is to calculate the present value of tax deductions now that all cash flows (including interest tax deductions) occur in the middle of the year;

viii. Cell C101 needs to be expressed as "=(C98-C100*Tax)/(1-Tax)". This change is necessary because all cash flows (including tax and interest deductibility) are now expressed on a mid year basis;

ix. In the IRR check calculation box (cells L96 to S11) the values for term credit spread and tax payable need to be shifted from the end of each year to the middle of each year (ie, the values in these rows should appear one column to the left). When this is performed the IRR check in cell P111 should give a "True" answer.

4.2. Assuming all cash flows (except tax) are made in the middle of the year

61. Notwithstanding my opinions set out in Section 3, if the Commission proceeds to model tax as payable at the end of the year then the Commission must, in my view, implement at least the following two changes to its model.

- Tax deductions for interest costs must be modelled on the assumption that interest payments are made in the middle of the year (at the same time that revenues are received). This is for the reasons set out in previously in this Section 4; and

- The discount rate used to measure the benefit to an EDB from a six month delay in tax payments should be a discount rate that is specific to risks avoided by that delay (ie, $R_{Tax\,Payable}$ from equation (1)). The Commission must estimate this directly and not assume that the WACC is the appropriate discount rate.

62. Implementing the first dot point requires changes set out in paragraph [75] sub paragraphs i) ii) iii), v) and vi) above.

63. Implementing the second dot point requires only that the formula in cell 101 be altered to read "=(C98-C100*Tax)/(1-Tax/(1-$R_{Tax\,Payable}$)). The derivation of this formula for cell 101 is set out below and starts from the NPV=0 identity requirement (ie, that the present value of revenues must equal the present value of building block costs).

$$PV\ of\ Revenue = PV\ return\ on\ RAB + PV\ of\ Opex - PV\ of\ \Delta RAB + PV\ of\ [(Revenue\ for\ tax\ purposes - Tax\ Deductions\ for\ tax\ purposes) \times tax] \quad (3)$$

64. Note that the term "PV of [(Revenue for tax purposes – Tax Deductions)*Tax]" is not the same as (PV of Revenue – PV of Tax Deductions)*Tax. This is because tax is only paid at the end of the year and, consequently, Revenue for tax purposes occurs a half year later than actual revenue. The PV of revenue for tax purposes can therefore be expressed as:

$$\text{PV of revenue for tax} = \frac{PV\ Revenue\ earned\ mid\ year}{(1+R_{Tax\,Payable})^{\frac{1}{2}}} \quad (4)$$

65. Where $R_{Tax\,Payable}$ reflects the risk free rate plus any measure of risk avoided by the EDB paying tax late (as described previously I consider that $R_{Tax\,Payable}$ should be set equal to the risk free rate).

66. Similarly, the PV of tax deductions for tax purposes can be expressed as

$$\text{PV of tax deductions} = \frac{PV\ tax\ deductions\ earned\ mid\ year}{(1+R_{Tax\,Payable})^{\frac{1}{2}}} \quad (5)$$

67. Substituting equations (4) and (5) into equation (3) gives:

$$PV\ of\ Revenue = PV\ return\ on\ RAB + PV\ of\ Opex - PV\ of\ \Delta RAB + \left(\frac{PV\ Revenue\ earned\ mid\ year}{(1+R_{Tax\ Payable})^{\frac{1}{2}}} - \frac{PV\ Tax\ Deductions\ earned\ mid\ year}{(1+R_{Tax\ Payable})^{\frac{1}{2}}}\right) \times tax \quad (6)$$

68. Rearranging this equation and noting that PV Revenues earned mid year is, by definition, equal to PV of Revenues (as revenues are assumed to be earned mid year) gives:

$$PV\ Revenue - \frac{PV\ Revenue}{(1+R_{Tax\ Payable})^{\frac{1}{2}}} \times tax = PV\ return\ on\ RAB + PV\ of\ Opex - PV\ of\ \Delta RAB - \frac{PV\ Tax\ Deductions\ earned\ mid\ year}{(1+R_{Tax\ Payable})^{\frac{1}{2}}} \times tax \quad (7)$$

69. Solving for PV Revenue gives:

$$PV\ Revenue = \frac{PV\ return\ on\ RAB + PV\ of\ Opex - PV\ of\ \Delta RAB - \frac{PV\ Tax\ Deductions\ earned\ mid\ year}{(1+R_{Tax\ Payable})^{\frac{1}{2}}} \times tax}{\left(1 - \frac{Tax}{(1+R_{Tax\ Payable})^{\frac{1}{2}}}\right)} \quad (8)$$

70. This is the equation the Commission has used to populate cell 101 of its spreadsheet except the Commission uses WACC as the measure for $R_{Tax\ Payable}$. For the reasons I have already set out in Section 3, I consider that the appropriate value for $R_{Tax\ Payable}$ is the annualised 6 month risk free rate. It is, in my opinion, certainly not the WACC – unless paying $1 of tax 6 months late offsets the same amount of risk as waiting for 6 months in the expectation of earning $1 of profits.

71. I note that if implemented, using a value of 3% for $R_{Tax\ Payable}$ will appear to give rise to an IRR in excess of WACC in the Commission's model (see cell M111) suggesting a positive NPV of the project. However, this is illusory. The reason the IRR rises under this solution is because low risk expenditures have been delayed relative to higher risk revenues – just as was the case in the examples provided at Table 1 and Table 2 in Section 3.2. This does not reflect a positive NPV project, it just reflects the fact that if

the Commission back loads low risk expenditures (by assuming delayed tax payments) the WACC must, as a matter of construction, rise to offset this effect.

4.3. Assuming all cash flows are at the end of the year

72. An approach of modelling all cash flows as occurring at the end of the period, consistent with the Input Methodologies would be consistent with the way, to the best of my knowledge, other regulators, including the AER and the Commission's own input methodologies, approach cost modelling.

Appendix A. Under compensation for inflation if the Commission timing assumption is applied consistently with the Input Methodologies depreciation formulae

73. The table below provides the relevant formulas used to generate the asset value of an investment and depreciation figures from the Input Methodologies (that do not escalate depreciation for inflation) and for an alternative approach that does escalate depreciation for inflation.

Table 3: Formulas used to derive figures in Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.**Table 4** and **Table 5 below**

Inflation escalation of depreciation?	Calculation of the Asset Value (AV) from years t=0 to t=	Calculation of Depreciation in years prior
Yes	$AV_t = \left(\frac{AV_{t-1}}{RL}\right) * (1 + 10\%) - D_{t-1}$ **Equation (1)**	$D_t = \left(\frac{AV_t}{RL_t}\right) * (1 + 10\%)$ **Equation 2**
No (as per Input Methodologies)	As above	$D_t = \left(\frac{AV_t}{RL_t}\right)$ **Equation 3**

74. In the example below the starting asset value at time zero is equal to $100 under both scenarios (the initial cost of the asset) and remaining life (RL) is 10 years in the first year and 9 years in the second year etc). Inflation is assumed to be a uniform 10% over time and real depreciation is calculated as nominal depreciation divided by cumulative inflation since the initial investment – as set out in the below equation:

Real depr^{n} assuming compensation occurs end year = $\frac{D_t}{(1+Inflation)^t}$ (4)

Real depr^{n} assuming compensation occurs mid year = $\frac{D_t}{(1+Inflation)^{t-0.5}}$ (4*)

75. Formulae 1 to 4 and 4* are used to derive the figures in **Error! Reference source not found.**Table 2 below. The calculation of real depreciation in equation 4 is based on the assumption that depreciation is compensated for at the end of the year (ie, a full year of inflation has occurred before investors receive the pre-determined nominal amount on depreciation (D_t). This is the assumption that underlies the construction of the building block values in the Input Methodologies. Equation 4* is the real value of depreciation assuming that revenues actually occur in the middle of the year (notwithstanding the implicit assumption in the Input Methodologies that revenues occur at the end of the year).

Table 4: Real depreciation compensation under the IM

Year	Asset value	Nominal depr^{n}	Real depr^{n} if received	
			end-year	mid-year
1	100.0	10.0	9.1	9.5
2	100.0	11.1	9.2	9.6
3	98.9	12.4	9.3	9.7
4	96.4	13.8	9.4	9.9
5	92.3	15.4	9.6	10.0
6	86.1	17.2	9.7	10.2
7	77.5	19.4	9.9	10.4
8	65.9	22.0	10.2	10.7
9	50.5	25.3	10.7	11.2
10	30.3	30.3	11.7	12.3
Total			**98.8**	**103.7**

76. The fourth column demonstrates that the total real depreciation over the asset's 10 year life is less than the original $100 if one assumes that revenues occur at the end of the year ($98.8 is returned on a $100 investment). Under this assumption, only if depreciation is escalated for inflation is 100% of the value of the original investment returned to investors over the life of the asset.

77. However, if one instead calculates the real value of depreciation returned to investors on the basis of an assumption that revenues are earned in the middle of the year the Input Methodologies actually over compensate for depreciation (ie, return $103.7 in real depreciation over the life of the asset that cost $100 initially). Given that the assumption that revenues are earned in the middle of the year is more realistic than the assumption that revenues are earned at the end of the year one can reasonably conclude that the Input Methodologies provide a measure of over compensation for the effects of inflation on the value of depreciation returned to investors.

78. However, the opposite is the case under the Commission's model which already departs from the Input Methodologies by assuming that revenues are earned in the middle of the year. Consequently, the Commission's model reduces the compensation for all elements of the building block by a half year's inflation. The effect of this is that, if the remainder of the Input methodologies are followed, the actual compensation for depreciation provided in revenues is equal to:

CC model nominal compensation for deprⁿ $D_t^{midyear} = \frac{D_t}{(1+inflation)^{0.5}}$ (5)

79. In **Error! Reference source not found.**Table 3, I use equation (5) above instead of the Input Methodologies' equation to determine the nominal compensation for depreciation allowed under the Commission's model. Determination of the asset value continues, consistent with the Commission's model, to be as set out in equation (1) above (see middle column of Table 3**)**

80. The real value of nominal depreciation returned to investors is also calculated in the middle of the year as per equation 6* below. Equation 6* takes nominal depreciation returned to investors by the Commission's model and discounts this by inflation up until the middle of the year. .[6]

Real deprⁿ assuming compⁿ occurs mid year = $\frac{D_t^{midyear}}{(1+inflation)^{t-0.5}} = \frac{D_t}{(1+inflation)^t}$ (6*)

[6] I note that substituting equation 5 into equation 6* shows that equation 6* is equivalent to equation 4.

Table 5: Real depreciation compensation under the Commission model and alternative proposed approach

	No inflation escalation of depreciation (as per the Commission's Model)			Inflation escalation of depreciation		
Year	Asset value	Nominal depreciation mid year	Real depreciation mid year	Asset value	Nominal depreciation mid year	Real depreciation mid year
1	100.0	9.5	9.1	100	10.5	10.0
2	100.0	10.6	9.2	99.0	11.5	10.0
3	98.9	11.8	9.3	96.8	12.7	10.0
4	96.4	13.1	9.4	93.2	14.0	10.0
5	92.3	14.7	9.6	87.8	15.4	10.0
6	86.1	16.4	9.7	80.5	16.9	10.0
7	77.5	18.5	9.9	70.9	18.6	10.0
8	65.9	20.9	10.2	58.5	20.4	10.0
9	50.5	24.1	10.7	42.9	22.5	10.0
10	30.3	28.9	11.7	23.6	24.7	10.0
Total			**98.8**			**100.0**

81. The figures in **Error! Reference source not found.**Table 3 show under compensation for depreciation in the Commission's model assuming mid year compensation is equal to under compensation in the Input Methodologies assuming end of year compensation. This is unsurprising. The reason that the Input Methodologies does not under compensate for inflation is that its timing assumption is generous/conservative. By taking away this conservative element of the Input methodologies the Commission's model is left under compensating EDBs.

A.1. Further approximation to IM depreciation in the Commission's model

82. The Commission's model also departs from the Input Methodologies by employing only an approximation to the Input Methodologies' depreciation calculation.

83. This approximation involves depreciating the RAB by an assumed constant remaining life. To the extent that this approximation exactly matches the depreciation that would be calculated under the Input Methodologies then, for the reasons described in section 2.1 and in this Appendix, the Commission's departure from the Input Methodologies timing assumptions will lead to this level of depreciation being insufficient to fully compensate for the initial asset value. This under compensation will be crystallised when the RAB is reset equal to the RAB calculated under the Input Methodologies (eg, when the next default price path is set in 2015 or earlier if an EDB requests a customised price path).

84. However, it can also be shown that, even if the Commission's model were applied forever, the model would never fully return the value of a new investment to investors.

85. To see this note that the Commission's assumption of a constant remaining life for the RAB as a whole is consistent with a steady state network where new capital expenditure is replacing assets that are retired. The example below demonstrates that the Commission's model will under compensate for real depreciation and will allow the RAB to grow in real terms. This is despite the example requiring by construction that the real value of the RAB remain constant – as new expenditure is simply replacing assets that have served their useful life and are therefore leaving the asset register. .

86. Imagine that an EDB starts "year 1" with an opening RAB of $100 and the average remaining life of the assets is 10 years – such that real depreciation should be $10 ($100/10). Also imagine that at the end of every year there is $10 of real expenditure[7] replacing the assets that wear out during that year - such that the real value of the RAB should remain at $100.

87. If inflation is zero this is precisely what the Commission's model does. However, if inflation is positive the Commission's model allows less than $10 in real depreciation. The effect is that the real value of the RAB continues to rise – even though the EDB is only spending to maintain the real value of the assets.

88. To see this, consider an example with 10% inflation. Note that the Commission's model will:

- Allow depreciation of $10 in the first year (being $100 asset value at the beginning of year 1 divided by remaining life of 10);
- Reset the value of the RAB at $111 at the end of year 1 (beginning of year 2). This $111 is calculated as:
  - $100 starting RAB; plus
  - $10 revaluation (inflation of 10% multiplied by the $100 starting RAB); less
  - $10 in depreciation (calculated in the Commission's model as $100 divided by an average remaining life of 10 years); plus
  - $11 in new expenditure to replace the depreciated assets ($11 is required to replace 10% of the initial RAB because inflation has increased 10% over the course of the first year).

89. However, a $111 nominal RAB at the end of the first year is an increase in the real RAB of 0.9% - from $100.0 to $100.9. This occurs because the Commission's model

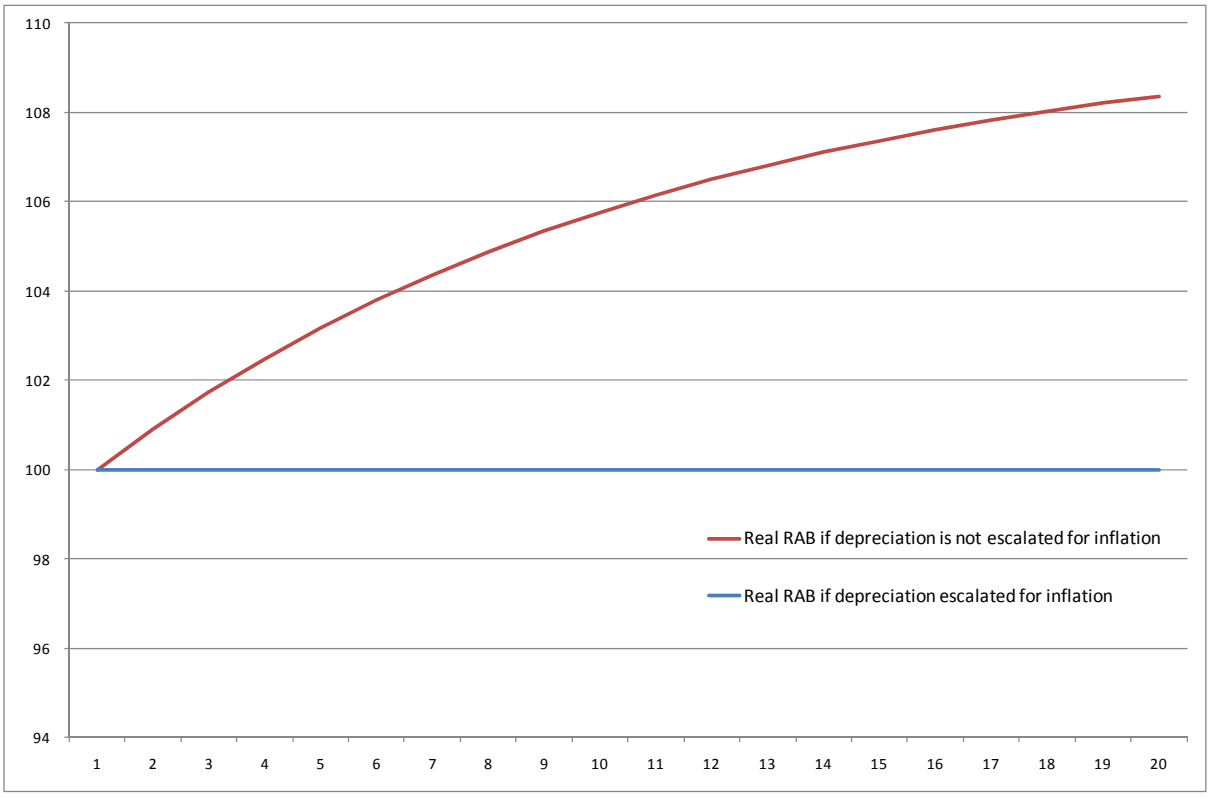
[7] References to "real dollars" mean dollars with the same purchasing power as exists at the start of year 1

does not escalate depreciation in the year in which it occurs for the inflation in the same year. In this example, depreciation should exactly match new expenditure because, by construction, new expenditure is purely to replace existing assets. That is, depreciation should equal $11.

90. However, the Commission's model calculates depreciation 'as if' inflation were zero. In this example, this underestimates true nominal depreciation which is $11 (being $10 of real depreciation plus $1 of compensation for inflation on that real depreciation).

91. As a consequence, even though investment is purely in the form of asset replacement, depreciation does not keep track with replacement expenditure – with the effect that the RAB grows in real terms. The following figure describes the course of the real RAB under the Commission's model and this stylised example. It compares this course with the correct course where the real asset value is maintained at $100.

Figure 1: Real RAB when depreciation is/is not adjusted for inflation



92. This figure shows an ever escalating real RAB which is the result of under-compensating for real depreciation in the preceding years.

93. One might argue that investors should be indifferent to the speed at which the value of the asset is being returned to them provided that the investors are continuing to earn a return on the value of the asset that has not been returned to them. Such an argument is problematic on a number of grounds. First, it assumes that the Commission will commit to allowing the RAB so escalated to be recovered in the future.

94. Second, it assumes that the profile of the risks perceived by investors is independent of the timing of the return of their capital. This assumption is clearly violated and that is why longer maturity investments commonly require higher returns to attract investors. In back loading the profile of return of investment beyond the actual economic lives of the assets the Commission is forcing investors to accept a longer maturity profile but is not providing investors with any additional return.

95. Third, it is arbitrary to adopt a model where back-loading of depreciation beyond an asset's useful live only occurs in the presence of positive inflation and where the amount of back-loading increases with the level of inflation. I am aware of no reason why the rate of real depreciation should depend negatively on the rate of inflation.