



# **Access network costing**

A REPORT PREPARED FOR VODAFONE GROUP

June 2011



## Access network costing

<b>1</b>	<b>Introduction and summary</b>	<b>4</b>
<b>2</b>	<b>Asset costing and regulatory objectives</b>	<b>6</b>
2.1	<i>Regulatory objectives.....</i>	6
2.2	<i>Potential methodologies.....</i>	8
<b>3</b>	<b>Recommendations</b>	<b>11</b>
3.1	<i>Duct .....</i>	13
3.2	<i>Copper cable.....</i>	15
3.3	<i>Access fibre .....</i>	16
3.4	<i>Active assets.....</i>	18
3.5	<i>Setting copper and fibre prices to account for externalities.....</i>	19
<b>4</b>	<b>Annexe 1: Objectives of access regulation</b>	<b>21</b>
4.1	<i>Ensuring efficient investment .....</i>	23
4.2	<i>Encouraging take-up of services.....</i>	25
4.3	<i>Promoting competition .....</i>	27
4.4	<i>Reducing costs and promoting efficiency.....</i>	29
4.5	<i>Practicability and consistency with approaches to other assets</i>	30
<b>5</b>	<b>Annexe 2: Asset costing approaches for price controls</b>	<b>32</b>
5.1	<i>Valuation and allowable revenues .....</i>	32
5.2	<i>Approaches to asset valuation and determining allowable revenues .....</i>	36
5.3	<i>Economic depreciation: UK mobile termination.....</i>	46
5.4	<i>Renewals accounting: UK water industry.....</i>	51
5.5	<i>Adjusting for discontinuities in valuation: UK fixed access.....</i>	53
5.6	<i>Determining the efficient asset base .....</i>	53

## Access network costing

<b>Figure 1.</b> Objectives of access regulation	6
<b>Figure 2.</b> Network access asset groups - with NGA	11
<b>Figure 3.</b> Summary of recommendations	12
<b>Figure 4.</b> Objectives of access regulation	22
<b>Figure 5.</b> Broadband take up in the UK	27
<b>Figure 6.</b> Fixed access network assets with NGA	28
<b>Figure 7.</b> Asset valuation based on deprival value	33
<b>Figure 8.</b> Asset valuation under regulation	35
<b>Figure 9.</b> Allowable revenues under HCA	38
<b>Figure 10.</b> Allowable revenues under CCA with increasing replacement cost	40
<b>Figure 11.</b> Allowable revenues under standard annuity	42
<b>Figure 12.</b> Allowable revenues under tilted annuity	43
<b>Figure 13.</b> Allowable revenues under economic depreciation	44
<b>Figure 14.</b> Comparison of economic depreciation results from Ofcom MTR models	46
<b>Figure 15.</b> RAV under renewals accounting	48
<b>Figure 16.</b> Allowable revenues under renewals accounting	49
<b>Table 1.</b> Approaches to asset valuation and determining allowable revenues	9
<b>Table 2.</b> Strengths and weaknesses of approaches	10
<b>Table 3.</b> Approaches to asset valuation and determining allowable revenues	37



# 1 Introduction and summary

The roll out of next generation access (NGA) networks in Europe and internationally has re-ignited interest in the issue of the appropriate approach to the costing of fixed access networks for regulatory purposes. In this context, Vodafone asked Frontier Economics and Sir Ian Byatt, to consider the appropriate approach to the costing of the underlying network access elements, taking into account experience not only from the communications industry, but also other industries that have been subject to access regulation.

The largest element of the cost of access to fixed access networks relates to network assets and is an area where there is the greatest scope for differences in allowable revenues<sup>1</sup> under a price control in a given period, depending on the approach adopted as decisions need to be made about the timing as well as the level of cost recovery. In contrast operational expenditure can be directly included in allowable revenues in the year it is incurred. In this report, we consider both the economic case for different approaches as well as the practical implications.

We find that different elements of the network equipment required to offer fixed access services, each have sufficiently different characteristics to justify a different costing approach. Such an approach is consistent with the EU NGA Recommendation<sup>2</sup> which provides for the costing approach to vary between assets<sup>3</sup>. Our views in terms of the most appropriate cost based approach for each of the assets is summarised in the Figure below.

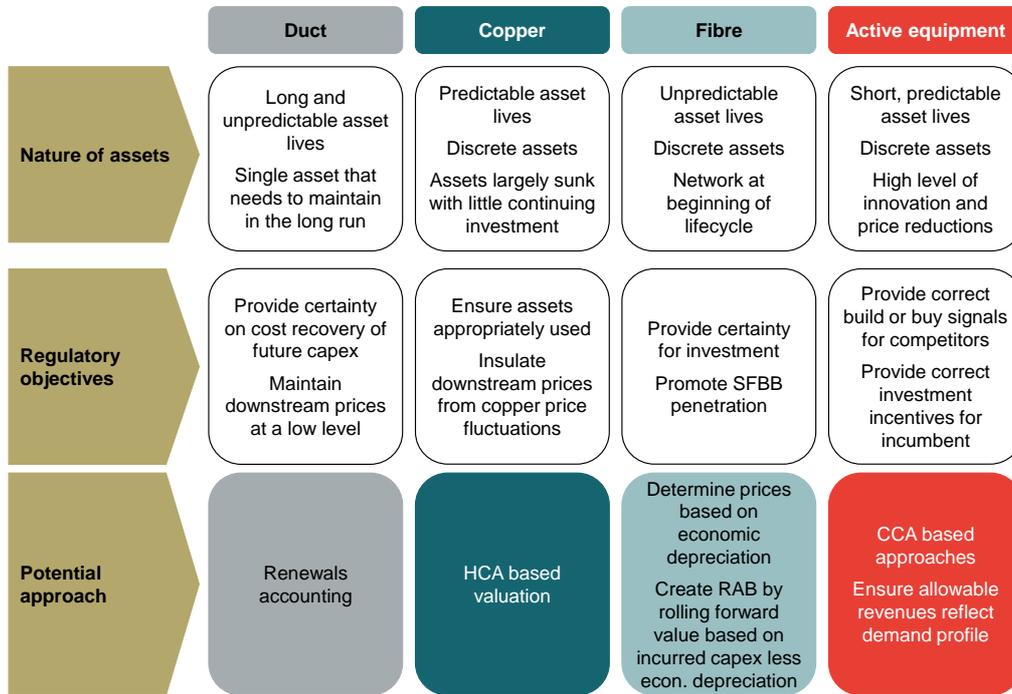
---

<sup>1</sup> In this report we use the term ‘allowable revenues’ to refer to the cost oriented target level of revenues that a regulated company is allowed to earn under a price control. We make the distinction between ‘allowable revenues’ and ‘cost’ to emphasise that there is no single unique measure of cost.

<sup>2</sup> COMMISSION RECOMMENDATION of 20 September 2010 on regulated access to Next Generation Access Networks (NGA)

<sup>3</sup> Annex I of the NGA Recommendation provides that a consistent regulatory approach may “imply that NRAs use different cost bases for the calculation of cost-oriented prices for replicable and non-replicable assets, or at least adjust the parameters underpinning their cost methodologies in the latter case.” Where there are relevant differences in the character of assets, those differences can and should be taken into account in the regulatory approach.

**Figure S1: Summary of recommendations**



Source: Frontier Economics

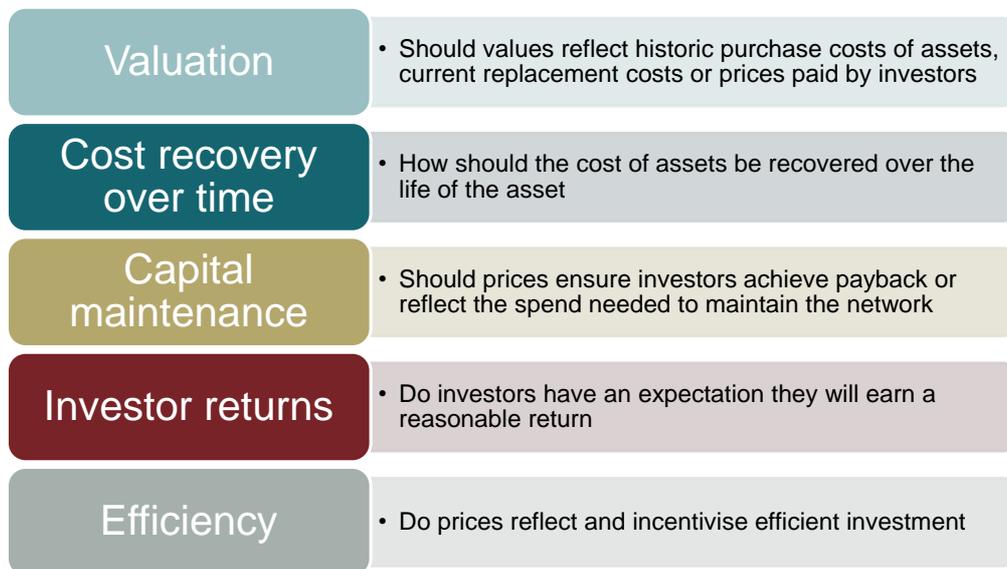
These recommendations are based on the principle of cost orientation and exclude the impact of any potential externalities which might justify a departure from these principles.

## 2 Asset costing and regulatory objectives

### 2.1 Regulatory objectives

Choosing the methodology to determining costs requires typically striking an appropriate balance between competing objectives<sup>4</sup>. There are a range of different decisions that need to be taken when determining asset summarised in **Figure 1**.

**Figure 1.** Objectives of access regulation



Source: Frontier Economics

The primary regulatory objective when costing methodologies were initially developed was to encourage the eventual deployment of competing fixed access infrastructures, where efficient for them to be deployed, with the ultimate aim of encouraging competition at the deepest level possible. In general, the most commonly used approach was a CCA-FAC method, which places weight on ensuring that prices match the regulator's current view of the 'competitive' level of prices, based on replacement costs in order to provide suitable entry signals. This was generally the case even where there was/is little prospect of the assets being duplicated by competitors.

Furthermore, regulatory costing in relation to access networks has commonly sought to use a 'one size fits all' approach, with all relevant assets being costed

<sup>4</sup> A more extensive discussion of the objectives is provided in Annexe 1.

using a similar approach, with limited variations to reflect the underlying characteristics of the assets themselves, including their replicability.

As a result of developments in Next Generation Access technologies, and the need to consider expanding the capability of the fixed access network through the deployment of such technologies, there has now been a renewed interest in the appropriate approach to the costing of access network costs. This is considering not only the appropriate approach to the costing of the NGA assets, but also the 'legacy' copper access network assets.

Whilst the overall regulatory objective of encouraging competition at the deepest level of the network possible, to deliver long-term benefits to consumers, appears to continue to be an important objective, the consideration of the appropriate approach to costing needs to take into account two key developments:

- First, the deployment of NGA networks requires significant investment, which is expected to have a more risky profile than the previous access network investment into the legacy networks of today.
- Second, there is experience of the deployment of alternative fixed access infrastructures, which has led to a better understanding of the conditions under which fixed access infrastructures are replicable.

The need for significant new investment, and the improved understanding of replicability, suggests that a more refined approach to costing may now be desirable, with greater emphasis placed on the following objectives:

- The need to provide greater regulatory certainty to **investors**, to enable efficient investment in next generation access networks by both incumbents and competitors; and
- The need to ensure that **consumers** are not paying more than necessary for the use of legacy networks and do not disconnect or inefficiently switch to alternatives.

## 2.2 Potential methodologies

A wide range of potential methodologies have been used and developed for determining the annual costs of assets in a regulatory context. These methodologies can be broadly classified into four groups:

1. Approaches consistent with statutory accounting standards used by the regulated operator;
2. Current cost accounting approaches that attempt to set prices that reflect the cost base of potential new entrant operators in order to ensure efficient entry;
3. Economic depreciation approaches which attempt to set the the profile of cost recovery over time to reflect demand for services; and
4. Regulatory asset valuation (RAV) approaches which focus on ensuring cost recovery over time.

**Table 1** summarises the range of methodologies that have been used by regulators to determine costs for price control purposes with the most commonly used methodologies (in both telecommunications and other regulated sectors). Annex 2 provides a more extensive discussion of the different approaches.

**Table 1.** Approaches to asset valuation and determining allowable revenues

Approach	Valuation	Determining allowable revenues
<b>Historic cost accounting</b>	Valuation based on acquisition costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line) and the cost of capital  Constant depreciation charge and falling cost of capital leads to “front loading” of cost recovery
<b>Current cost accounting (replacement costs)</b>	Valuation based on replacement costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line calculated as a percentage of the changing asset price), holding gain (loss) to reflect changing asset prices and the cost of capital  Shifts cost recovery forwards (if asset prices are falling) or back (if asset prices are rising) compared to HCA
<b>Annuities</b>	Not required to estimate allowable revenues  For an individual asset, derived using discounted future allowable revenues	Allowable revenues are constant over time in nominal or real terms
<b>Economic depreciation</b>	As for annuities	Allowable revenues may take account of the volume of output of assets in addition to changes in asset prices
<b>Renewals accounting (regulatory asset base)</b>	Changes in value calculated as capital expenditure less capital charges. Initial valuation may be exogenously determined, for example as price paid at acquisition.	Allowable revenues reflect capital expenditure required to maintain the asset base plus cost of capital employed

Source: Frontier Economics

Each of these approaches has strengths and weaknesses which may make them more or less applicable to a given set of assets as set out in **Table 2**. We consider these in the next section, where we provide our recommendations on the appropriate approaches to costing of fixed access networks.

**Table 2.** Strengths and weaknesses of approaches

Approach	Strengths	Weaknesses
<b>Historic cost accounting</b>	Costs can be precisely and objectively determined	Resulting prices do not reflect the changing costs of assets. Front loaded cost recovery may not be appropriate
<b>Current cost accounting (replacement costs)</b>	Costs reflect changes in underlying asset prices	Determining the replacement cost of assets introduces subjectivity and unpredictability Front loaded cost recovery may not be efficient
<b>Annuities</b>	No front loading of cost recovery Tilted annuities simple to implement in bottom up models	Allowable revenues are constant over time in nominal or real terms
<b>Economic depreciation</b>	Flexibility to profile cost recovery to reflect demand	High degree of subjectivity Valuations of existing assets may be highly sensitive to assumptions about future developments
<b>Renewals accounting/regulatory asset base</b>	Provides high certainty to investors that they will recover future investments	May be uncertainty over the correct level of maintenance expenditure Requires an initial valuation of existing assets

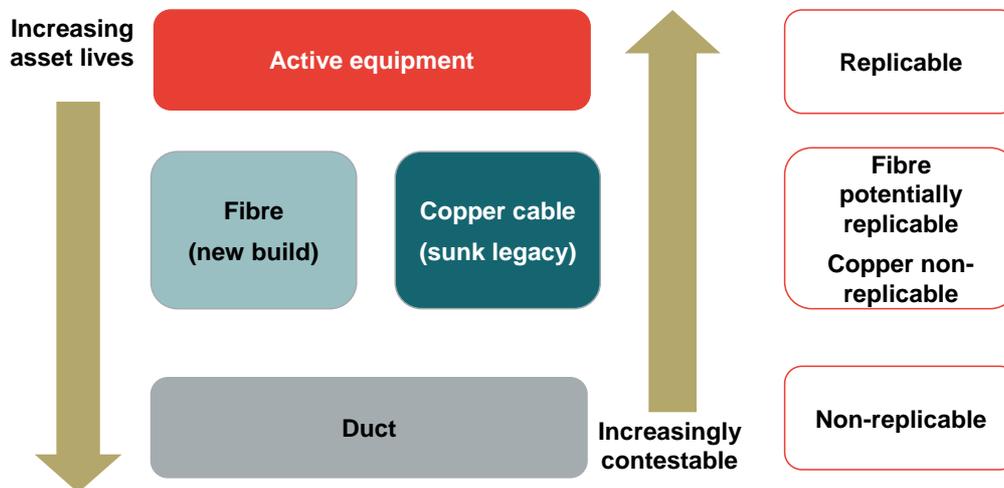
Source: Frontier Economics

### 3 Recommendations

The review of different methodologies available highlights that there is no single methodology that will necessarily achieve the best balance of the differing objectives for all assets. Thus the choice of methodology should follow an analysis of both the characteristics of the assets themselves and the regulatory and market context.

In this respect, it is useful to consider the ‘supply chain’ of the network access services, and analyse the factors that will affect the choice of methodology for each of the different groups of assets, as illustrated in **Figure 2** below.

**Figure 2.** Network access asset groups - with NGA



Source: Frontier Economics

Our view is that different elements of the network equipment required to offer fixed access services, have sufficiently different characteristics to justify a different costing approach for the different elements. Regulation based on differential approaches reflecting the characteristics of each class of asset are widely used in both fixed telecommunications and other sectors<sup>5</sup>, with the EU explicitly recognising this possibility in Annex I of the NGA Recommendation.

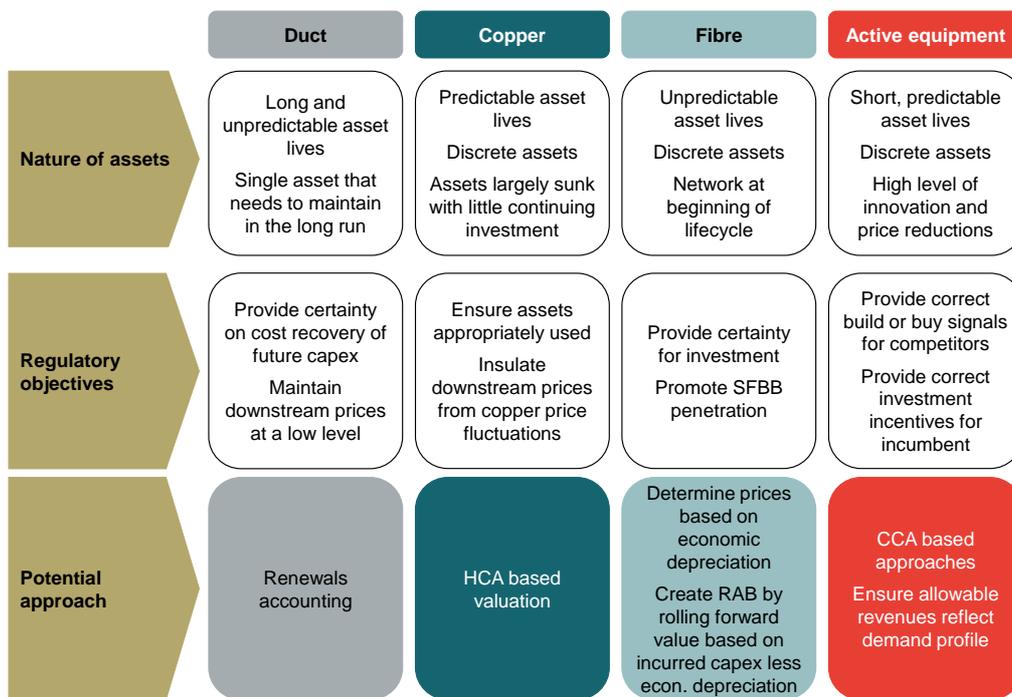
With the increasing complexity of regulated wholesale access in the EU, assets such as duct are inputs for a range of regulated services using different technology, for example fibre or copper, and for wholesale services in different parts of the value chain, such as active and passive services. Using different costing approaches for different assets should not lead to arbitrage opportunities

<sup>5</sup> For example in the UK water industry ‘underground’ assets are accounted for on a renewals accounting basis while ‘above ground’ assets are accounted for on a CCA basis.

between the prices set for those services provided regulators ensure consistency between services in both the determination of costs and the recovery of fixed and common costs.<sup>6</sup>

A summary of our recommendations on the most appropriate cost based approach for each of the assets is summarised in **Figure 3** and explained in more detail in sections 3.1 to 3.4. These recommendations are based on the principle of cost orientation and therefore exclude the impact of any potential externalities on pricing. Section 3.5 discusses how externalities may be taken into account by policy makers.

**Figure 3.** Summary of recommendations



Source: Frontier Economics

<sup>6</sup> We note for instance that the NGA Recommendation provides that IT and system costs fixed and common to different services should be allocated on a ‘proportionate’ basis across all access seekers including the downstream arm of the SMP operator. It also provides that costs for civil infrastructure access should be ‘consistent’ with the methodology used for pricing access to the copper loop. However, as noted in footnote [3] above, consistency does not imply an identical treatment particularly if there are relevant differences in the nature of the assets.

## Recommendations

## 3.1 Duct

### 3.1.1 Nature of the assets

Duct assets are typically the longest lived assets in telecommunications network, with asset lives typically determined by regulators to be of the order of 40 years, although there is considerable variation in assumptions. The asset base is also not a collection of discrete assets as ducts are by their nature a continuous network. For example when a section of duct is replaced, it is not immediately obvious which, if any, part of the existing duct asset has been retired.

The asset valuation largely relates to the capitalised labour costs involved in installing and maintaining the duct network, rather than the underlying physical inputs, which also increases the difficulty of assigning value to individual assets. A single entry in the asset register for capitalised costs may relate to a installation and maintenance activities across a range of duct assets.

### 3.1.2 Regulatory objectives

Given the very long life of access assets, the risk of setting allowable revenues which result in over- or under-recovery of efficient costs is considerable. This is accentuated by the difficulties of accurately measuring the installed asset base or accurately modelling the assets required for a hypothetical “efficient” operator through a model.

In addition, the roll out of NGA may require significant forward expenditure in upgrading the existing duct network to allow fibre rollout. Ensuring these investments are made will require providing investors with certainty on the future recovery of these asset costs.

As duct will be used for both current broadband services and SFBB services, keeping prices as low as possible consistent with efficient investment, and providing a smooth and predictable profile of allowable revenues appears to be the more important objective.

To the extent that ducts are largely non-replicable, setting prices to reflect the “competitive” level of prices based on replacement cost should not be one of the objectives.

### 3.1.3 Potential approach

A renewals accounting based approach<sup>7</sup> seems consistent with both the nature of the asset and the need to provide regulatory certainty. Such an approach raises some challenges in terms of:

---

<sup>7</sup> See Annexe 2 for a more detailed description of the approach.

- Determining the opening valuation;
- Determining the operational capital maintenance based depreciation charge; and
- Ensuring that additions to the asset base are efficient and justified.

The most contentious issue is likely to be the opening valuation. A book value (HCA) based approach may be appropriate in many jurisdictions for a number of reasons.

First, there seems little reason to base an initial valuation on an estimate of net replacement cost for competition reasons to the extent that the network is assessed to be largely non-replicable.

Second, even where regulated prices are currently set based upon CCA this change is likely to have been made relatively recently. Thus any holding loss in moving from a CCA valuation to a HCA valuation will to a large extent be a reversal of the holding gain made when regulation moved to CCA.

Third, HCA based approaches are likely to result in relatively low prices in the future which is consistent with the objectives of ensuring high penetration of broadband services and ensuring productive efficiency by making full use of sunk assets.

Where evidence suggests that the book value of the network is overstated due to previous inefficiencies, additional downwards efficiency adjustments could be considered to the valuation.<sup>8</sup>

In theory, if the duct network is in a steady state, the average capital expenditure required to maintain the network should be approximately equal to a depreciation charge based on replacement costs. Thus, a move to a renewals accounting approach should not significantly alter the level of prices. In practical terms, basing prices on the directly observable level of capital expenditure, rather than a series of highly uncertain estimates of duct asset lives and the replacement cost of the complete network, are likely to provide far greater certainty to both regulators and to investors.<sup>9</sup>

---

<sup>8</sup> Such evidence may come from, for example, bottom-up cost models.

<sup>9</sup> This should help achieve the objective of the NGA Recommendation which provides that access prices 'reflect the costs effectively borne by the SMP operator' taking account of actual asset lifetimes.

## Recommendations

## 3.2 Copper cable

### 3.2.1 Nature of the assets

The asset life of copper cable is typically determined to be of the order of 20 years, reflecting degradation in the cable over time. While the cable network forms an end-to-end network, it can be broken down into individual assets in a way that is not possible with duct, for example. This is because the physical materials are a high proportion of the costs of copper cable and each cable will generally be replaced in its entirety at the end of its useful life.

### 3.2.2 Regulatory objectives

Copper cable is no longer likely to be the Modern Equivalent Asset (MEA), which can be observed by the increasing use of fibre only networks in new build property developments. Setting regulated prices based on the replacement cost of copper cable would not seem therefore to provide appropriate price signals for future investments by potential entrants or existing competitors to the incumbent network. Indeed, using replacement costs could mean that wholesale access prices would be driven by volatility in the prices of copper in commodity markets and could lead to a disincentive to invest in downstream markets as future profitability would be dependent on the price of copper. Linking regulated prices to volatile copper prices may also lead to significant under or over recovery of costs, compared to the valuation of existing assets.

Where the likelihood of future investment in copper cables is limited, incentivising future investment in copper is not likely to be a primary consideration. A more important consideration is likely to be maximising overall productive efficiency by ensuring that this existing asset is adequately utilised.

In areas where fibre is either already rolled out or could be rolled out, the level of prices determined for copper based services will have an effect both on the incentives for fibre investment and the penetration of fibre in the areas where it is rolled out. The exact relationships will be complex, depending on current and future parameters (such as cross price elasticities of demand between copper and fibre based products) which cannot be determined with any level of certainty at present.

In the absence of significant externalities, the regulator may not need to directly address issues of fibre investment when setting prices for copper based prices. If the regulator commits to setting prices that reflect forward looking costs for both copper and fibre based products, investors can internalise the decision as to whether a given fibre based investment is efficient or not. This case is addressed further below.

If NGA generates significant positive externalities, regulators may choose to set prices in a way to realise these gains by incentivising investment in NGA above a

level that would occur when prices are set to solely reflect costs. This is addressed further in section 3.5 below

### 3.2.3 Potential approach

In the absence of any externalities, productive and allocative efficiency would suggest setting prices at a level that reflects the forward looking costs of operating and maintaining the network.

In terms of allocative efficiency, setting prices at this level would ensure that the existing sunk asset was efficiently utilised, avoiding the risk that demand that could be met went unserved, for example broadband customers leaving the network. In terms of productive efficiency, it would incentivise future investment in substitute networks where such alternative networks offered some combination of lower forward looking costs and increased capability.

However, setting prices to only reflect forward looking costs, if leading to an implicit writing off of the remaining value of past investments, would set a precedent which could discourage future investment. Thus, some account must be taken of the value of the existing assets. An HCA valuation of the existing network may be a reasonable opening RAV (Regulatory Asset Value), where this allows the operator to make a reasonable return on their past investment, without pricing copper based services significantly above forward looking cost.

## 3.3 Access fibre

### 3.3.1 Nature of the assets

Given the limited experience of operating mass market fibre access networks, the economic and engineering life of fibre cables may not be readily determined. Regulatory precedent for core transmission fibre and fibre serving large enterprises suggest an asset life similar to copper cable.

Similarly to copper cable, it should be possible to easily identify individual components of a fibre network, and given the availability of geographic information systems, as the fibre network is being rolled out, operators should have an accurate inventory of the network.

### 3.3.2 Regulatory objectives

The Commission has dual objectives of ensuring widespread availability of SFBB and encourage take up. This requires a balance between investment incentives for efficient roll out and maintain prices at a level that allows for rapid take up.

There is potential for competition for fibre based wholesale services, both from alternative networks and from operators using regulated access to the duct network. However, given the nascent stage of the market and the long pay back

## Recommendations

periods for competing networks, competitors' investment decisions may be less dependent on the level of prices in the period of network roll out and more dependent on certainty on the regulatory regime going forwards.

### 3.3.3 Potential approach

While the nature of the asset base means that it would be relatively straightforward to develop CCA estimates for fibre networks, on a straight line basis or a tilted annuity basis, the relative low utilisation of networks in the early years of roll out may result in achievable revenues being below the calculated allowable revenues based on a CCA straight line or annuity approach initially. This may lead to under-recovery over the longer term as the operator would never be able to recover the allowable revenues 'foregone' in the initial period.

An economic depreciation approach could be used initially to allow allowable revenues to reflect the limited demand during the phase when the network was being rolled out.

The main weakness of an economic depreciation approach which is dependent on judgemental assumptions about future developments, is the increased regulatory risk to investors. This risk is likely to be especially great for fibre roll out, given the high degree of uncertainty about future demand and costs. Under many economic depreciation approaches both the forward looking allowable revenues and the (implied) opening valuation of assets in each price control period will differ from the closing value from the previous control, reflecting the new information available since the previous price control. This could result in significant holding gains and losses at the beginning of each price control period as new data and revised forecasts of future market developments are included in the valuation. These holding gains or losses could in turn lead to under- or over-recovery of investments.

The regulatory risk due to resetting the valuation at the beginning of each price control period could be significantly reduced by using a RAV approach. Rather than independently setting the opening valuation for each price control, the opening regulatory valuation for successive price control periods would be calculated by "rolling forwards" the previously determined opening valuation adding the capital expenditure incurred and subtracting the determined depreciation charges in the previous period. This would remove the risk of significant holding gains or losses.

Such an approach would require three elements to be determined by the regulator:

- The opening RAV when the price control was first introduced;
- The depreciation charges used to set the allowable revenues; and

- The level of capital expenditure to include when the RAV is rolled forwards to the next period.

As investment in Next Generation Access networks has been relatively recent and to date has been limited, setting the opening RAV may not be critical, as the valuation should be relatively close to the expenditure to date, less an allowance for the costs recovered to date.

Depreciation charges can be determined according to an economic depreciation calculation, similar to that used in MTR determinations in many jurisdictions. This would be a two stage process:

- Setting the profile of future allowable revenues for existing assets to reflect expected changes in asset prices and demand; and
- Scaling this profile so that the net present value of the future allowable revenues equals the current RAV for the asset.

Setting forward looking prices controls will require some forecasting of future capital expenditure. In some regulated industries, for example UK water, forecasts have been included as an input when setting the RAV in order to provide incentives for the regulated company to ensure capital expenditure is efficiently incurred. However given the uncertainties surrounding investments in NGA, any regulatory forecasts are likely to be subject to a high degree of uncertainty and the incentive effects of giving weight to such forecasts is likely to be small. Thus it is likely to be appropriate to include actually incurred capital expenditure in the RAV.

Including actual capital expenditure would provide both investor certainty and protect consumers from over-recovery. Using an economic depreciation approach would set prices at a level that reflected the need to increase penetration in the medium term.

## 3.4 Active assets

### 3.4.1 Nature of the assets

Active assets used for providing broadband and/or narrowband services over the fixed access networks typically have relatively short economic lives, driven by technological developments making existing assets obsolete. Equipment may be in service for say 10 years, but for some of the operational life, the equipment may be used to provide support for legacy services in parallel with the latest generation of equipment. Thus some allowance may need to be made for the fact the equipment is not fully utilised for the whole of its operational life. Technological development typically results in comparable equipment either falling in price in real terms over time, or increasing in capability (on a MEA basis resulting in falling unit costs).

## Recommendations

Compared to the passive elements of the access network, the number of active components is relatively small and the components are discrete, rather than continuous.

### 3.4.2 Regulatory objectives

Many active components may be considered to be replicable. For these components the regulator's objectives will need to balance allocative and productive efficiency with the benefits resulting from greater competition.

### 3.4.3 Recommendation

Given that assets are likely to be determined to be replicable a CCA based approach reflecting replacement costs is likely to be appropriate. The exact choice of methodology will need to take into account a number of factors including:

- Whether the network is in a "steady state" with an even mix of asset lives and steady demand or whether the allowable revenue profile needs to take account of rapidly changing utilisation; and
- The need to allow for the additional costs of dual running technologies.

## 3.5 Setting copper and fibre prices to account for externalities

If there are significant externalities associated with NGA roll out, then setting regulated prices on the basis of forward looking costs alone could lead to welfare enhancing investment not being undertaken. This is because investors would only take account of the potential increase in revenues due to the availability of fibre based services relative to the increase in cost of rolling out fibre. Thus there may be cases where the increase in revenues due to fibre is not sufficient, even where overall economic welfare would be enhanced by the investment being made. In these circumstances an efficient outcome may require the policymaker to provide a subsidy to the operator for rolling out fibre in these areas, which would reflect identified externalities. These subsidies could be funded from outside the industry, for example through general taxation, or within the industry if a direct subsidy from government was not available. Any subsidies would need to be directly linked to increased roll out, rather than simply increasing the revenues of fixed access operators.



## 4 Annexe 1: Objectives of access regulation

In order to develop a framework for evaluating the appropriateness of different costing approaches, it is necessary to consider the explicit objectives of access price regulation. Estimates of network costs are used as directly as an input for price controls in order to calculate allowable revenues and may form part of the inputs of reviews to ensure compliance with other *ex ante* obligations such as non-discrimination, cost-orientation and transparency. Estimates of network costs may also be required to demonstrate that prices of regulated wholesale services do not result in margin squeeze as well as to calculate the cost of universal service obligations.<sup>10</sup>

Under the European regulatory framework, the overall objectives of regulation are *inter alia* to encourage efficient investment and promote competition. Where competition is not effective, *ex ante* regulatory measures (remedies) should be aimed at addressing market failure where a firm is found to have significant market power (SMP).<sup>11</sup> These objectives are echoed in the EC's recommendation on cost accounting.<sup>12</sup> In the case of fixed access networks, the market failure is due to the high fixed cost of parts of the network restricting competition as it is neither economically feasible nor efficient for entrants to duplicate the required facilities to enter the market.

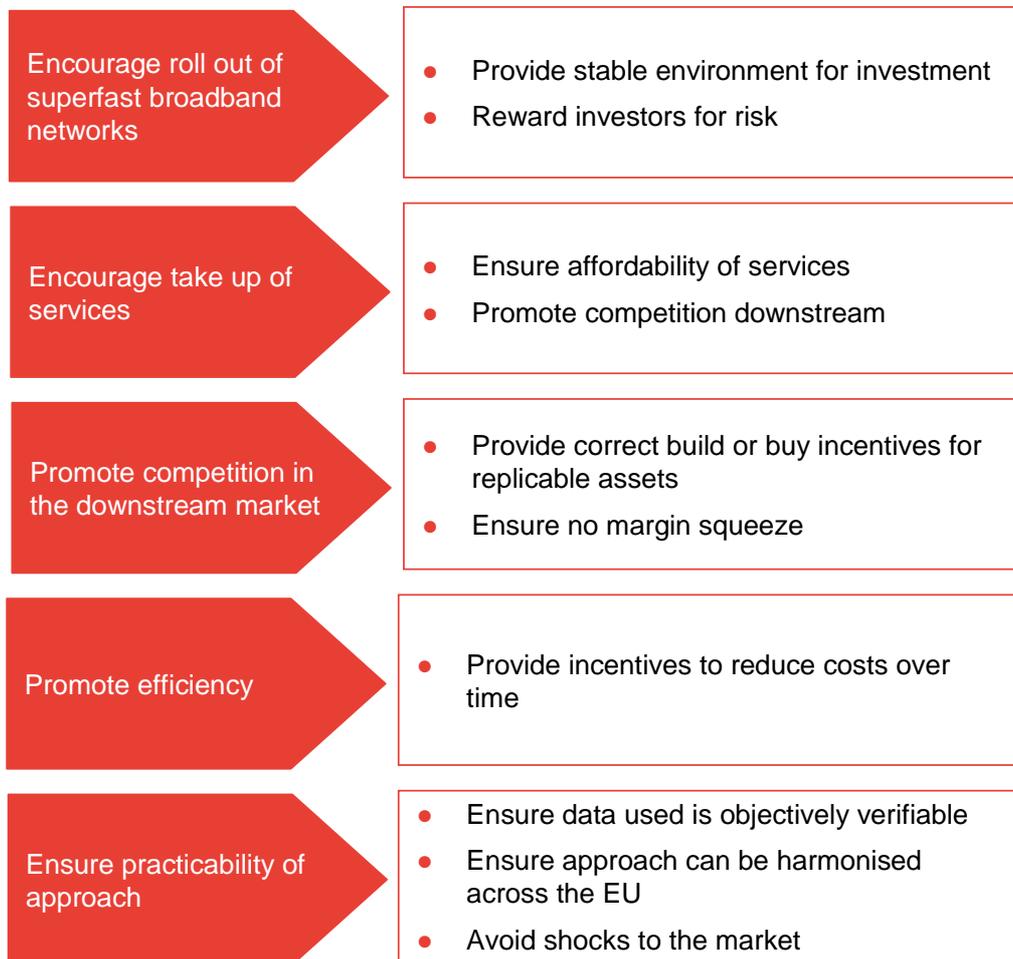
These regulatory objectives are ultimately aimed at promoting the interests of consumers and European citizens. The objectives of access regulation are summarised in the figure below and described in further detail in the rest of this section.

---

<sup>10</sup> *Ex ante* margin squeeze tests are explicitly identified by the EC as being important to ensure downstream competition.

<sup>11</sup> Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive)

<sup>12</sup> "Any mandated cost accounting or accounting separation methodology used in particular as a basis for price control decisions should be specified in a way that encourages efficient investment, identifies potential anticompetitive behaviour, notably margin squeezes, and should be in accordance with the national regulatory authority's policy objectives as set out in Article 8 of Directive 2002/21/EC." Source: EC 2005 Recommendation on cost accounting

**Figure 4.** Objectives of access regulation

Source: Frontier Economics

## 4.1 Ensuring efficient investment

The EC has set out ambitious targets for universal access to superfast broadband networks by 2020<sup>13</sup> requiring investment in both fixed and wireless<sup>14</sup> technologies. Cost based access prices can encourage efficient future investment both in access networks themselves and also in downstream markets. Providing a stable environment for investment

Regulatory uncertainty may deter investment with operators not exercising the option to invest until there is more clarity. In addition, regulatory regimes which lead to greater uncertainty in returns around a regulated rate will increase the risk associated with investment and therefore the cost of capital.<sup>15</sup> . This applies both to operators investing in access networks and to the operators that rely on access to provide downstream services. Therefore, provided that it does not disguise economic risks, regulation should seek to provide a stable and predictable environment for investment, reducing variability in returns.

Regulators can provide a stable environment for investment in three main ways:

- By providing clear signals early on of how access to new investments, such as NGA, will be regulated;
- By providing the expectation that efficient (i.e. after allowing for economic risk), future investment in the access network will make a reasonable return; and
- By adopting an approach that provides stability over time, minimising any variability in returns resulting from regulation.

These are described in further detail below.

### 4.1.1 Providing clear signals early on

In its NGA Recommendation<sup>16</sup>, the EC emphasises the need for a consistent regulatory approach over time in order to provide investors with confidence in the design of their business plans. Further, the EC recommends that regulators

---

<sup>13</sup> Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Agenda for Europe, 19 May 2010, COM (2010) 245

<sup>14</sup> This includes both terrestrial and satellite wireless technologies.

<sup>15</sup> Increased regulatory certainty can to a degree offset the additional risk associated with investing in NGA specific assets which should be duly taken account of in calculating costs. Such risk may include, for example, uncertainty over the future level of demand.

<sup>16</sup> Commission recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA), (2010/572/EU)

“should clarify to the greatest extent possible how foreseeable changes in market circumstances might affect remedies”. By providing clear signals early on, regulators can reduce the uncertainty at each future market review.

#### 4.1.2 Rewarding and incentivising investment

Regulated charges should provide incentives for further investment and compensate investors for investments already made. Recognising this, the EC recommends that “access prices reflect the costs effectively borne by the SMP operator, including due consideration of the level of investment risk”. This means that operators should be able to recover the costs efficient investments that it will incur and to earn a sufficient, but not excessive, return on capital employed to compensate it for the risk associated with investing in the access network.

If access prices are set so that an operator earns above the cost of capital, there may be inefficient investment for example through the inefficient duplication of networks as operators attempt to bypass existing infrastructure by building their own networks.<sup>17</sup> If access prices are set based on the regulated operator’s capital base, there may also be an incentive for it to maximise its capital base inefficiently.

The treatment of existing assets may have an effect on future willingness to invest. If access prices for sunk assets are set too low, and an operator is not able to recover efficient costs it has already incurred, it could mean that investors would be unwilling to make sunk investments in the future. However in some cases it may be reasonable to set the regulatory valuation below the carrying value of the assets to reflect the fact that assets have been stranded, for example due to technological developments. Such stranding is a common risk in both regulated and unregulated businesses. Therefore, the regulated cost of capital will implicitly take account of the risk of not being able to fully recover the initial acquisition cost of assets due to stranding.

#### 4.1.3 Providing stable outcomes over time

A regulatory approach which produces predictable and stable returns over time, can minimise the risks faced by investors in access networks. This can help reduce the returns they require and therefore increase the scope of efficient investment and reduce regulated prices. Such an approach can also help to provide operators that rely on regulated access to wholesale services with greater certainty and therefore reduce their costs. This can help to promote downstream competition.

---

<sup>17</sup> The extent to which this will be inefficient this will depend on whether assets are non-replicable (see Section 4.3).

Conversely a regulatory approach can increase investors' risk through inherent unpredictability (for example where prices not solely based on objective data) or if returns are correlated with external uncontrollable variables (such as commodity prices).

## 4.2 Encouraging take-up of services

The Europe 2020 Strategy<sup>18</sup> aims to have more than half of European households subscribing to internet connections above 100 Mbps by 2020. Lower retail prices and improved product offerings will play a key role in ensuring take-up of services and the availability of higher access speeds.<sup>19</sup> In the absence of regulation, operators with market power could set prices above an efficient level and thus reduce take up.

Allocative efficiency is maximised when the price to the end user reflects the forward looking marginal cost of serving that customer.<sup>20</sup> Setting prices at this level will often conflict with other regulatory objectives, such as ensuring investment as this does not allow the regulated operator to recover fixed and/or sunk costs from regulated services. Therefore, regulated prices may be set above marginal costs, for example, using long run incremental costs plus a mark up for common costs (LRIC+).

Rather than directly regulating retail prices where an operator has SMP, the EU regulatory framework focuses on setting wholesale access prices at a level as low as is consistent with providing the correct incentives for network investment and other regulatory objectives described in this section. This increases competition in downstream markets which drives retail prices down towards cost.

The high fixed cost of parts of the access network can represent a bottleneck if these cannot be efficiently replicated by competitors (these are non-replicable assets). This can be a source of market power for the incumbent operator. In such circumstances, the lack of competitive threat means that the access operator could seek to try to set retail prices above an efficient level and restrict or prevent access to the bottleneck, thereby restricting or excluding competitors in downstream markets. Therefore, the objectives of regulation can include setting wholesale access prices at an efficient level and creating "a genuine level playing field between the downstream arm of the SMP operator and alternative network

---

<sup>18</sup> "EUROPE 2020 - A strategy for smart, sustainable and inclusive growth - COM(2010) 2020." [http://ec.europa.eu/europe2020/index\\_en.htm](http://ec.europa.eu/europe2020/index_en.htm)

<sup>19</sup> While cost-based prices are generally considered to be the most efficient level, there may also be wider social objectives that justify the use of subsidised access for certain groups.

<sup>20</sup> In the presence of positive externalities, that is benefits that are enjoyed by people who do not directly consume or produce the service, there may be an argument for divergence away from cost based pricing.

operators<sup>21</sup> in order to promote competition in the downstream market. This requires non-discrimination, in both price and non-price terms, between the regulated operator's competitors and its own downstream activities.

Competition through regulated access to fixed networks, for example local loop unbundling, has proven to be a key enabler of take-up of broadband services provided over traditional networks. For example, in the UK, the effective implementation of local loop unbundling in mid-2005 with reduced access prices reflecting forward looking costs led to a sharp decline in retail broadband prices.<sup>22</sup> At the end of December 2009 85% of UK households were connected to an LLU-enabled local exchange (Figure 5.2), up from 67% three years previously.<sup>23</sup> **Figure 5** shows the total number of broadband lines in the UK from 2003 to 2010, as well as the number of DSL lines provided by the incumbent operator and alternative operators using full or shared ULL. It can be seen that the number of lines provided using LLU increased significantly after 2005.

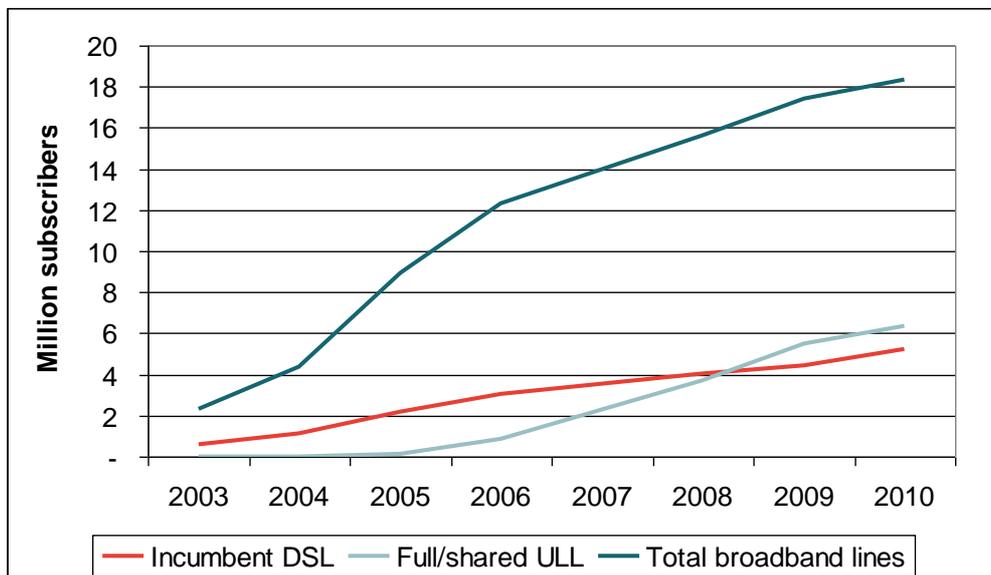
---

<sup>21</sup> Source: Annex 1 of EC recommendation on NGA regulation

<sup>22</sup> BT voluntarily reduced the annual rental charge for metallic path facility (MPF) from £105.09 to £80. Ofcom set a price cap on MPF at £81.69 in November 2005 based on forward looking costs (source: "Local loop unbundling: setting the fully unbundled rental charge ceiling and minor amendment to SMP conditions FA6 and FB6", 30 November 2005). To date, MPF rental charges have remained close to this level. The ceiling for the annual rental charge is now £91.50 (Source: "Charges for LLU and WLR services from 1 April 2011", Ofcom, 1 December 2010).

<sup>23</sup> <http://www.ofcom.org.uk/static/cmr-10/NI-5.2.html>

## Annexe 1: Objectives of access regulation

**Figure 5.** Broadband take up in the UK

Source: EC Implementation Reports

Further, competition has led to citizens across Europe gaining access to higher access speeds with average spending levels receiving 8 Mbps rather than 2 Mbps.<sup>24</sup>

### 4.3 Promoting competition

Where the regulator believes replication of the assets by competitors may enhance overall efficiency, and subject to other considerations and objectives, prices should be set in principle at a level which reflects the costs of efficient entrants – in other words, at the competitive level. This is so that access prices provide the correct “build or buy” incentives. In particular, prices should be set so that there is only duplication of infrastructure if an entrant is able to provide services over its own network at a lower cost than an efficient hypothetical operator. This means that regulation plays a role both in promoting competition in downstream markets as well as potentially in the provision of infrastructure.

While wholesale cost-based price regulation will seek to set prices at a level consistent with the regulated business making a reasonable return on capital expenditure (see Section 4.2), the costing of replicable assets also needs to take

<sup>24</sup> “Europe’s digital deficit: revitalising the market in electronic communications”, Analysys Mason, Final report for ECTA, 3 March 2010. Available online: [http://www.ectportal.com/en/upload/Press%20Releases/2010/Europes\\_Digital\\_Deficit.pdf](http://www.ectportal.com/en/upload/Press%20Releases/2010/Europes_Digital_Deficit.pdf)

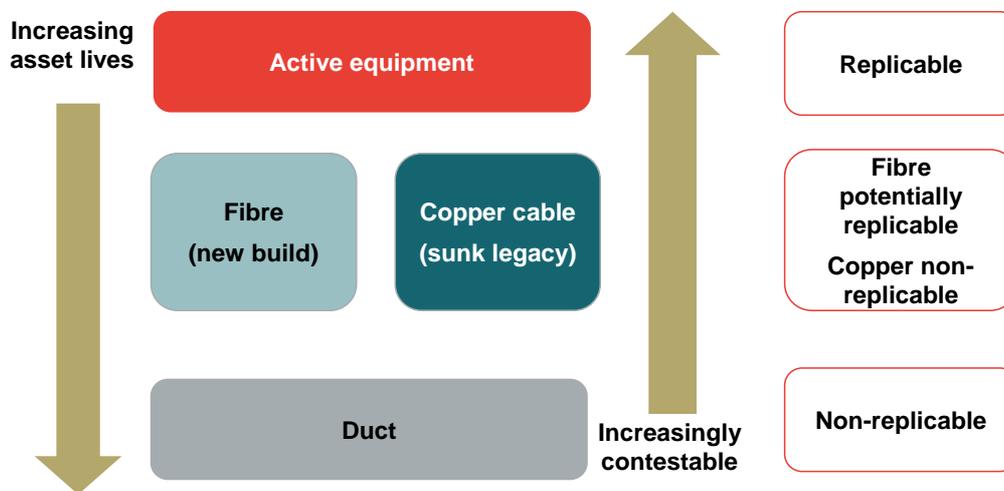
account of the impact on competitors or potential entrants in the provision of these assets and hence services. This additional constraint which applies to replicable assets, but which does not apply to the non-replicable bottleneck assets, may mean approaches to costing may also differ, as noted in the recommendation.<sup>25</sup> This may also mean that the returns of the regulated operator may vary to a greater degree around the cost of capital (for example, where the operator is not able to recover the cost of stranded assets as these do not represent the costs that would be incurred by a hypothetical efficient operator).

#### 4.3.1 Different approaches may be required for replicable and non-replicable assets

**Figure 6** provides an illustration of the main categories of assets in the access network and identifies replicable and non-replicable assets.

Active equipment (such as concentrators and DSLAMs), represents a relatively small proportion of access network costs and have relatively short useful lives. The development of LLU has implied that such assets are generally considered as being replicable by rivals.

**Figure 6.** Fixed access network assets with NGA



Source: Frontier

Whilst copper cable may be considered to be replicable in certain areas, it would no longer represent modern technology. In other words, if an operator was rolling out an access network today, it would most likely invest in fibre rather

<sup>25</sup> Annex 1, NGA Recommendation

than copper cable. Depending on the cost of fibre relative to its useful life, fibre could be considered to be replicable.

The high fixed costs of rolling out a duct network mean that any advantages brought by a duplication of the duct network would be more than outweighed by the additional fixed costs incurred. Thus, in general, regulators are likely to consider duct non-replicable.

For passive elements of legacy fixed access network (duct and copper cable) that can be treated as broadly homogeneous for the purposes of regulatory costing, and that are expected with a reasonable degree of certainty to be non-replicable, there would be a limited weight given to attempt to proxy competitive prices as an objective. There is therefore greater freedom to set valuation and allowable revenue calculation methodologies. In this case, in addition to the requirement for the regulated company to earn a reasonable return on the regulated assets, other objectives, such as providing regulatory certainty for investors or ensuring prices are stable over time, may also be taken into account.

## 4.4 Reducing costs and promoting efficiency

One of the goals of price regulation should be productive efficiency, in other words, minimising the resource inputs required to deliver a given level of demand. This can be seen from two perspectives:

- Ensuring that the regulated operator minimises the forward looking expenditures required to deliver a given level of demand; and
- Where there is a possibility of substitution between networks and/or operators, that services are delivered in a way that minimises the overall forward looking operational and capital expenditure required to deliver a given level of demand (in other words, regulation should seek to provide the correct “build or buy” incentives).

In both cases it is the forward looking costs that needs to be taken into account, with the past acquisition cost of sunk assets ignored, although the costs of operating these assets and any disposal value of the assets should be taken into account.

### 4.4.1 Efficiency within the regulated operator

Price controls can be designed to give the regulated business strong incentives to reduce operational expenditure over time. This can be done, for example, through multi-year RPI-X price controls where X represents expected efficiency improvements over time.

A well defined regulatory regime can help to provide incentives for efficient investment. In addition, the regulatory regime should also attempt to provide dis-incentives to inefficient investments when investment decisions are being

made by providing investors with clear signals that operators would not be able to recover from regulated charges the costs of investments that are determined to be inefficient. This could help to ensure that operators invest in future network infrastructure in the most efficient way feasible. Nevertheless, such approaches have limited direct impact on operators' existing asset base (in terms of the volume of assets) where assets are largely sunk and thus the any inefficiently incurred investments cannot be easily removed from the asset base.

Further, the approach to asset valuation used to determine regulated charges can exclude assets that are found to be inefficiently employed (see Section 5.6). This would provide incentives to minimise capital expenditure as any inefficiently incurred costs would not be recoverable from regulated charges.

#### 4.4.2 Overall productive efficiency

As noted in Section 4.2, although allocative efficiency is maximised by setting prices according to forward looking marginal costs, regulated prices may be set above this level to reflect other efficiency gains and policy objectives.

Where there is the possibility of substitution between networks and operators, setting prices above the level of marginal forward looking costs could lead to substitution even where the alternative network or operator faces higher costs. This could lead to the overall level of forward looking costs being higher than the minimum (efficient) level.

Setting regulated prices at the level of forward looking marginal costs (in other words, excluding sunk costs and fixed and common costs), would maximise overall productive efficiency as substitution would only occur if the forward looking marginal costs of the substitute network were lower.

### 4.5 Practicability and consistency with approaches to other assets

A regulatory approach that is simple and transparent can help to reduce the burden on both regulated operators and regulators. This can also help to provide stakeholders – including access seekers – with confidence in the regulatory process. This may be implemented in three main ways.

First, the approach used should be objectively verifiable. This relies on there being sufficient objective data to provide confidence in the accuracy of the calculation of costs used to set wholesale access prices. This may require data being collected from various sources (in other words, from the regulated operator and other stakeholders).

Second, the approach should be suitable to be applied in a harmonised manner across the EU. This would be consistent with the EC's objectives to avoid distortions of the single market and provide greater legal certainty for investors.

## Annexe 1: Objectives of access regulation

Nevertheless, there should be flexibility for regulators to take proper account of national circumstances.

Third, if the approach results in access prices that are very different to current access prices, there should be a mechanism to avoid shocks to the market. For example, the EC recommends that if changing the costing methodology leads to changes in regulated charges and/or price mechanisms, this could be spread over a reasonable period of time.<sup>26</sup> This would help to provide greater certainty to both the regulated operator and the operators that rely on it for access. In addition regulators should analyse the impact of any changes in methodology on the level of return.

---

<sup>26</sup> Source: EC 2005 recommendation on cost accounting

## 5 **Annexe 2: Asset costing approaches for price controls**

The EC has recommended that regulators should set regulated prices following an SMP determination based upon cost orientation<sup>27</sup>. The NGA recommendation recommends that regulators mandate access to passive and active access facilities, for both current and NGA networks, at cost-oriented rates. In Section 5.1, we examine the relationship between asset valuation and allowable revenues under price controls based on cost-orientation. In Section 5.2, we consider different approaches to asset valuation and determining allowable revenues under regulation. For each approach, we consider the main strengths and weaknesses.

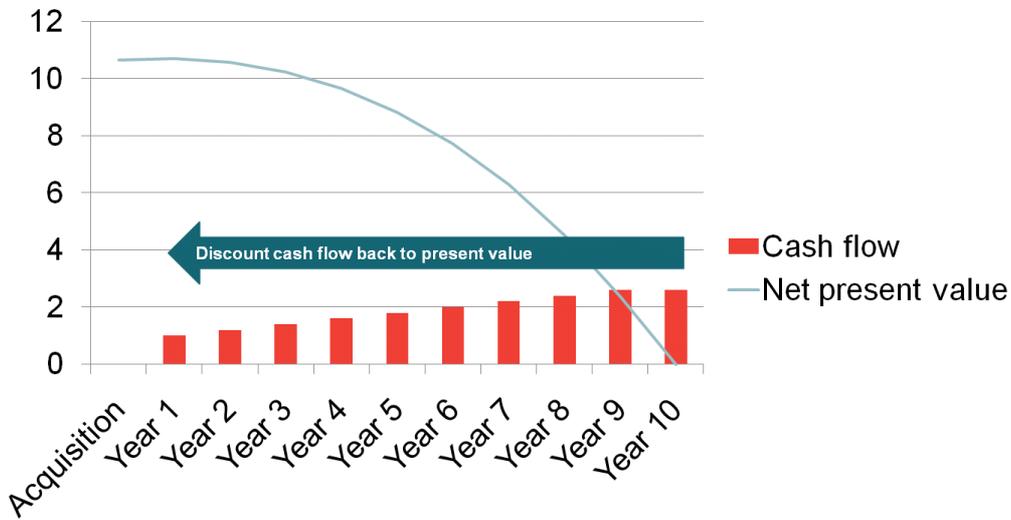
### 5.1 **Valuation and allowable revenues**

Under standard financial theory, the value of an asset to an investor is dependent on the future cash flows resulting from operating that asset over its lifetime, with future cash flows discounted to a present value based on an appropriate discount rate (deprival value). This is illustrated in the figure below.

---

<sup>27</sup> Commission Recommendation of 19 September 2005 on accounting separation and cost accounting systems under the regulatory framework for electronic communications (2005/698/EC).

**Figure 7.** Asset valuation based on deprival value



Source: Frontier Economics

If an asset is used to provide regulated services, an investor will only purchase that asset if it expects that allowable revenues under regulation will be at least as much as the cost of that asset. This means that for regulatory purposes, it is only necessary to determine either the asset valuation or the allowable revenues.

The relationship between valuation and allowable revenues is described in further detail below.

### 5.1.1 Relationship between valuation and allowable revenues

Assuming periodic cash flows and a constant discount rate, the value of an asset can be expressed as follows:

$$Asset\ value_t = \sum_{p=1}^{\infty} \frac{cash\ flow_{t+p}}{(1+WACC)^p}$$

This provides a simple relationship between the valuation of an asset in a given period ( $t$ ) and its value in the next period ( $t+1$ ).

$$\begin{aligned} Asset\ value_t &= \frac{cash\ flow_{t+1}}{(1+WACC)} + \sum_{p=2}^{\infty} \frac{cash\ flow_{t+p}}{(1+WACC)^p} \\ &= \frac{cash\ flow_{t+1}}{(1+WACC)} + \frac{1}{(1+WACC)} \cdot \sum_{p=1}^{\infty} \frac{cash\ flow_{(t+1)+p}}{(1+WACC)^p} \\ &= \frac{cash\ flow_{t+1} + asset\ value_{t+1}}{(1+WACC)} \end{aligned}$$

In a regulatory context, we can assume that operational expenditure is treated separately and as such the cash flow generated by the asset is the allowable revenues determined by the regulator. Rearranging then gives:

$$\begin{aligned} \text{Allowable revenues}_{t+1} \\ = WACC \cdot \text{asset value}_t + (\text{asset value}_t - \text{asset value}_{t+1}) \end{aligned}$$

The first component reflects the opportunity cost to investors for the capital employed for the assets. The second component is a compensation for the reduction in the value of the asset during the period. Based on this, the problem of determining the allowable revenues can be reduced to one of determining the opening asset and closing asset valuation and the WACC. Conversely, where future allowable revenues have been determined, we can calculate the asset value by discounting these to the present value.

### 5.1.2 Determining valuation

In the case of an asset used to provide regulated services, an investor will only purchase the asset if its expectation is that the value of the assets (in terms of allowable revenues) is at least equal to the acquisition cost of the asset. In addition, a regulator will wish to ensure prices are set at the minimum level that ensures investment. That is, the regulator will wish to ensure that the present value of future allowable revenue is no lower than the acquisition cost as shown in the equation below. This is also illustrated in **Figure 8** below.

$$\text{Acquisition cost} = \sum_{p=1}^{\infty} \frac{\text{allowable revenues}_{\text{acquisition date}+p}}{(1 + WACC)^p}$$

**Figure 8.** Asset valuation under regulation

Source: Frontier Economics

This constraint does not uniquely define the profile of allowable revenues over time since the profile of allowable revenues can be altered while maintaining this constraint. In theory, investors should be indifferent between different profiles of cost recovery over time. Thus, additional criteria must be employed to determine the appropriate approach to valuation and the calculation of allowable revenues.

These additional criteria may include:

- Ensuring that the valuation of the asset base is dependent only on those assets that are in service (in other words, that all operating assets have positive valuations and those assets not in service have zero valuation);
- Ensuring that the valuation of an asset is always above realisable value to ensure assets are not scrapped;
- Ensuring that the valuation of an asset reflects current replacement costs of the asset;
- Ensuring the methodology is predictable and objective; and
- Ensuring that the profile of allowable revenues reflects demand side criteria (for example keeping the profile of prices smooth).

The relative importance of these criteria may depend on the type of asset or the services it is used to provide. Since the regulated business should be indifferent to the approach used, different approaches could be used for different assets within the regulated business.

## 5.2 Approaches to asset valuation and determining allowable revenues

In this section we describe the main approaches to valuing assets and determining allowable revenues under ex ante regulation. These are summarised in **Table 3** and described in further detail in the rest of this section. We also examine the strengths and limitations of each approach and provide examples of where they have been implemented in Europe.

**Table 3.** Approaches to asset valuation and determining allowable revenues

Approach	Valuation	Determining allowable revenues
<b>Historic cost accounting</b>	Valuation based on acquisition costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line) and the cost of capital  Constant depreciation charge and falling cost of capital leads to “front loading” of cost recovery
<b>Current cost accounting (replacement costs)</b>	Valuation based on replacement costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line calculated as a percentage of the changing asset price), holding gain (loss) to reflect changing asset prices and the cost of capital  Shifts cost recovery forwards (if asset prices are falling) or back (if asset prices are rising) compared to HCA
<b>Annuities</b>	Not required to estimate allowable revenues  For an individual asset, derived using discounted future allowable revenues	Allowable revenues are constant over time in nominal or real terms
<b>Economic depreciation</b>	As for annuities	Allowable revenues may take account of the volume of output of assets in addition to changes in asset prices
<b>Renewals accounting (regulatory asset base)</b>	Changes in value reflect capital expenditure and capital charges. Initial valuation may be exogenously determined.	Cost of capital plus the capital expenditure required to maintain the asset base

Source: Frontier Economics

### 5.2.1 Historic cost accounting (acquisition costs)

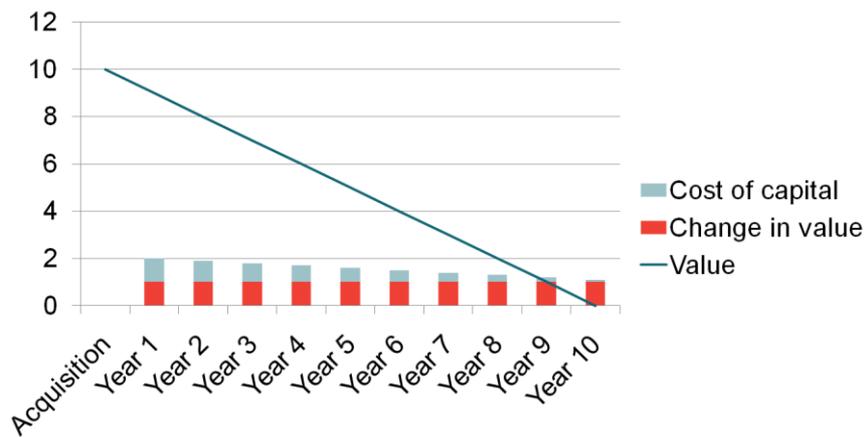
#### *Valuation approach*

Under historic cost accounting (HCA), the value of an asset at any point in time depends on the cost of acquiring that asset. In a regulatory context, the most commonly used depreciation method is straight line depreciation. Under this method, the asset value is assumed to decline in a straight line from the moment the asset is brought into service to the assumed disposal value at the end of its defined asset life<sup>28</sup>.

### Allowable revenues

Under straight line depreciation, the change in valuation (depreciation) is constant over the defined asset life. However, as the valuation of the asset is declining linearly over time, the component in allowable revenues related to the opportunity cost of financing the capital employed also falls linearly over time.<sup>29</sup> This leads to a “front loading” of cost recovery.

**Figure 9.** Allowable revenues under HCA



Source: Frontier Economics

### Strengths and weaknesses

The advantage of HCA approaches is that once the asset life and form of depreciation is determined, the asset valuation and allowable revenues can be precisely calculated. For this reason, HCA approaches are favoured for applications such as statutory reporting and calculating tax liabilities.

The main disadvantage of this approach is that no account is taken either of general inflation (purchasing power) or of changes in the unit cost of assets resulting from technological change. In addition, under straight line depreciation

<sup>28</sup> This should ensure Financial Capital Maintenance (FCM)

<sup>29</sup> Assuming a constant WACC.

the allowable revenues decline over time. This may not reflect demand side factors or the utilisation of assets. This may mean that, where demand is increasing over time, regulated unit prices start relatively high and fall over time.

In addition, if the asset life assumption differs from the actual asset life then and the assumed asset life is too short, there may be fully depreciated assets still in use. If assumed the asset life is too long, the assets will have non-zero valuation at time of retirement, requiring the inclusion of a write down charge in allowable revenues<sup>30</sup>

## 5.2.2 Current cost accounting (replacement costs)

### *Valuation approach*

Under current cost accounting (CCA) approaches used in a regulatory context, the value of an asset at any point in time depends on the cost of replacing that asset<sup>31</sup>. The EC notes that a key element of CCA approaches is the “evaluation of network assets at forward-looking or current value of an efficient operator, that is, estimating the costs faced by equivalent operators if the market were vigorously competitive.”<sup>32</sup>

Replacement costs can be calculated either directly by estimating the costs of a similar asset or by applying an estimate of the price change since acquisition to the acquisition cost.<sup>33</sup>

Typically straight line depreciation is used. However, in this case, the valuation falls linearly as a percentage of the (changing) replacement cost over the assumed asset lifetime.

### *Allowable revenues*

The change in the valuation in a given period is the combination of two factors:

1. The reduction in valuation (depreciation); and
2. Any changes driven by changes in the replacement cost (holding gains resulting from increasing asset prices or holding losses resulting from falling asset prices).

---

<sup>30</sup> The write-down charge is required to ensure FCM.

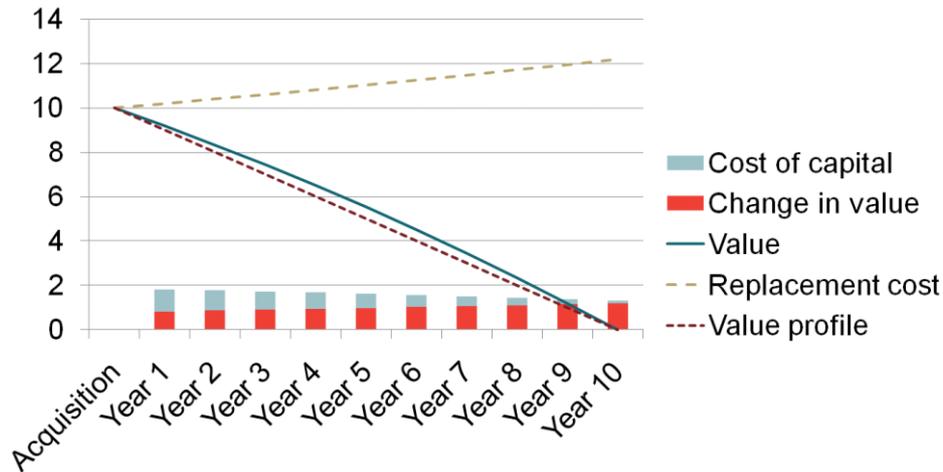
<sup>31</sup> In other contexts, such as statutory accounting in jurisdictions with hyper-inflation, current costs approaches may be based on indexing asset values to take account of general inflation.

<sup>32</sup> EC 2005 recommendation on cost accounting

<sup>33</sup> Direct valuation or indexation (applying a price trend to the acquisition cost) can be used where the asset in service is still the appropriate replacement. A modern equivalent asset (MEA) approach should be used where the asset would be replaced by another asset which can deliver similar functionality.

These two elements are generally identified separately in CCA estimates. If real asset prices are falling over time, allowable revenues are greater leading to the front loading of cost recovery on a discounted basis.

**Figure 10.** Allowable revenues under CCA with increasing replacement cost



Source: Frontier Economics

### Strengths and weaknesses

The key advantage of CCA approaches over HCA is that the allowable revenues in a given time period reflect replacement costs in that period rather than acquisition costs. As this reflects the costs that would be incurred by operators if there were effective competition, this can help to provide the correct “build or buy” signals for replicable assets. In particular, in a given time period, there will only be competition in the provision of infrastructure if the entrant is able to do so efficiently. Where duplication of infrastructure is not possible, entrants can compete in the downstream market by relying on the infrastructure of the incumbent.

A key disadvantage of CCA approaches, particularly for very assets with long lives, is that the estimation of replacement costs can be subject to a large degree of uncertainty, which introduces a degree of subjectivity. At best, this means that allowable revenues under CCA may not exactly reflect replacement costs, but are predictable. At worst, the level of allowable revenues can vary depending on subjective judgements on methodology rather than actual price movements<sup>34</sup>.

Even where CCA estimates do closely reflect replacement costs, unpredictable price movements, for example changes in copper cable prices driven by copper

<sup>34</sup> [Reference to BT’s 2010 duct valuation change]

metal price movements, can lead to significant changes in the level of allowable revenues due to large holding gains and losses. This can lead to a range of unwanted side effects including volatility in end user pricing if these price movements are passed on to end users; volatility in margins if wholesale prices vary but retail prices do not reflect this; or pricing above or below allowable revenues if wholesale prices do not reflect this.

Finally if asset values are changed from an HCA basis to a CCA basis for long lived assets, this can result in significant holding gains and losses, which in theory should be reflected in allowable revenues. For example, in the UK, Ofcom changed its approach to valuing BT's copper access network in 2005. This is because when Oftel (Ofcom's predecessor) moved from CCA from HCA for pricing LLU products in 1997, this led to a change in the path of cost recovery for assets purchased before the price control period.<sup>35</sup> This meant that BT would have over-recovered the cost of pre-1997 copper access networks. Therefore, Ofcom created a regulatory asset value based on HCA (see Section \*\*\*\*).

Recognising these issues with respect to long lived access assets, the Commission recommended "that national regulatory authorities have due regard to price and competition issues that might be raised when implementing CCA, such as in the case of local loop unbundling."<sup>36</sup>

### 5.2.3 Annuities

#### *Allowable revenues*

As described in Section 5.2.1, straight line depreciation tends to front load cost recovery by setting allowable revenues that decline over time<sup>37</sup>. This means that identical assets purchased at different times will result in different allowable revenues, even if used to deliver identical services.

The HCA and CCA approaches described above attempt to set the profile of valuation over the asset life to determine the allowable revenues. In contrast, an annuity approach sets directly the profile of allowable revenues to be either constant over time (standard annuity), or to vary at a constant rate (tilted annuity).

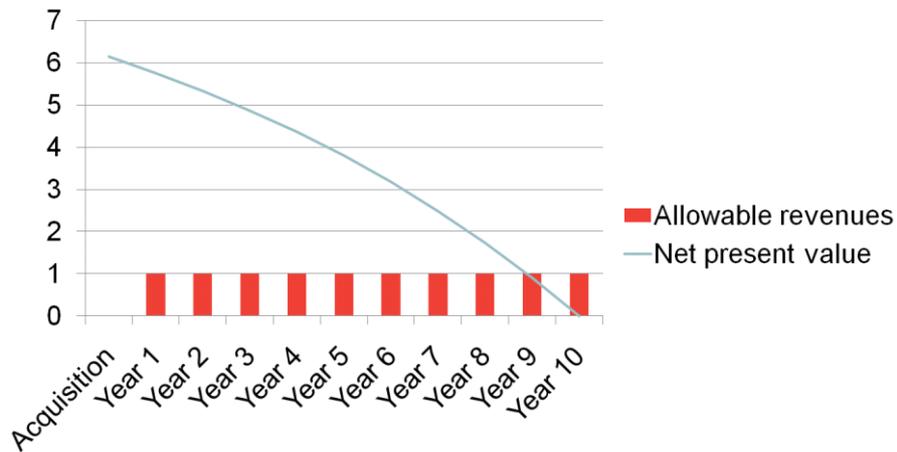
Under a standard annuity approach, the NPV in any given period is always higher than the NPV under straight line HCA.

---

<sup>35</sup> See "Valuing BT's copper access network", Ofcom final statement, 18 August 2005, available online: <http://stakeholders.ofcom.org.uk/consultations/copper/value2/statement/>

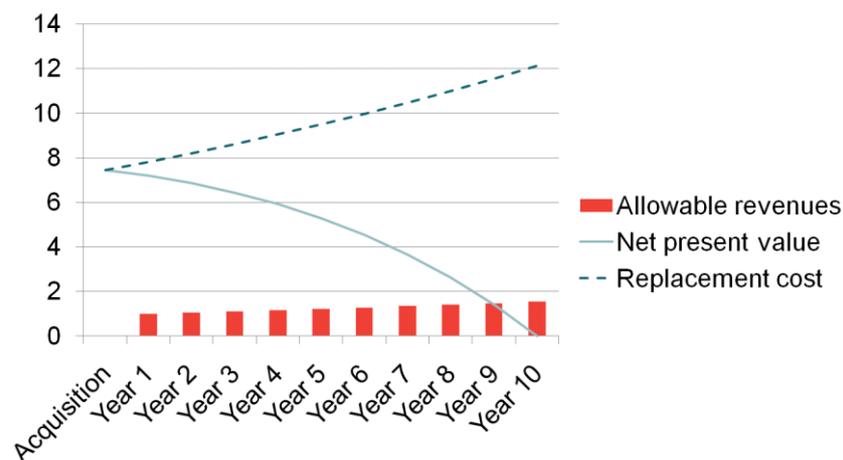
<sup>36</sup> EC 2005 recommendation on cost accounting

<sup>37</sup> Where replacement costs are increasing, allowable revenues may initially increase before falling towards the end of an asset's assumed life.

**Figure 11.** Allowable revenues under standard annuity

Source: Frontier Economics

A tilted annuity approach sets the rate of change in allowable revenues so that it reflects the rate of change in the replacement costs of assets. Such an approach has two key strengths. First, allowable revenues reflect replacement costs rather than acquisition costs. This means that it implements a form of CCA. Second, the allowable revenues for similar assets are independent of the date of purchase of the assets.

**Figure 12.** Allowable revenues under tilted annuity

Source: Frontier Economics

### Valuation

As annuity formulae calculate allowable revenues directly rather than first calculating valuations, it is not necessary to estimate valuations. However for an individual asset, the valuation can be derived by discounting future allowable revenues.

The resulting valuation is higher than the corresponding straight line depreciation because the allowable revenues are higher towards the end of the asset life, compared to the front loaded straight line estimates.

### Strengths and weaknesses

Standard and tilted annuities, while correcting for the front loading of straight line depreciation, will have similar strengths and weaknesses to any HCA or CCA approaches respectively.

One additional advantage of the tilted annuity approach over CCA is that detailed information on when assets were purchased is not required as allowable revenues are not dependent on the asset age. This means that in practical terms, tilted annuities are often used in bottom-up cost modelling since total allowable revenues can be calculated based solely on the volume of assets in service without the need to model past network roll out.

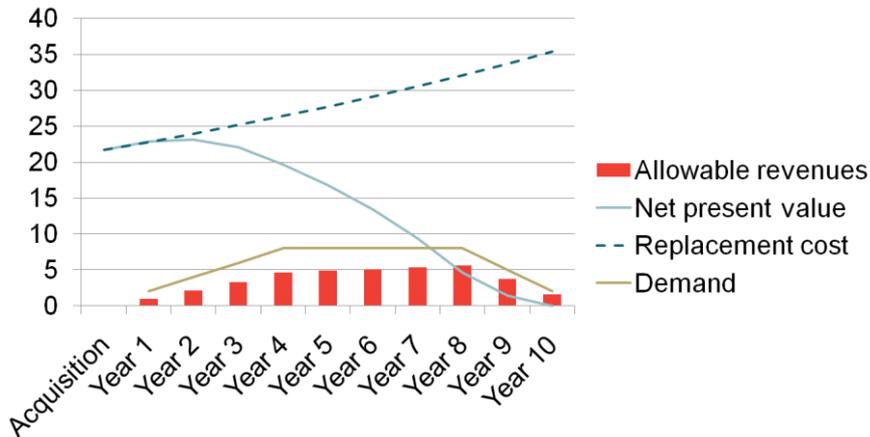
### 5.2.4 Economic depreciation

#### Allowable revenues

Annuities, which focus on determining the profile of allowable revenues with valuation being dependent on this profile, can be considered a form of economic depreciation.

More complex forms of economic depreciation attempt to set the profile of allowable revenues to take into account both changes in replacement costs and the volume of output of individual assets. Such approaches have been implemented in a regulatory context where supply and demand are evolving rapidly. The figure below illustrates allowable revenues over time taking account of increasing asset replacement costs, and changing demand.

**Figure 13.** Allowable revenues under economic depreciation



Source: Frontier Economics

#### Valuation

As with annuity approaches, valuation is not an explicit output but the implied valuation under economic depreciation can be estimated by discounting determined future allowable revenues.

#### Strengths and weaknesses

While there are some theoretical advantages to complex economic depreciation calculations, implementation is typically complex, requiring models of assets deployed and demand over the whole network lifecycle. Given the high degree of uncertainty relating to the level of demand, future price changes and technological evolution, the resulting allowable revenue estimates will be subject

## Annexe 2: Asset costing approaches for price controls

to a high degree of uncertainty. This means that current regulated prices are dependent on subjective assumptions about future demand.

## Economic depreciation: UK mobile termination

In the UK, mobile termination rates are calculated using a hybrid LRIC model which reconciles bottom-up and top-down approaches.

The cost of mobile termination services is calculated using economic depreciation. Economic depreciation is used in order to derive a path of cost recovery over the lifetime of the network based on reconciled estimates for the past and forecasts for the future taking into account changes in demand over time, changes in the costs of equipment and operations and the network required by technology. This allows a smooth profile of unit allowable revenues over time, despite rapid changes in demand, with the profile reflect both demand and supply side factors.

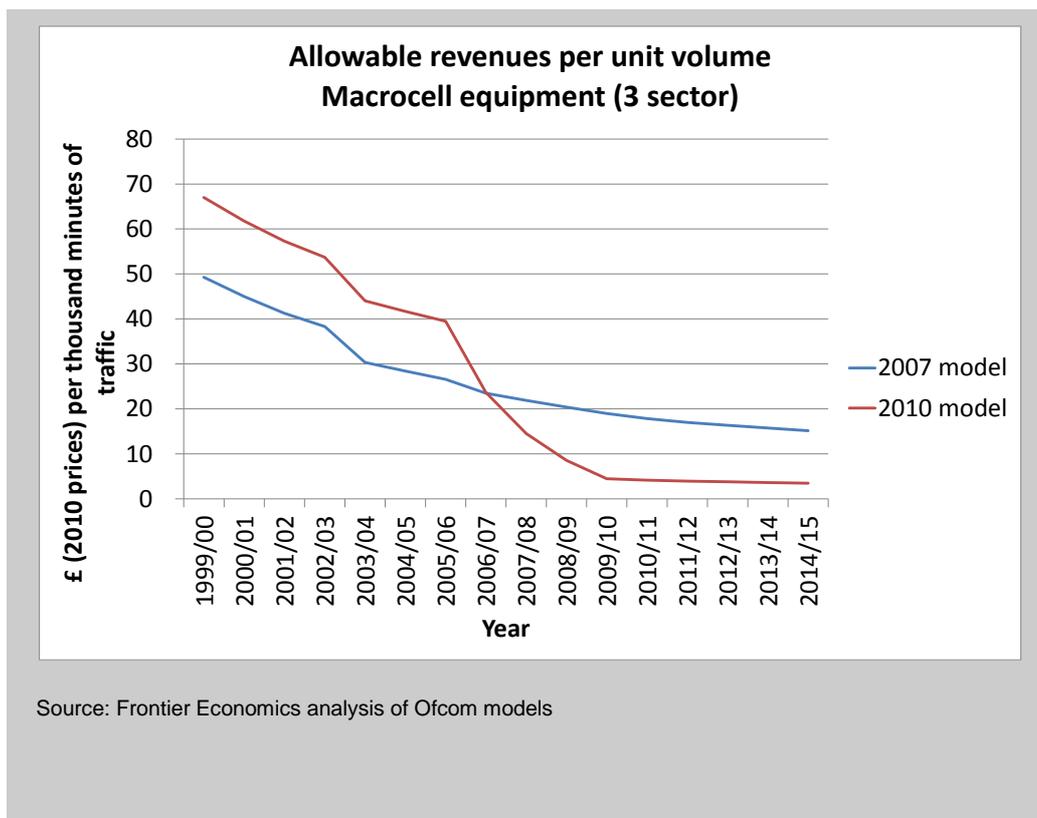
One disadvantage of this approach is that the current level of charges is dependent on forecasts of variables such as demand, equipment costs and technology transitions which are unavoidably judgemental and hence subjectivity.

Another major weakness is that at each and every point in time the resulting allowable revenues are dependent on the assumptions over the whole network lifecycle. As a result as new information becomes available and forecasts are revisited, not only do forward looking allowable revenues change but also the historical time series of allowable revenues and by implication the regulatory valuation of the existing assets. For example between the 2007 and 2010 versions of the model, Ofcom incorporated new information on equipment prices and revised estimated of future demand which significantly lowered the forward looking allowable revenues from 2010. The implied valuation of existing assets at 2010, based on the forward looking cash flows generated were consequently imposing a holding loss on the operators<sup>38</sup>.

In theory the revised profile of allowable revenues is consistent with financial capital maintenance as under the revised depreciation profile, allowable revenues should have been higher in the years prior to 2007. In practice it is impossible to adjust regulated prices retrospectively to take account of the new information and hence there is under-recovery of costs.

The uncertainty and subjectivity of such approaches will increase the perceived risk of investments and hence the returns required by investors.

**Figure 14.** Comparison of economic depreciation results from Ofcom MTR models



### 5.3.1 Regulatory asset value and renewals accounting

#### *Valuation*

The approaches above attempt to determine valuations and allowable revenues for individual assets from the date they are brought into service for an assumed asset lifetime, at the end of which the asset value is set to zero.

However, in the case of infrastructure assets with long operational lives, it may not be possible to estimate a single typical asset life. This is because of wide variations in the time between installations. In addition, when assets are not discrete but part of an overall system (for example, a network of pipes or ducts), replacement of the system may be continuous over time. In these cases, a renewals accounting approach can be adopted. This treats the whole system as a single asset.<sup>39</sup>

Under renewals accounting, the reduction in valuation of the assets related to depreciation is an estimate of the required rate of expenditure to maintain the operating capacity of the system<sup>40</sup>. This reduction in value is offset by the capital

<sup>39</sup> Implicit in this is an indefinite asset lifetime for this single asset.

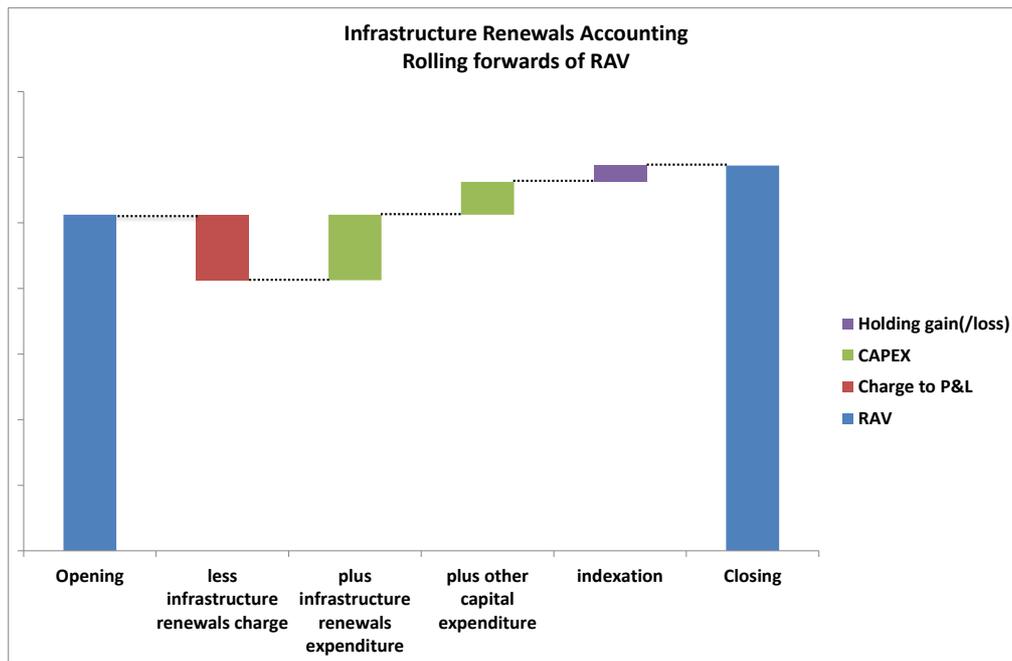
<sup>40</sup> So called operational capital maintenance (OCM). This should be an average value which could differ from the actual expenditure in any given year due to some expenditure taking place in large

expenditure on the network. The capital expenditure required to maintain the network should on average be equal to the infrastructure renewals charge, and vice-versa. There may also be additional capital expenditure to extend the capability or size of the system which, if efficiently incurred, should also be added to the asset base. In a steady state, with no extensions to the network, the RAV will remain broadly constant over time, as the depreciation charge and capital expenditure are balanced. Regulators may choose to apply indexation so that allowable revenues reflect changes in purchasing power.

Under this approach, the valuation at the end of the period is estimated by “rolling forwards” the valuation at the beginning of the period:

$$\begin{aligned} \text{Valuation}_{\text{closing}} &= \text{Valuation}_{\text{opening}} - \text{depreciation} + \text{revaluation} \\ &+ \text{CAPEX} \end{aligned}$$

**Figure 15.** RAV under renewals accounting



Source: Frontier Economics

increments at infrequent intervals (“lumpy” expenditure) or variations in expenditure for example due to variations in weather conditions.

## Annexe 2: Asset costing approaches for price controls

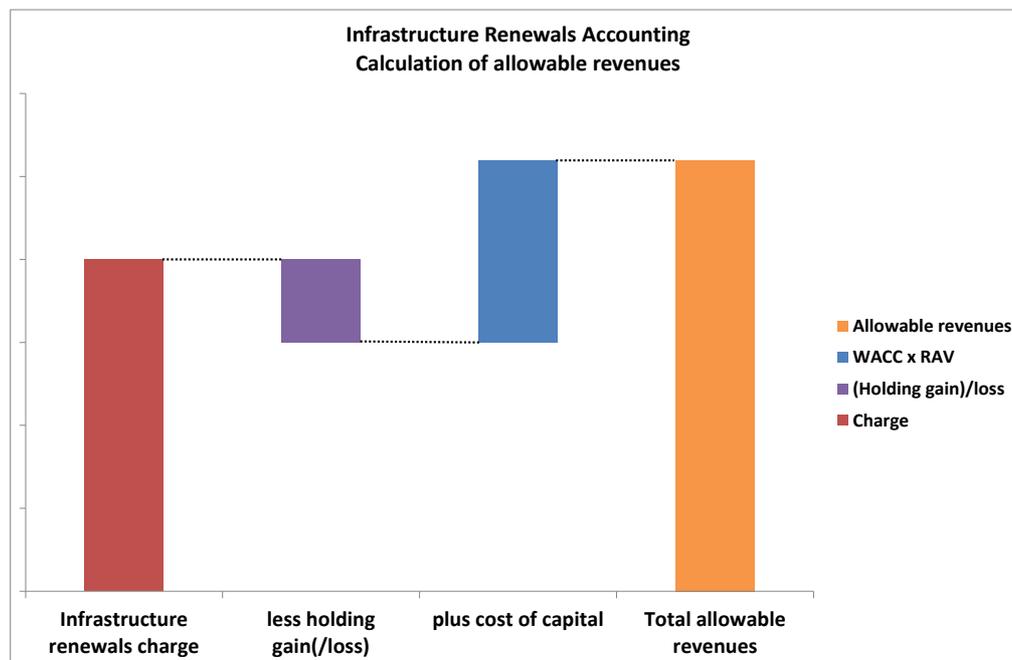
If renewals accounting is implemented from the start of the roll out of the infrastructure, then the initial valuation is zero. However, renewals accounting is typically applied when the system is already in service. Therefore, the valuation of the business must be exogenously determined, for example by determining a regulatory asset base based on the investors' valuation at privatisation or the book value of assets in the accounts.

### *Allowable revenues*

The allowable revenues are determined as the sum of the cost of capital multiplied by the WACC plus the change in valuation of the existing asset base (i.e. excluding capital expenditure):

$$\text{Allowable revenues} = \text{WACC} \cdot \text{Valuation} + \text{depreciation} - \text{revaluation}$$

**Figure 16.** Allowable revenues under renewals accounting



Source: Frontier Economics

### *Strengths and weaknesses*

A renewals accounting approach, and indeed any approach in which the regulatory asset base is rolled forwards from the existing valuation, provides a high degree of certainty for investors. While the decision on the appropriate level of depreciation may be subject to some uncertainty, investors should be indifferent to the actual level of depreciation, as the return on the existing asset base and any efficient capital expenditure is assured. This approach is also likely

to lead to smooth pricing evolution for customers and has limited data requirements. Where the RAV is linked to changes in asset prices through indexation, this approach may provide a reasonable proxy for competitive prices where demand is stable.

Disadvantages of the approach are the need to determine an opening asset base for existing systems when renewals accounting or a RAV is introduced. In addition, the lack of a one-to-one link between the valuation and individual assets can raise difficulties, for example, when disaggregated valuations are required for the purposes of cost allocation. Further, the efficient level of capital expenditure on maintenance must be estimated. However, incentive regulation, such as multi-year price controls, can be used to encourage efficient forward expenditure.

## Renewals accounting: UK water industry

The approach of ‘rolling forwards’ a regulatory asset value is used in a number of regulated industries in the UK, including the water industry.

Ofwat sets the price control based on a financial forecasts (‘business plans’) for each regulated company required to meet a set of output requirements. Each companies ‘revenue requirement’ based on the output requirement is then calculated as the sum of: operating expenditure; capital charges; a return on capital and; taxation<sup>41</sup>.

The capital charges are calculated using two different methodologies:

- a current cost depreciation charge (CCD) for above-ground assets such as treatment works; and
- an infrastructure renewals charge (IRC) for underground assets, such as pipes, which form part of either the water or sewerage networks.

The IRC is estimated as the annualised costs of maintain the system at its current level of operations based on a medium term view (15 years in recent price controls) of average annual capital expenditure requirements.

The return on capital is calculated by applying a cost of capital to the average regulatory capital value (RCV) during the year. The closing RCV at the end of each period is calculated by ‘rolling forwards’ the opening RCV by adding forecast capital expenditure and subtracting the capital charges included in the calculation of the revenue requirement plus a range of other adjustments<sup>42</sup>.

The RCV was initial set with reference to the price paid by investors for the companies at privatization.

### 5.4.1 Changes to the regulatory valuation of existing assets

The relationships outlined above between acquisition cost, valuations and allowable revenues provide the correct incentives to make investments if they are applied consistently over the lifetime of each asset.

Over the lifetime of an asset, the regulatory environment may change. For example, regulators may choose to re-evaluate the methodology used to value assets. Similarly, where valuations rely on parameters such as the replacement

---

<sup>41</sup> As the financial forecast covers the whole business, financial forecasts can include a forecast of the tax paid by the business. This contrasts with the price regulation of telecommunications operators, where only a small proportion of the business is regulated and thus taxation is not separately identified but included within the cost of capital.

<sup>42</sup> These other adjustments primarily related to ‘grants and contributions’ and incentive mechanisms designed to promote efficiency in capital expenditure.

cost of assets or assumptions about the useful economic life of assets, new information may come to light which leads to a re-estimation of these parameters. If existing assets are simply re-valued based on new information or methodologies without taking account of the allowable revenues to date, this will lead to holding gains or losses not included in allowable revenues. This will lead to investors being under- or over-compensated.

Where CCA asset valuations are used to set forward looking price controls, it may be the norm that some holding gains and losses are not reflected in allowable revenues. In this case, differences between forecast and out-turn asset price movements will result in divergences between forecast allowable revenues and the actual change in valuations. However, as long as these differences are *ex ante* expected to be symmetric, investors should have the expectation that the present value of future allowable revenues will equal the acquisition cost, even if the out turn returns will vary. However, this variation between the regulated cost of capital and actual returns will increase the cost of capital; compared to systems where returns are not subject to forecasting errors.

In the case of extraordinary changes in valuation (for example, due to changes in the valuation methodology),<sup>43</sup> regulators must judge whether overall efficiency will be enhanced by avoiding discontinuities in asset valuation or by incorporating new information directly in the calculation of allowable revenues.

Where regulators choose to avoid introducing discontinuities in valuation, there are a number of potential approaches that can be taken including:

- For reasons of consistency continue valuing the existing assets using the previous approach, but introduce the new methodology/information for assets acquired from this date;
- Maintain the asset valuation based on allowable revenues to date, but adjust the profile of forward looking allowable revenues to reflect the new information (for example, by simply applying a factor to the future allowable revenues calculated using the new methodology/information); or
- Setting a “glide path” from the old to new valuations with the allowable revenues calculated based on this glide path.

---

<sup>43</sup> The change in valuation methodology may result from a changed regulatory or market environment or from methodological improvements, for example.

## Adjusting for discontinuities in valuation: UK fixed access

Up to 1997, BT's regulated prices were set according to HCA valuations and depreciation charges. From 1997, both retail and wholesale regulated prices were set reflecting CCA valuations and depreciation charges.

At the time of the move to CCA, considered the holding gains (principally in the access network) and losses (principally in the core network) due to the change in methodology. Oftel decided not to make any changes to regulated prices to account for these holding gains and losses.

When Ofcom (the successor to Oftel) revisited the valuation of BT's copper access network in 2005, Ofcom reconsidered the CCA approach. In order to minimise the over-recovery of costs due to the holding gain for the assets that were in service at the time of the change in methodology, Ofcom decided to create a RAV for duct and cable to set the price controls for LLU and WLR services. This RAV differed from the CCA valuation and depreciation charges published in BT's Regulatory Financial Statement. The opening RAV of those assets purchased prior to the 1997 change was based on the HCA valuation of those assets while assets purchased after the change continued to be valued on a CCA basis.

## 5.6 Determining the efficient asset base

Under each of the approaches to asset valuation and determining allowable revenues described in Section 5.2, a regulator may wish to determine the underlying asset base so that the regulated operator is only recover efficiently incurred costs from regulated charges in order to dis-incentivise inefficient investment. This estimation may be done using:

- A top-down approach, where the operators report asset base is adjusted retrospectively for identified inefficiencies;
- A bottom-up approach where an independent assessment of the efficient level of assets is made based on an engineering model; or
- An *ex ante* determination of the efficient level of capital expenditure required.

For practical implementation reasons, there is an inter-dependency between the approach used to estimate the efficient asset base and the approach used to estimate allowable revenues. These approaches are summarised in **Table 4** below and described in further detail in the rest of this section. For example, economic depreciation approaches which are dependent on estimates of future utilisation of equipment generally require a bottom up engineering model.

**Table 4.** Approaches to estimating efficient asset base

Approach	Valuation/ allowable revenues approach typically used
<b>Top down</b>	Typically based on straight line depreciation (HCA or CCA) in order to allow reconciliation with statutory accounts.
<b>Bottom-up</b>	Tilted annuities typically used where model does not include the whole network lifecycle and hence information on asset purchase data is not estimated.  Bottom up approaches covering the whole network lifecycle generally used for implementation demand dependent of economic depreciation.
<b>Ex ante determination of capital expenditure</b>	Valuation approaches based on rolling forwards existing asset valuations, such as IRA

Source: Frontier Economics

### 5.6.1 Top down approaches

Under a top-down approach, the regulator takes the asset base reported by an operator to provide regulated services and then revises it using estimates of the efficiency of the operator. These estimates may be based on benchmarking studies (ranging from simple unit cost comparisons to econometric studies) or on analysis of the operations of the operator itself. The main advantage of this approach is that it is relatively easy to implement and, when used with HCA, allows a direct reconciliation with data used in statutory accounts. However, the limitations of this approach include difficulties in finding appropriate benchmark operators and in defining a methodology that provides objective results.

Applying CCA based on a direct approach, i.e. revaluation based on price quotes for replacement equipment, may inherently adjust for any inefficiencies which result in the unit acquisition cost being above an efficient level. However, such an approach will not adjust for inefficiencies arising from unnecessary assets being purchased.

### 5.6.2 Bottom up approaches

Under a bottom-up approach, rather than taking information on the asset base from the regulated operator, cost models are based on a hypothetical efficient

## Annexe 2: Asset costing approaches for price controls

operator. The level of demand is taken as given and engineering assumptions are used to estimate the number and type of assets required. These are combined with estimates of the acquisition cost of these assets and asset lifetimes to estimate allowable revenues.

The main advantage of this approach is that it provides a direct estimate of the efficient asset base rather than attempting to adjust the regulated operator's asset based for inefficiencies. However, this approach relies on a number of assumptions including the relationship between demand and network dimensioning and the appropriate technology choice. Models are necessarily reductionist, simplifying complex investment decisions made over time to a series of rules which approximate these decisions. This means that the model may not provide an accurate reflection of the operating conditions faced by operators and may inaccurately estimate the level of efficient costs. Bottom-up models risk being biased downwards.

A hybrid approach reconciles costs estimates derived using a top-down approach with those derived using a bottom-up approach. This approach attempts to minimise the disadvantages associated with each of the approaches. However, where there are differences between top down and bottom up approaches, it may be difficult to determine whether these are due to inefficiencies inflating the top down estimates or inaccuracies in the bottom up estimates.<sup>44</sup>

### 5.6.3 Determination of efficient capital expenditure

Under approaches based on rolling forwards a RAV, it may be impossible to compare the valuation directly to any external benchmark. Instead, regulators will wish to ensure that any additions to the RAV reflect efficient expenditure and where necessary exclude inefficient expenditure.

If the efficient level of investment is forecast within the framework of a multi-year price control and this is used to update the RAV during the price control, this provides incentives for the regulated operator to minimise capital expenditure as this would lead to a higher than forecast rate of return on a smaller than forecast asset base.

At the end of the price control period, the regulator can then compare the regulated company's the out turn capital expenditure with the regulator's forecast in order to improve the forecast for the next price control period. The degree to which the RCV should reflect actual expenditure rather than forecast expenditure will depend on the incentive structure for the regulated company, with an

---

<sup>44</sup> This assumes the bottom up estimates are lower than the top down estimates. Conversely, if top down estimates are lower it is likely that any discrepancy will relate to inaccuracies in the bottom up model as generally actual costs will not be below an efficient level.

approach giving greater weight to forecast expenditure potentially providing stronger incentives to minimise actual expenditure.

Frontier Economics Limited in Europe is a member of the Frontier Economics network, which consists of separate companies based in Europe (Brussels, Cologne, London & Madrid) and Australia (Brisbane, Melbourne & Sydney). The companies are independently owned, and legal commitments entered into by any one company do not impose any obligations on other companies in the network. All views expressed in this document are the views of Frontier Economics Limited.

FRONTIER ECONOMICS EUROPE

BRUSSELS | COLOGNE | LONDON | MADRID

Frontier Economics Ltd 71 High Holborn London WC1V 6DA

Tel. +44 (0)20 7031 7000 Fax. +44 (0)20 7031 7001 [www.frontier-economics.com](http://www.frontier-economics.com)