# Derivation of the annual revenue requirement formula, deferred tax approach

We derive in this document a formula for the Annual Revenue Requirement of a regulated business, given cash flow timing assumptions, the opening RAB at the start of the year, the operating expenditure, change in the deferred tax balance in the year and a number of other variables.

This derivation focuses on just one year in a regulatory period, not on a multi-year regulatory period as a whole. It is intended that the formulas derived would be applied to determine the building blocks revenue for each year, which would then need to be "smoothed" to form a CPI minus X price path.

This note first covers preliminary matters before setting out the derivation proper. The preliminary matters are defining variables, discussion of timing factors (used with respect to intra-year cash flow timing) and setting out the fundamental equations on which the derivation is based.

Following the derivation, an interpretation of the derived revenue formula is also provided, setting out a building blocks view of the revenue formula.

## Variable definitions

### Input variables[1]

| | |
|---|---|
| $RAB_0$ | RAB at start of the year |
| $DT_0$ | Deferred tax asset value at the start of the year |
| WACC | Weighted Average Cost of Capital (used as the discount rate) |
| O | Operating Expenditure, net of pass through costs and recoverable costs |
| D | Regulatory Depreciation |
| TCSD | Term Credit Spread Differential Allowance |
| I | Interest Cost, including TCSD |
| Reval | Revaluation |
| VCA | Value of Commissioned Assets |
| t | Company tax rate |
| PD | Permanent Differences |
| RTA | Regulatory Tax Adjustments |
| $\Delta DT$ | Increase in deferred tax asset value during the year |
| Dispos | Opening RAB value of assets disposed of during the year |
| ORI | Other Regulated Income |

[1] These "Input Variables" are inputs to this derivation, not necessarily inputs to a spreadsheet model. For example, they include regulatory depreciation which is treated as a given input in this derivation, but it will be calculated from other parameters in any spreadsheet model. Some of the inputs, such as regulatory tax adjustments and TCSD are parameters that are defined in the Commerce Act (Electricity Distribution Services Input Methodologies) Determination 2010

**Derived values** (i.e. formulas are provided in this derivation)

| | |
|---|---|
| $RAB_1$ | RAB at end of the year |
| $DT_1$ | Deferred tax asset value at the end of the year |
| TP | Tax Payable |
| TA | Tax Allowance |
| Rev | Revenue requirement for the year,ie, building blocks revenue[2] |
| RonC | Return on Capital |
| RofC | Return of Capital |

**Present value functions**

| | |
|---|---|
| $PV_{start}()$ | Present value as at the start of the year |
| $PV_{end}()$ | Present value as at the end of the year |

## Timing Factors

A Timing Factor (TF) reflects the year-end value of a cash flow that occurs part-way through the year. For example, operating expenditure, tax payments, new asset commissioning and other regulated income are assumed to occur at mid year, so half a year of discounting at WACC is required to determine the equivalent value at year-end. Thus:

$$TF_{opex} = (1 + WACC)^{182/365}$$

$$TF_{tax} = (1 + WACC)^{182/365}$$

$$TF_{vca} = (1 + WACC)^{182/365}$$

$$TF_{ori} = (1 + WACC)^{182/365}$$

Revenue has been assumed to occur with timing equivalent to being received on 3 November each year[3]. There are 148 days between 3 November and the end of the financial year on the following 31 March, which means that the timing factor for revenue is given by:

$$TF_{rev} = (1 + WACC)^{148/365}$$

The Term Credit Spread Differential (TCSD) is in all cases at most a small amount, and the timing assumption for TCSD will be immaterial. For simplicity, it has been assumed to occur at year end, so:

$$TF_{TCSD} = 1$$

These TF values are applied when calculating the PVend() of a cash flow. For example:

[2] This is the revenue amount received on the revenue date during the year, not an amount expressed in year-end terms.

[3] The 3 November date is proposed as it is equivalent (in time value of money terms) to revenues being received in 12 equal monthly instalments on the 20th of the month following the provision of the service. This applies for a regulatory year ending on 31 March. A calculation setting out this equivalence is in Sheet 'Timing Assumptions' in the 2012 draft decision reset model.

$$PV_{end}(Rev) = Rev * TF_{rev}$$

The $PV_{end}()$ function can be applied in a similar fashion for each of the other cash flows.

## Equations on which this derivation is based

The equations which form the basis of this derivation are as follows:

### Financial Capital Maintenance equation

The following equation expresses the financial capital maintenance approach of having the opening total value[4] of the assets equal to the sum of:

- the present value of cash flows over a year plus
- the discounted total asset value at the end of that year.

$$RAB_0 + DT_0 = PV_{start}(\text{Cash flows}) + (RAB_1 + DT_1)/(1 + WACC) \quad 1$$

### RAB roll-forward equation

The roll-forward of the RAB from one year to the next[5] is given by:

$$RAB_1 = RAB_0 + VCA - D + Reval - Dispos \quad 2$$

### Tax Allowance

The tax allowance, in the absence of tax losses[6], is given by:

TA = (Regulatory profit / (loss) before tax + RTA) * t

Regulatory profit / (loss) before tax = Rev + ORI

TA = (Rev + ORI - O - D + PD + RTA) * t

The term PD in this equation has been assumed to have a value of zero for the purposes of the DPP, and may be deleted, such that this equation becomes:

TA = (Rev + ORI - O - D + RTA) * t 3

### Deferred tax balance roll-forward

The roll-forward of the deferred tax balance from one year to the next[7] is given by:

[4] This total opening value includes the value of the deferred tax asset.

[5] This RAB roll-forward equation is consistent with the RAB roll-forward approach in the Commerce Act (Electricity Distribution Services Input Methodologies) Determination 2010, and Commerce Act (Gas Distribution Services Input Methodologies) Determination 2010 Clauses 2.2.4, with some simplifying assumptions, such as not accounting for lost and found assets.

[6] This tax allowance equation is consistent with the tax allowance approach in the Commerce Act (Electricity Distribution Services Input Methodologies) Determination 2010 and Commerce Act (Gas Distribution Services Input Methodologies) Determination 2010, Clauses 2.3.1 to 2.3.9.

$$DT_1 = DT_0 + \Delta DT \quad (4)$$

**Tax payable**

The formula for tax payable is as follows:

$$TP = TA + \Delta DT \quad (5)$$

**Year-end present values, relative to year-start**

The present value of a set of cash flows as at the end of the year is (1 + WACC) multiplied by the present value at the start of the year:

$$PV_{end}(\text{Cash flows}) = PV_{start}(\text{Cash flows}) * (1+ WACC) \quad (6)$$

## Derivation

The derivation of a non-circular formula for the annual revenue requirement is set out below, based on the 6 equations above (Equations 1 to 6).

Equation 1 multiplied by (1 + WACC) becomes, after applying Equation 6:

$$(RAB_0 + DT_0) * (1 + WACC) = PV_{start}(\text{Cash flows}) * (1 + WACC) + (RAB_1 + DT_1) * (1 + WACC) / (1 + WACC)$$

Applying Equation 6 and removing the "(1 + WACC) / (1 + WACC)" factor (which is equal to 1) gives:

$$(RAB_0 + DT_0) * (1 + WACC) = PV_{end}(\text{Cash flows}) + RAB_1 + DT_1$$

Subtracting $(RAB_0 + DT_0)$ from each side of this equation gives:

$$(RAB_0 + DT_0) * WACC = PV_{end}(\text{Cash flows}) + RAB_1 - RAB_0 + DT_1 - DT_0$$

Recognising that the cash flows comprise Rev, O, VCA, TCSD, TP and ORI, and applying Equation 4 gives:

$$(RAB_0 + DT_0) * WACC = PV_{end}(\text{Rev, O, VCA, TCSD, TP and ORI}) + RAB_1 - RAB_0 + \Delta DT$$

Equation 2 indicates that $RAB_1 - RAB_0 = VCA - D + Reval - Dispos$, and applying this to the equation above gives:

$$(RAB_0 + DT_0) * WACC = PV_{end}(\text{Rev, O, VCA, TCSD, TP and ORI}) + VCA - D + Reval - Dispos + \Delta DT$$

Expanding the $PV_{end}()$ function above using the timing factors gives:

$$(RAB_0 + DT_0) * WACC = Rev*TF_{rev} - O*TF_{opex} - VCA*TF_{VCA} - TCSD - TP*TF_{tax} + ORI*TF_{ORI} + VCA - D + Reval - Dispos + \Delta DT \quad (8)$$

We define the variable "Opening Investment Value" (OIV) as follows:

$$OIV = RAB_0 + DT_0$$

[7] This deferred tax equation is consistent with the deferred tax approach in the Commerce Act (Electricity Distribution Services Input Methodologies) Determination 2010 and Commerce Act (Gas Distribution Services Input Methodologies) Determination 2010, Clauses 2.3.7.

Rearranging Equation 8 and substituting OIV for $RAB_0 + DT_0$ gives:

$$Rev*TF_{rev} = OIV * WACC + VCA*(TF_{VCA} - 1) + TCSD - Reval + D + Dispos + O*TF_{opex} + TP*TF_{tax} – \Delta DT - ORI*TF_{ORI} \quad 9$$

We define two variables, Return on Capital (RonC) and Return of Capital (RofC) as follows:

$$RonC = OIV * WACC + VCA*(TF_{VCA} - 1) + TCSD – Reval \quad 10$$

$$RofC = D + Dispos \quad 11$$

Substituting these variables into equation 9 gives:

$$Rev*TF_{rev} = RonC + RofC + O*TF_{opex} + TP*TF_{tax} – \Delta DT - ORI*TF_{ORI}$$

Substituting the expression for TP from Equation 5 into this equation for TP gives

$$Rev*TF_{rev} = RonC + RofC + O*TF_{opex} + (TA + \Delta DT) *TF_{tax} – \Delta DT - ORI*TF_{ORI} \quad 12$$

The expression for TA in Equation 3 is:

$$TA = (Rev + ORI - O - D + RTA) * t$$

Substituting the right-hand-side of this expression for TA in Equation 12 gives:

$$Rev*TF_{rev} = RonC + RofC + O*TF_{opex} + ((Rev + ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} - \Delta DT - ORI*TF_{ORI} \quad 13$$

Collecting terms in Rev to the left-hand-side gives:

$$Rev*(TF_{rev} - t * TF_{tax}) = RonC + RofC + O*TF_{opex} + ((ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} - \Delta DT - ORI*TF_{ORI}$$

Dividing both sides of this equation by $TF_{rev} - t * TF_{tax}$ gives:

$$Rev = (RonC + RofC + O*TF_{opex} + ((ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} - \Delta DT - ORI*TF_{ORI})/(TF_{rev} - t * TF_{tax}) \quad 14$$

## Conclusion: Non-circular formulas for modelling

The following formulas may be applied in a spreadsheet model in the order given below to determine the annual revenue requirement without creating calculation circularity.

$$RonC = OIV * WACC + VCA*(TF_{VCA} -1) + TCSD – Reval$$

$$RofC = D + Dispos$$

$$Rev = \big(RonC + RofC + O*TF_{opex} + ((ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} - \Delta DT - ORI*TF_{ORI}\big)/(TF_{rev} - t * TF_{tax}) \quad \text{Eqn 14}$$

$$TA = (Rev + ORI - O - D + RTA) * t \quad \text{Eqn 3}$$

## Interpretation of revenue formula in building blocks terms

Equation 14, multiplied by the factor $TF_{rev}$ and with some re-arranging is:

$$Rev * TF_{rev} = \big(RonC + RofC + O*TF_{opex} + ((ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} - \Delta DT - ORI*TF_{ORI}\big)/(1 - t * TF_{tax} / TF_{rev})$$

This is an expression of the revenue requirement in year-end terms, i.e. Rev * $TF_{rev}$ . It can be broken down into a number of building blocks, each of which incorporates a tax gross-up factor of (1 - t * $TF_{tax}$ / $TF_{rev}$)

Rev * $TF_{rev}$ =

| | |
|---|---|
| $RonC / (1 - t * TF_{tax} / TF_{rev}) +$ | Return on capital |
| $RofC / (1 - t * TF_{tax} / TF_{rev}) +$ | Return of capital |
| $O*TF_{opex} / (1 - t * TF_{tax} / TF_{rev}) -$ | Operating expenditure |
| $ORI*TF_{ORI} / (1 - t * TF_{tax} / TF_{rev}) +$ | Other regulatory income |
| $((ORI - O - D + RTA) * t + \Delta DT) *TF_{tax} -$ - $\Delta DT - ORI*TF_{ORI}) / (1 - t * TF_{tax} / TF_{rev})$ | Some of the tax costs |

The equation above may be viewed as the year-end revenue requirement expressed in building blocks terms. Note that the tax gross-up factor would become the familiar (1 - t) tax gross-up factor if the timing of the tax payable cash flow was the same as the timing of the receipt of revenues, i.e. if $TF_{tax} = TF_{rev}$.

While this formula may provide some intuitive insight into how Equation 14 could be viewed in building blocks terms, it is not particularly satisfactory in terms of a tax building block. The total of a tax building block would comprise the last term of the formula above, plus the gross-up effect in the other building blocks.

Note that the expression for the year-end revenue requirement set out in Equation 12 can be readily broken down into building blocks. The equation however is circular in nature and therefore cannot be used to directly calculate the revenue requirement.