WIK-Consult • Report

Study for ECTA

Cost Methodologies and Pricing Schemes to Support the Transition to NGA

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Executive Summary

1. There are two different perspectives on cost which are of a fundamental nature. The one perspective is that of a decider who has to decide on a future course of action regarding his or her business. Typically, such decisions involve the use of resources and it is the costs of these resources that need to inform the decisions. This is the so-called forward-looking perspective. The other perspective on cost concerns the recovery of the investment cost once it has been incurred. These two perspectives need not be the same, but there is reason to assume that the two coincide under effective competition. Both perspectives have lead regulators to widely focus on the FL-LRIC cost standard to determine cost-based regulated wholesale prices.

2. The FL-LRIC cost standard, however, no longer is appropriate to be applied for the copper access network for five reasons: (1) Copper access is no longer the modern equivalent of a fixed-line access infrastructure; (2) Demand for copper access is declining; (3) No newly entering operator would invest in a copper-based access network anymore; (4) Given the actual lifetime of the copper access network and its status of depreciation, applying FL-LRIC furthermore would lead to a (significant) over-recovery of costs for the network owner; (5) Given the cost drivers of an access network, applying FL-LRIC furthermore would lead to increasing costs, in contrast to the real market value of the copper access network assets and the opportunity costs of the operator.

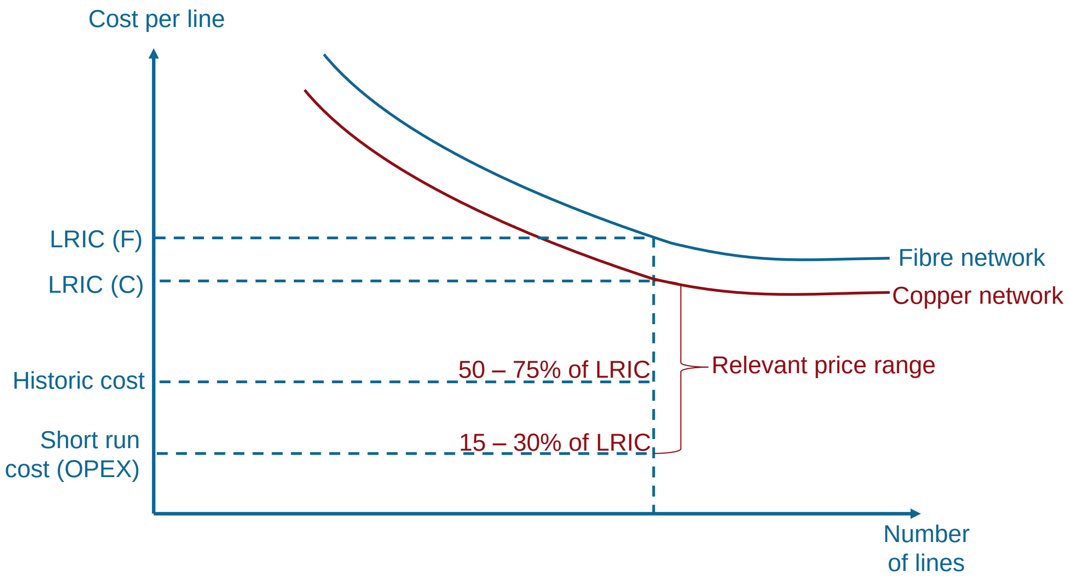
3. In Chapter 1 we argue that in the case that the demand for copper is steadily declining, the cost concept for the copper access network should be SRIC+, which would be the short-run cost of maintaining the network plus an opportunity cost component reflecting consumers' valuation of the network to be determined on the basis of incentive pricing. We also argue that if an independent estimate of SRIC+ is required, cost on the basis of HCA might be a default solution, lying as it does between SRIC and a cost determined as if FL-LRIC were still applicable. Regulators should take care to reflect depreciation when applying HCA such that fully depreciated assets are not subject to double compensation.

4. For fibre the decision-relevant cost is a mix consisting of FL-LRIC for the fibre part and the so-called Brownfield approach for the duct part, whereby "Brownfield" reflects the extent to which existing ducts may be reused or there is a need for installing new ducts for the purposes of installing fibre. In respect of the Brownfield cost of ducts we argue in Chapter 1 that, if the information for determining the proper Brownfield cost is not available, cost on the basis of HCA can be used as default solution.

5. For regions in which either copper networks or ducts are in a situation of nearly steady state, the costing concept of Investment Renewals Accounting (IRA),

whereby only the cost of renewal investment are recognized as a depreciation equivalent, is applicable.

6. Only detailed cost modeling for each individual Member State can tell where the relevant access costs according to the cost concepts used in this paper actually are. The following graph can, however, provide the relevant structural relationship between the relevant cost concepts in a stylized form. The current European average for the copper ULL price is at 8.55 €, in most cases calculated on the basis of a FL-LRIC concept. From the rough available information on the actual historic cost of the copper access line, we expect that value to be in the range of 50% - 75% of the current ULL price. The SRIC of the copper access lines will only amount to 15% - 30% of the current prices, which in absolute term means a value between 1.50 € and 3.00 €. Fibre access is somewhat more expensive than copper access. In our previous Euroland cost calculations fibre access amounts (at a 40% coverage ration) to around 14 € per line in a Greenfield deployment and to around 12 € if (some) existing ducts can be used (Brownfield approach).



7. A copper incumbent will invest in fibre if total expected profits from such an investment exceed the expected profits from staying with copper. This decision is influenced by the copper and fibre wholesale access charges, because these are main factors influencing the profitability of both these technologies. High copper access charges (relative to relevant cost) and low fibre access charges (relative to relevant cost) make fibre investment less attractive to the extent that they would result in high copper profits relative to fibre profits.

8. While the incumbent's decision to build out fibre would be favoured by a low copper access charge, the resulting low copper end-user prices could prevent such customers to switch to fibre, when it is available. Thus, after the fibre network has

been built copper subscribers may not want to switch to fibre, as long as the price difference between copper and fibre is large and copper remains available.

9. In the WIK study "Wholesale pricing, NGA take-up and competition" we put forward the proposition that a rate shock could be mitigated in the transition from copper to fibre by signalling that copper charges would come down through a glide-path, thereby encouraging the dominant firm to invest before copper prices decline significantly. This remains a relevant option. However, in its consultation of October 3, the European Commission has put forward an alternative "incentive pricing" scenario whereby incumbents would be allowed to keep wholesale copper access charges high, provided they credibly commit to a timetable for building out the NGA network and follow through on the build-out. We have assessed such incentive pricing schemes in the current report.

10. In cases where the incumbent has entered into a commitment for fibre build-out we discuss the following pricing options for the time after commitment and for the transition phase, in which both copper and fibre services are offered:

    (1) Copper <u>and</u> fibre charge <u>both</u> at the level of LRIC of FTTH.

    (2) Same average price for copper and fibre, based on copper and fibre costs and the relative weights depending on the share of fibre build-out. Within this option we differentiate the case that the copper component of the average price is determined by the relevant copper costs according to HCA or SRIC+ (Option 2a) from the case where the copper component is equal to the current price for copper (Option 2b).

    (3) Only the price of copper is based on averaging (as in Option 2), the price of fibre is based on the LRIC of fibre.

    (4) The price for copper remains at its current level in case of commitment and faces a glide-path downwards in case of no commitment.

11. Any commitment to NGA build-out should address the type of NGA investment, regions covered and the time frame for build-out. The NGA network to which the commitment applies should be open to wholesale access, preferably through unbundling.

12. The incentive pricing options proposed by the Commission rely on attracting a commitment to invest by maintaining copper access charges above relevant cost levels. However, this will only incentivize NGA build-out if there is a credible commitment by the regulator to keep following the policy that has been the basis for the incumbent's commitment. This requires that there are sanctions in place that induce the incumbent to follow through with the commitment (profits should be

lower if the commitment is not met) and that the regulator will actually want to apply if the incumbent violates the commitment.

13. Raising or maintaining copper access charges above relevant cost could also raise issues of consumer welfare and competitive neutrality since contributions to excessive copper profits come to a large extent from consumers and alternative operators who pay the higher copper access charges. They should also benefit e.g. by lowering initial fibre access charges or by having access to the same funds in order to support their own investments. Only one of the options suggested by the Commission – averaging copper and fibre costs – would avoid these concerns. In effect, this would be a form of penetration pricing, in which fibre is cross-subsidised by copper during the period of parallel operation.

14. In order to compare the options considering all relevant factors, we calculated the corresponding wholesale prices over an assumed time frame of several periods. Relevant cost data were taken from our previous study on this subject matter. In our overall assessment, Option 2 appears to have the largest net advantages over the other options. The uniform wholesale price for copper and fibre access increases in this option over time in case there is commitment to invest in fibre and ends at the LRIC of fibre. It is the increased fibre share that triggers this increase, thereby incentivising the dominant firm to maximise the planned proportion of fibre in the network. Because wholesale charges for copper and fibre would be the same, migration would be encouraged.

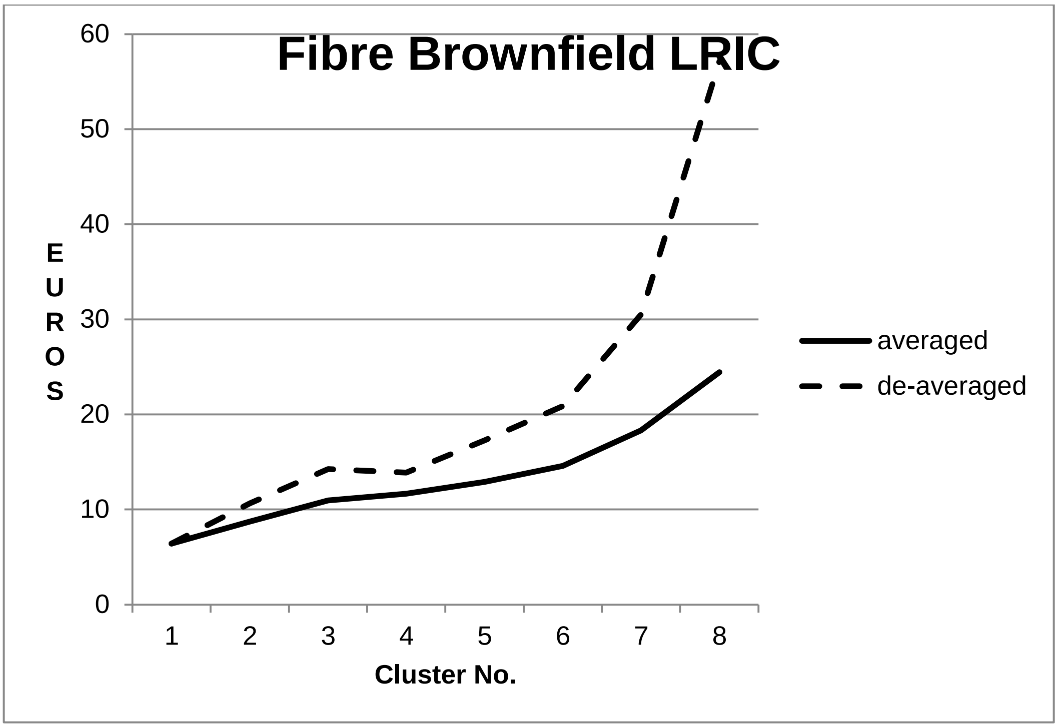
15. Our overall assessment of Option 2 to become the option with the largest net advantages rests on the five criteria (1) incentive to commit to fibre investment, (2) incentive to deliver the fibre investment, (3) migration incentive for customers, (4) consumer welfare and (5) competitive neutrality. Within these criteria consumer welfare is basically driven by the degree of access profits and competitive neutrality by the issue of whether access profits are either repaid or can be used by all market players for fibre investment. The following table provides the evaluation of all options according to these criteria.

Option	Objective	Incentive to commit	Incentive to deliver	Migration incentive	Consumer welfare	Competitive neutrality
1	Fibre as MEA for copper (Brownfield LRIC)	Highest	Low	High	Least	Least
2a	Fibre = copper price = average of costs (Brownfield LRIC, HCA)	High	High	High	High	High
2b	Fibre = copper price = average of current copper price and Brownfield LRIC fibre	High	High	High	High	Medium
3	Copper averaged, fibre LRIC	High	Medium	Medium	Medium	Medium
4	Copper held at current charge	Medium	Medium	Medium	Medium	Medium

16. In order to enforce the commitment for fibre build-out we consider the following proposal: In case the incumbent does not live up to the commitment any funds generated by the incumbent above the funds, that would have been generated under the no-commitment case, should be returned to the access seekers who overpaid. Additionally, we consider a suggestion that any excess profits from copper access charges may be used for NGA build-out. This would require the establishment of a fund or surcharge, potentially outside the scope of the cost-based charging regime, which could be made available to any investor in open fibre infrastructure. This kind of scheme would be relevant only in circumstances where alternative investors to the incumbent exist.

17. Over the whole country there should be an additional retail-minus option for the access seekers. Thus, the wholesale access charge should always be the lower of the cost-based regulated access charge (including glide-path and/or averaging) and the retail-minus access price. This also allows the incumbent to compete with other access modes in high-density and low-density areas and to use penetration pricing for fibre if deemed necessary.

18. Because there are areas where FTTH is too costly to be installed, because there are only very few areas where network replicability of fibre networks is viable and areas where FTTH is a viable investment, we have to face geographic diversity in terms of deployment. This diversity may be accompanied with a certain degree of geographic de-averaging. The graph below shows how fibre costs vary depending on whether they are averaged over the roll-out area or set on a regional basis.



19. The effects of such de-averaging may be ambivalent. Because of the ambivalent effects, if geographic de-averaging is chosen it should always be accompanied by a retail-minus option. In case of de-averaging of wholesale access charges this would also allow the incumbent to use geographically uniform retail charges (with the consequence that wholesale access charges may have to be adjusted via retail-minus regulation). If no fibre de-averaging is chosen the relevant fibre LRIC should be based on the actual or planned economic footprint of fibre, not on the LRIC for the whole country.

20. When assessing incentive pricing, some options such as option 2 (averaging the cost of copper and fibre) would allow significant flexibility over the geographic area chosen. This could range from a single exchange, to a group of exchanges or similar areas to nationwide averaging. Regulators should take account of the effect of the geographic scope on practical implementation, retail pricing, investment incentives and consumer welfare when taking decisions about the geographic scope of incentive and pricing regimes.

Introduction

This paper is a contribution to the Commission's consultation on costing methodologies for key wholesale access in electronic communications issued on 3 October 2011. The consultation is a preparatory step for an upcoming Recommendation of the Commission to the same subject matters.

Although the consultation is also dealing with cost methodology in general, the main focus is on costing and pricing of wholesale access in copper and fibre networks. It is of particular importance how the wholesale prices for copper and fibre access effect the transition from copper to fibre networks and in particular the incentives to invest in fibre networks.

This paper follows this route and first deals with the relevant costing concepts and methodologies. In its second part it analyses incentive pricing, in particular how certain concepts to set copper and fibre access prices affect investments into fibre networks. Before addressing the specific questions of the Commission, the respective analytical framework is developed to answer the questions in a coherent and consistent way.

This paper extends the analysis on "Wholesale pricing, NGA take-up and competition" which has been conducted by the authors of the current paper and three other colleagues on behalf of the European Competitive Telecommunications Association. In the previous study the analytical and empirical ground was laid for the current paper.

This paper represents the views of the authors, and cannot be assumed to reflect the views of ECTA or its individual members.

1 Costing Concepts and Methodologies

1.1 Conceptual Discussion

This section deals with features of various costing concepts and methodologies and their implications when used for different market situations. It also addresses ideas that do not relate directly to costs but are relevant for the application of certain of the cost concepts discussed.

1.1.1 Two different perspectives on cost

Most basically, cost is the value of the resources used up in an activity, where in our context the activity consists of the provision of a good or a service. If it is a service, the cost is expressed in terms of time, i.e. the time period during which the service is being provided, for example a year during which a subscriber line is being put at the disposal of somebody. Also the cost is either occasioned by the work of people or the use of facilities. If it is a good, it would in our context typically consist of a capital item (other words: a physical asset, a facility, an infrastructure, plant, a duct) that is being installed, in turn to provide a service. Thus the cost say of a duct consists of the digging of a trench and installing the required tubes; this cost is incurred at the point in time at which the duct becomes available to the operator. The duct is then used by the operator to house wires and cables to make subscriber lines, in other words it provides a service for which, as above, the cost must be expressed in terms of time. The task consists then in transforming the cost of the duct at the time of installation into a cost of the service per unit of time. A number of the concepts discussed in the following concern this transformation.

There are two different perspectives on cost which are of a fundamental nature. The one perspective is that of a decider who has to decide on a future course of action regarding his or her business. Typically, such decisions involve the use of resources and it is the costs of these resources that need to inform the decisions. This is the so-called forward-looking perspective. Arguments on cost take this perspective if the implications of the provision of services now and in the future are at issue. The arguments usually are then about the efficiency of the said service provision, respectively, the cost of such efficient provision. Efficient provision may mean different things for a company than from the point of view of the economy at large, which is the one a regulator has to entertain. For a company, it means the best possible performance of the company, from the point of view of the economy at large it is the type and scope of provision leading to a level of economy-wide welfare which is at least a great as that of any other situation. The two views need not be the same, but it is often said that the two coincide under effective competition.

The other perspective on cost concerns the recovery of the investment cost once it has been incurred. Suppose that decisions as just described were undertaken in the past and they turned out to be correct, then the recovery of the cost will be assured. For a viable and well-managed company, this would normally be true, although there may be variations around a level of achievement; the risk expressed thereby would then be reflected in the risk premium on the invested capital that investors would require and be able to get. So there need not be a divergence between the concerns associated with efficiency aspects of cost and their recovery. However, in a regulatory environment things are not quite this simple. There may be arguments of the one side claiming that when prices were based on costs of efficient production this would lead to under-recovery of cost. From the other side, with a different perspective, there would be claims that the costs of existing facilities were already fully recovered in the past – due to the then less than competitive market situation – and that therefore these costs should not be included in prices anymore.

Economists tend to insist that the efficiency concerns of present and future provision should dominate in regulatory decisions and therefore what happened in the past should be considered as bygone. Nevertheless, in a less than perfectly competitive environment where past events may influence current and future situations (access to capital, competitive position) this basic economist's position may – however again out of efficiency consideration – have to be modified. This will particularly become apparent in our discussion of incentivising access prices.

1.1.2 Short-run vs. long-run costs

A differentiation between long-run and short-run cost is caused by the fact that physical assets are long-lived. The (long-run) cost of an asset itself occurs once at the time of installation although it is supposed to provide services over many years, sometimes up to 50 years or more. The short-run cost is due to the activities of operation and maintenance. The difference lies in the degree of irrevocability of costs. As regards physical assets of telecommunications networks, once the facility is installed its cost must be considered as sunk and irrevocable. The cost can only be recovered by making productive use of the asset, it cannot be recovered by prematurely retiring the asset and reselling it; there usually exists no market for second-hand telecommunications facilities. The point is that when a company has physical assets in place but is currently not in a position to fully cover the cost due to depreciation and the cost of the invested capital with the corresponding revenues, the company would still continue using the asset as long as the revenues cover the short-run costs. Whenever, even in a situation of chronic underutilisation of assets, revenues surpass these short-run costs, there would at least in part be a contribution toward covering the long-run cost. In case revenues fall even below this level, the company would have no commercial interest any more to continue offering services produced by the facility.

For regulatory decisions that involve chronically underutilised facilities typically in a multiproduct context, the so-called short-run incremental cost (SRIC) is the relevant concept. It is the short-run cost caused by a particular service or a particular asset among many services the operator produces or many assets that make up a network. Regulated prices should at least cover the SRIC; they should correspond to SRIC+ where the "+" refers to a margin above SRIC that may not be determinable on the basis of cost concepts but would be the result of decisions that depend on the demand for the services by that facilities. This will become apparent in our discussion on incentivising pricing.

1.1.3 Forward-looking long-run Incremental Costs (FL-LRIC)

FL-LRIC is one of the standard approaches used by NRAs to determine the cost of regulated services. In its recommendation of 7 May 2009 on the regulation of termination rates, the European Commission strongly recommends the approach.

The starting point for justifying the approach is the premise that newly in a telecommunications market entering operators would have to determine their cost in a way that is compatible with FL-LRIC. Since in an effectively competitive environment, existing operators would always have to face the potential of newly entering operators, they would in such a market themselves have to apply FL-LRIC. That markets may in reality not be effectively competitive does not mean that this competitive standard should not apply. Effective competition among many providers is from a competition policy point of view the desirable situation; the fact that this situation does not exist should for a regulated service nevertheless imply that it be priced as if that situation prevailed.

Costs according to FL-LRIC can both be determined on the basis of a bottom-up or a top-down model. Bottom-up models are typically preferred in cases where data from the incumbent is considered incomplete or unreliable, and bottom-up models and top-down models are also typically used to cross-check each other’s results. A bottom-up cost model starts with first determining the network on the basis of which the regulated service is delivered. While the adequate representation of the relevant network on a computer is the most challenging part in such modelling exercises, the focus here is on the derivation of the costs according to the FL-LRIC standard once the list of all the facilities and equipment items making up the modelled network are known. For one of the network elements making up the network, these costs consist of the depreciation over time of the value of the network element, the return on the capital invested into it and of expenditures for operation and maintenance. The focus here is on the determination of cost due to depreciation and the cost of capital, while the role of operating and maintenance cost has already been considered in the preceding section.

In bottom-up cost models, depreciation and the cost of capital are normally determined in one step by calculating the annuity amounts that would have to be earned during the lifetime of the network element. Mathematically we would have

(1) $$I = A\left[\frac{1}{(1+r)} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \cdots + \frac{1}{(1+r)^n}\right]$$

Note that in equation (1), the values of all the determining variables (*I* = invested capital, *r* = cost of capital, *n* = length of economic lifetime) are known so that *A*, the value of the amount of amortisation to be determined, can be derived from this equation.[1] Note too, however, that conceptually there is no necessity to have a constant amount of depreciation/amortisation per year (which by the way corresponds to linear depreciation). Conceptually, one could replace equation (1) with

(2) $$\mathrm{I} = \mathrm{A}\left[\frac{1}{(1+\mathrm{r})} + \frac{\mathrm{k}_2}{(1+\mathrm{r})^2} + \frac{\mathrm{k}_2}{(1+\mathrm{r})^3} + \cdots + \frac{\mathrm{k}_\mathrm{n}}{(1+\mathrm{r})^\mathrm{n}}\right],$$

in which the k_i express by how much the usage in period *i* (= 2, 3, …, *n*) would be different from that in period 1 so that the k_i represent the profile of usage of the asset over its entire lifetime and the amounts of annual depreciation/amortisation could be assigned to the different periods according to this profile. What one would need is good forecasts of the usage of the facility during the *n* periods. The calculation of *A*, the amount for the first period could then as easily be calculated from equation (2) as from equation (1).[2]

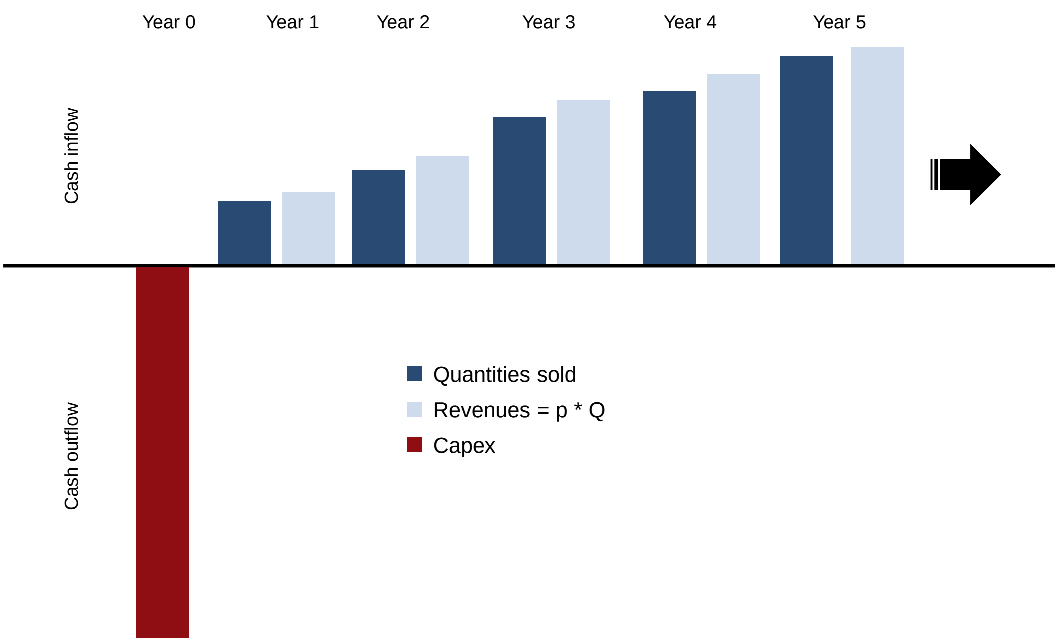
1.1.4 Discounted cash flow (DCF)

DCF does not belong to the standard tool kit of NRAs (it has, however, been used by Opta for its price decisions on NGA projects). It is more known as an approach applied by companies when deciding on business cases. Nevertheless, it is equivalent with FL-LRIC provided the same basic information is used and the focus is on the same questions.

In the context of the price regulation of a telecommunications service, the starting point are forecasts regarding the expenditures for installing and maintaining capacity and regarding the demand for services now and during the lifetime of the capacity. From this set of information the price is determined that equates the discounted present value of revenues (on the basis of this price) with the value of the investment. Figure 1 shows this relationship graphically.

1 The amount for *A* is then determined according to the well-known annuity formula $A = I(r/(1/(1+r)^n))$.
2 In a footnote to the next section, we will discuss depreciation approaches in more detail.

Figure 1: Example of discounted cash flow calculation



Mathematically, the relationship between initial capital expenditure, revenues and the price to be determined is expressed by the following equation:

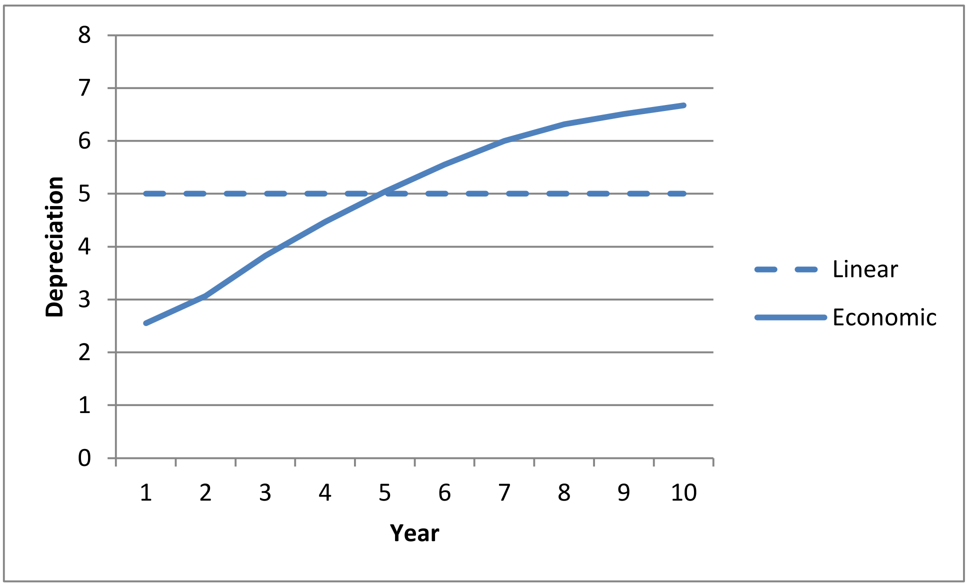
(3) $$I = p\left[\frac{Q_1}{(1+r)} + \frac{Q_2}{(1+r)^2} + \frac{Q_3}{(1+r)^3} + \cdots + \frac{Q_n}{(1+r)^n}\right]$$

The Q_i correspond to the quantities expected to be sold in period *i* (shown in Figure 1 as the darkly shaded columns), the *r* is the interest used for discounting, *I* is the initial capital expenditure (shown in the Figure 1 for period 0 as downward-pointed column), and the *p* is selected such that the equation holds. In other words, the price is selected such that the present values of the initial capital expenditure and the expected revenues are equal.

Exactly the same is also accomplished with the annuity formula used in bottom-up cost models to determine FL-LRIC. For this note the formal similarity between equations (2) and (3). The *A* corresponds to *p* and the k_i correspond to Q_i. There is, however, a notional difference. The *A* in FL-LRIC represents the cost of the asset to be assigned to the current year. In DCF, the *p* corresponds to the value per unit of service produced by the asset in the current year so that then pQ_1 would be the total value of that service, which in turn is equivalent to the consumption of the asset during year 1 and therefore to depreciation or the cost of the asset during that year.[3]

A further difference between the two approaches lies in the contexts in which the two are usually applied. DCF is a tool for business case evaluation, in which the whole investment into a project, here the *I*, is supposed to be known beforehand and in relation to which the projected expected sales generated by the project, here the Q_i, are evaluated. When applying FL-LRIC in the context of a bottom-up model, the *I* is typically

3 The language used to describe DCF is in terms of (negative and positive) cash-flows and makes no reference to depreciation; there is no need for this for managers to arrive at a decision. Once, however, a project is decided on and the investment has been made, there has to be depreciation of the corresponding asset in the books. A natural way of deciding on the amounts of depreciation would then be to take for each year the expected values from the DCF calculation as expressed in equation (3) in the text, i.e. $pQ_1/(1+r)$ in year 1, $pQ_2/(1+r)^2$ in year 2, $pQ_3/(1+r)^3$ in year 3, and so forth. The amount for each year would represent the loss in value of the asset, because in the process of realising the value by selling the output produced by the asset, as expected in the DCF analysis, the asset has lost this value (which in the books has to be expressed in terms of the purchase value, which is achieved here by applying the discount factor). This approach is called "economic" depreciation because the value is written down in step with the actual loss of value. In practice, depreciation is often decided upon on other grounds than the desire to correctly reflect the actual loss of value. One reason is lack of information regarding the actual loss of value of an asset (accounting people, who decide on depreciation policy, may not be in tune with the managers who decided on the project and have a different perception regarding it); other reasons may have to do with taxes and legal requirements. Depreciation is then often carried out on the basis of rules. The most common rule is straight line depreciation, According to this rule, a fixed proportion of the asset is written down over *n* years where *n* stands for the economic life of the asset. The figure below compares possible diverging profiles of depreciation (measured along the vertical axis) for an asset lasting 10 years (shown on the horizontal axis).



Straight line depreciation produces the same amount of deprecation for each of the ten years (it is represented by the horizontal line in the figure). Economic depreciation in this example reflects the judgement at the time the project was decided upon, that at the beginning production by the asset may be small and then pick up until it reaches its maximum after 10 years (when it would have to be replaced). Depreciation would correspondingly be lower at the beginning and higher at the end of the asset's life (as shown by the ascending line in the figure). While the amounts of depreciation add up to the same total (50 in the example), their profiles are quite different. In this example, prices based on depreciation (as a cost of production) would in year 1 lead under economic depreciation to lower prices than under straight line depreciation. The opposite would be true for year 10.

the invested capital into one particular network element – as determined by a bottom-up model – and the *A* is the contribution toward covering its depreciation and cost of capital out of the revenues from the various services for which the network element is being used.

For the application of DCF for the purpose of price regulation in telecommunications, one would typically have to rely on information from the operator. If one had to obtain this information by modelling the infrastructure, one would actually be doing a FL-LRIC costing exercise.

1.1.5 Infrastructure renewals accounting (IRA)

As a costing approach in addition to FL-LRIC and DCF, the concept of infrastructure renewals accounting (IRA) has been introduced by participants in the discussion.[4]

IRA is an approach which has its roots in financial accounting and not in regulatory economics or business planning. Still, Ofwat, the NRA for water in the UK, has in the early 1990s adopted the approach for determining the infrastructure cost of pipes lying in the ground.[5] A basic assumption is that the stock of pipes is in a steady state. The cost of the infrastructure that would normally be represented by depreciation is in this case equal to the renewals to maintain the existing level of the stock. The consumption of the physical asset is then exactly equal to the investments that are needed to maintain the stock.

There are essentially four variables that go into IRA (the wording below is from the glossary accompanying Ofwat's 2009 price review[6]):

- Infrastructure renewal expenditure (IRE): The actual expenditure incurred in the financial year in maintaining the operating capability of infrastructure assets through renewal or renovation of those assets.
- Infrastructure renewals charge (IRC): An accounting charge for the medium- to long-term maintenance needs of underground pipes.
- Regulatory capital value (RCV): The capital base used in setting price limits. The value of the regulated business which earns a return on investment.
- Cost of capital: The minimum return that providers of capital require to prompt them to invest in or lend to the appointed water companies given their risk.

The cost of using the water pipes in a given year then consists of the IRC and the return to investors calculated on the RCV. In the case of water regulation in the UK, the RCV

4 See for example Accounting Standards Board (1999). Its Financial Reporting Standard (FRS) 15 for fixed asset provides for "renewals accounting".
5 See Ofwat (1993).
6 See Ofwat (2009a).

is rolled forward starting from an initial level determined at the time of privatisation of the water companies, adding each year the IRE and deducting the IRC. Also, the RCV is always adjusted on the basis of the retail price index (RPI) to account for the effect of inflation.[7] If the assumption of steady state is correct, then the average of the IRE over a longer period should equal the IRC. In fact, it appears that the IRC is determined on such a basis.[8]

The IRA as applied by Ofwat appears to be a current cost concept. This follows because – as just mentioned – the RCV is always adjusted to account for the effect of inflation, the IRE is necessarily at current prices, and the statement that the IRC corresponds to the "medium- to long-term maintenance needs" implies that it must be at current prices otherwise IRC could not meet these needs. This also follows because the rate of return granted investors on the RCV appears to be on a real rate of interest basis and not on a nominal rate of interest basis as would be required if historical cost accounting (HCA) were used.

Provided the assumption of steady state is correct, this implementation of IRA is consistent with the other two long-run cost concepts, FL-LRIC and DCF. The steady state assumption implies that there is now sufficient infrastructure to provide a steady state of services now and in the future over all relevant time. The depreciation is then exactly equal to the renewal investment to maintain the stock at that level. From this follows that depreciation does not need to be determined laboriously by making assumptions about the length of economic life and the profile of use, but the depreciation in form of the IRC fulfils the same function as depreciation in FL-LRIC. It reflects the long-term cost of using the infrastructure. Also, as we have just seen, this cost is at current cost as is the case with FL-LRIC and DCF. We therefore consider IRA as applicable provided the circumstances warrant it. Note that in this setting the steady state assumption is crucial. If the stock of infrastructure is decreasing, which would mean that the IRE is actually less than would be needed to maintain a constant level, the ICE, being an average of past IREs, would be too high relative to the current IRE and thus make for higher cost. The converse would be true if the stock of infrastructure were increasing. In both cases, the relevant cost for using the infrastructure would be determined incorrectly.

Beside the steady state assumption, another basic assumption in IRA is that the existing stock of infrastructure should be considered as one asset.[9] This makes it actually possible to deal with the case of new investment if it should occur. Provided this new – capacity increasing – investment is separately identifiable, the depreciation to be applied to it should stand in the same relation to the value of the new investment as the IRC stands to the RCV. For example, if the IRC is 2 % of the RCV, then the depreciation applied to the new investment should also be 2 %, applied to the value of

7 See Ofwat (2009b).
8 See Water Industry Commission of Scotland (2010), Table 1.
9 See, for example, Accounting Standards Board (1999), Paragraph 99.

the new investment. The rationale for this is that this new investment will eventually call for replacement investment at the same rate as the current stock of the infrastructure.[10]

IRA as applied by Ofwat has above been described as a CCA approach. This characterisation is based on the fact that the RCV is based on the essentially forward-looking value assessed on privatisation and is from year to year adjusted on the basis of the retail price index (RPI) to account for the effect of inflation. While for proper CCA the revaluation of assets should be on the basis of the price changes in the underlying resources (land, pipes or ducts, etc.), applying the RPI lets the RCV move in line with general inflation so that the impact of its cost on the prices that consumers pay is also in line with inflation. Also, given that the prices of underlying resources are likely to move in the same direction and more or less with the same rate of change as general inflation, one can consider the procedure as a realistic approximation to what would be appropriate under a CCA approach.

Now, participants in the discussion have argued that IRA should not be seen as an approach based on CCA but as a mixed HCA/CCA approach. For this, the RCV would not be re-valued on a yearly basis but be kept at original book values. The justification provided for this approach is that it would avoid overcompensation the risk of which would exist if a rate of return is calculated on a RCV that is annually re-valued. We will deal with the arguments for using the HCA below, but in this context it should be noted that this way of applying IRA would invalidate its use in the case of new investment as the relation of the IRC to RCV could not be used to determine the depreciation for this new investment.

If applied in the context of telecommunications, IRA would require accurate information from the operators, in particular regarding past renewals investment, to verify that the steady state assumption is correct and that an appropriate average of these investments could be used to determine the IRC. In respect of the information requirement, IRA would be similar to DCF.

1.1.6 Historical cost accounting (HCA) vs. current cost accounting (CCA)

HCA is what most companies do when they record their costs. Also, in many countries, published statutory accounts need to be in terms of HCA.

A main differentiating feature of HCA relative to the cost concepts discussed above is that assets are valued at the cost at which they were acquired in the past and that the depreciation is recorded as a fraction of the remaining balance of that historical cost.

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10 Note in this context that if the assumption of steady state is correct, information gathered for the application of IRA provides the information for determining the length of the economic life of the relevant infrastructure. In steady state, periodic depreciation = value of the asset divided by length of economic life. Here we know the depreciation, being equal to the average of renewal investment over several years, as well as the value of the asset. From this follows that length of economic life = value of the asset divided by periodic depreciation.

Another feature is that it is based on the existing stock of assets which may include inefficiently installed facilities. When the cost of assets is to be determined for regulatory purposes on the basis of HCA, care must be taken that such inefficiencies are properly identified and corresponding corrections be made. It must also be assured that there should be no depreciation charged on assets that are still in use but have already been fully depreciated. It is one of the concerns of alternative operators that this has in the past not always been done this way when regulated prices were set.

The two aspects of HCA that may be considered as particularly relevant in the context of the current discussion are:

(1) If the prices of assets that are equivalent to those in the books of the company increase (due to inflation) or decrease (due to the impact of technological change), the cost determined according to HCA does not reflect current value of resources used up.

(2) Consistent application of HCA and setting of prices according to HCA insures that the investment outlay is recovered from the revenues.

Point (1) implies that in the case of rising prices of assets, which as regards subscriber lines is the relevant case, the cost of the services of an asset derived on the basis of HCA is lower than if calculated on a current cost basis.

HCA is in contrast to current cost accounting (CCA) which underlies the cost concepts of FL-LRIC, DCF and IRA. CCA differs primarily in respect of point (1) above in that assets in the books of the company are re-valued at current prices when it is the question of calculating the cost of services provided by these assets. Whether in this case point (2) above also applies depends on whether the effects of changes in the assets' prices, as they are enjoyed (in case of increasing prices) or suffered (in case of decreasing prices) by the remaining capital stock, the so-called windfall profits or losses, are taken into account when determining the costs of services and then prices on the basis of these costs.

When we place the cost determined on the basis of HCA in relation to the cost determined according to the other cost concepts discussed above, we obtain the following:

$C_{SRIC} < C_{HCA} < C_{CCA}$,

where we let C_{CCA} stand for the cost either determined according to FL-LRIC, DCF or IRA. The first inequality holds because C_{HCA} always also includes C_{SRIC} in addition to depreciation charges. The second inequality does not hold in principle but empirically for copper access networks, since due to inflation the values of assets under HCA are lower than under CCA.

1.1.7 Brownfield cost

This is an approach that has achieved some currency in recent discussions regarding the costs of inputs into NGA subscriber lines. It has been used in WIK-Consult's recent analysis of wholesale pricing, NGA and take-up and competition.[11] The term refers to the practice of using a weighted average of the costs determined according to two different concepts, one short-run the other long-run oriented. This mixture is justified on the grounds that different states of the market for the input in question apply within the relevant region leading to cost differences that are sufficiently large to be taken into account.

For example, ducts as an input for the laying of fibre may in some areas of the region be in oversupply so that a SRIC measure would apply, in other areas the stock of ducts may be in a steady state situation so that determining the cost according to IRA would be correct, while in still other areas the need for newly built ducts may arise so that FL-LRIC is the appropriate approach.

When we now place the cost determined on the basis of Brownfield in relation to the cost determined according to the other cost concepts discussed above, we obtain the following:

$C_{SRIC} < C_{Brownfield} < C_{CCA}$,

for which as before we let C_{CCA} stand for the cost either determined according to FL-LRIC, DCF or IRA. Note that the same relation has above been shown to hold for C_{HCA}. When below we answer the questions in the Commission's consultation document, we will make use of this fact.

1.1.8 Fully distributed cost (FDC)

The objective of FDC is to fully allocate all applicable costs to the different services. For the purpose of price regulation, FDC is considered an outdated approach although it has been mentioned in the context of the current discussion. The main issue with FDC is to determine the allocation keys on the basis of which the distribution of the various types of cost (capital cost, depreciation, cost of manpower engaged in operations, etc.) are to be undertaken. The approach is usually associated with HCA or CCA derived from the cost accounting records of the company.

As is obvious from the above description, FDC may be applicable if it is the objective to determine the cost of all services that a telecommunications operator offers. This may have been relevant when operators were still monopolies and were regulated across the board, as in the USA with rate of return regulation. The criticism already then of the approach was that the arbitrariness of the allocation keys would not reflect the actual

11 See WIK-Consult (2011).

causes of cost. Some of the cost concepts discussed earlier, when they also include a margin for common cost – which for FL-LRIC is not unusual – would also strive to fully include all relevant cost. The focus would then be on a particular regulated service, for example access to customers for competitors, and much effort would be spent on assuring that the allocation of relevant costs would be on the basis of cost causation. If then the task included the determination of the costs of all services provided by the operator, this approach would also lead to FDC, but - to repeat – on the basis of cost causation.

1.1.9 Retail minus

Retail minus is by itself not a costing concept. However, the justification for its use for determining the cost of an asset – or the services based on that asset – involves costing concepts. There should be effective competition in the relevant retail market on the basis of which can be assumed that prices approach the cost of efficient provision. The 'minus' to be applied to the retail price covers the cost items due to retailing the product. Under effective competition retail prices of the services of an asset are close to the sum of the efficient costs of all inputs. Thus the deduction of the cost of retailing from the retail price leads to the cost of efficient provision of the services of the asset in question.

Even if effective competition in the retail market cannot be assumed, the concept retains usefulness. In the case of an access product demanded by competitors, the cost figure derived from it would show whether there is a case of "squeezing", i.e. whether that cost figure is below the price that the competitor would have to pay for the access product.

1.1.10 Replicability

When an asset is considered replicable, this means that under competitive conditions the asset is being built, i.e. replicated or duplicated, by more than one provider. This now applies to many parts and assets of telecommunications networks, for example those network assets that consist primarily of electronic equipment.

When an asset is considered non-replicable, this is another way of identifying and designating a bottleneck or essential facility. A bottleneck or essential facility is by definition not replicable. The extent of the market, i.e. demand for it, would not support the provision of the asset more than once. The 2008 WIK-Consult report “Economics of Next Generation Access” could be seen as indicating the state of replicability in fibre access networks by calculating critical market shares that would be required for a viable business case. In the majority of cases it shows that no more than one or two fibre access lines could profitably be installed . Moreover, even where replicability may be theoretically be possible (in the most dense clusters of a country), differences in the market shares of operators or in their relative cost-base can render replication unlikely in practice. In many countries cable networks already exist and have been upgraded to provide high speeds. The fact of their existence does not imply that fibre networks are replicable, since cable was typically installed at a time when it did not substitute for telephone access lines. However, where cable does exist, it makes the potential for any duplication of the incumbent copper or fibre access line unlikely. This was a clear result from the WIK study on “Wholesale pricing, NGA take-up and competition” [12].

It may be necessary to differentiate between non-replicable assets that are in different states of supply, either in oversupply or undersupply. The non-replicability aspect would in any case apply to assets in undersupply or in a steady state situation, provided they are essential or bottleneck facilities. It may also apply to assets in oversupply, independently of whether they were previously replicable or not, if now there is no new investment into them either by competitors or by the current owner of the assets. This would be relevant as long as there is still demand for the services of these assets.

1.2 Answers to the Questions

The section contains answers to the questions of Section IV "Possible costing methodologies" of the Commission's consultation.

1.2.1 Question 3

Which is the most adequate cost model (LRIC, FDC, other) to calculate prices for regulated assets in markets 4, 5, and 6?

The answer is differentiated according to whether they apply to ducts, copper or fibre.

<u>Ducts</u>

Ducts are an input into both copper and fibre subscriber lines. They are thus part of the legacy subscriber line network as well as of the newly emerging NGA. There are four states of the market that may be found in the different regions in respect of this input:

(1) A (nearly) steady state situation where the stock of ducts is sufficient to accommodate both the still existing demand of copper subscriber lines as well as the current and future demand for fibre subscriber lines.

(2) Increasing demand where the current stock is not sufficient to accommodate existing and current demand and where additional investment into this infrastructure is required.

(3) Oversupply of ducts.

12 See WIK (2011).

(4) A mixture of the above three market situations.

In question 3 there is reference to LRIC and FDC as possible options. In our conceptual discussion we pointed out that FDC is not a relevant concept while LRIC may be relevant. We also pointed out that DCF and IRA are approaches that are essentially equivalent to FL-LRIC, depending on the market situation. Thus, situation (1) above gives reasons for using the IRA cost concept because of the steady-state assumption, for situation (2) the concepts of either FL-LRIC or DCF appear appropriate because there is not sufficient capacity and there is a need for new investment, and to situation (3) applies the concept that may be referred to as SRIC+ (see following paragraph). For situation (4) the application of the Brownfield costing approach would appear to be appropriate which, as discussed in the conceptual section, is a mixture of the other cost concepts.

The "+" in the SRIC concept refers to the inclusion of a component in the cost for the use of an asset in oversupply that reflects the current valuation of that asset by the economy at large. This component cannot be determined on the basis of conventional cost concepts alone. It needs to be determined in the context of determining the prices that best achieve policy goals which in the current context means progressing toward the goals of the DAE.

For obtaining a feeling of what the level of SRC+ would be, note that the relation

$C_{SRIC} < C_{SRIC+} < C_{CCA}$,

holds, since C_{SRIC+} should be higher than the actual short-run cost but lower than the heretofore long-run current cost (remember that C_{CCA} stands for either FL-LRIC and DCF) given that the value of the copper network is declining due to the competition from fibre. The exact level of C_{SRIC+} will be influenced by a number of considerations and will, as mentioned, have to be determined in the context of optimal pricing, as discussed in Chapter 2.

Note further that in the conceptual discussion we also found the above relation to hold both for the costs on the basis of HCA (C_{HCA}) and the cost according to Brownfield ($C_{Brownfield}$). If an independent cost estimate for C_{SRIC+} is needed, and if the information to determine C_{SRIC+}, and by extension, $C_{Brownfield}$ is difficult to obtain, the default solution for either may actually be the cost according to HCA.

Copper

When discussing the costing of copper, we mean the cost of the actual copper wires when they are in ducts or of whole subscriber lines when they are buried in the ground (without ducts). The market situation applying to these assets is one of oversupply in areas where there will be fibre rollout. Because of the situation of oversupply, the concept of SRIC+ should apply, or as a fall-back solution HCA as discussed below. In regions where no rollout of fibre is expected, the situation will likely be one of nearly steady state. In a state of steady state, the cost concept according to IRA should apply.

As argued in the conceptual section, cost determined on the basis of HCA falls in the range between SRIC and the cost if that had heretofore been derived on the basis of LRIC/CCA. A cost determined on the basis of HCA may be considered a default solution in case that a cost estimate reflecting SRCI+ cannot be determined.

Fibre

When addressing the cost of fibre, we mean the cost of the actual fibre and associated electronic equipment. Since the demand for fibre subscriber lines will be increasing, the cost concept of FL-LRIC is applicable. For the complete fibre subscriber line, the Brownfield approach may be applicable due to the fact that for ducts, which is an important input into subscriber lines, this costing approach may apply.

1.2.2 Question 4

Which is the most adequate modelling approach (top-down, bottom up) and asset valuation method for regulated assets in the above markets?

The type of modelling approach and asset valuation method follow from the applicable cost methodology as discussed in the answer to Question 3.

- The application of FL-LRIC, proposed for fibre subscriber lines and ducts, when these need to be newly built, calls for bottom-up cost modelling and current cost accounting.

- The application of IRA, proposed for ducts and copper subscriber lines when they are in a nearly steady state, calls for top-down cost modelling and current cost accounting.

- The application of SRIC, proposed as the basis for costing ducts and copper subscriber lines in oversupply, calls for top-down cost modelling and current cost accounting.

- If HCA is used as a default solution for the costing of ducts in oversupply and copper subscriber lines, or in general as a default solution for Brownfield costing, top-down modelling is the approach, and valuation occurs by definition on a historical basis.

1.2.3 Question 5

Would the use of BU-LRIC based on CCA lead to an increase in copper access prices due to the reduction in subscriber numbers and the valuation at current cost of (nearly) fully depreciated assets?

We would not think that this question is relevant, since BU-LRIC is per se not applicable any more if the number of subscriber lines is decreasing and overcapacities develop. The question implies, for example, that the cost of the copper in the subscriber line should be determined on the basis of the current price of copper. However, no one is going to install new copper subscriber lines so that the link between the price of the commodity copper and the value of the copper currently in the ground is broken and cannot be used for this purpose.

If contrary to the insight referred to above, BU-LRIC based on CCA were used to derive a figure that is supposed to represent the cost of a copper subscriber line, this figure would be higher than the cost from earlier determinations. The reasons are obvious. Since the size of the infrastructure has remained the same while the demand for it has decreased, this implies that an essentially unchanged cost base is divided by a smaller number of subscriber lines which necessarily leads to a higher figure. Also, the cost base would currently not have remained unchanged but increased due to the recent substantial increases in the price of the raw material copper.

1.2.4 Question 6

What is your view on the argument that the use of a CCA BU-LRIC model for the copper network could unduly compensate the incumbent for legacy assets?

In answering question 5, we have already pointed out that the CCA BU-LRIC model is inapplicable for determining the cost of the copper subscriber line network, once demand for copper lines is decreasing.

The consequences of setting prices for copper lines higher than when based on the relevant cost, for example derived from SRIC or HCA, should be judged on the answers to questions like the following:

- What will the extra revenues be used for?
- Will such prices enhance the desirable migration to fibre access?
- Will they hinder competition by alternative providers?

These questions will be addressed in Chapter 2 on incentive pricing.

1.2.5 Question 7

Would you expect fibre networks to be built in a cost-efficient manner? In this regard, would you consider the use of a CCA BU-LRIC model for fibre as appropriate?

We have no reason to assume that, in general, fibre networks will not be built in a cost-effective manner.

As regards the cost concepts to be applied for the fibre network, we consider the use of the following cost concepts as appropriate (is already implied by our answers to Question 3):

- CCA/FL-LRIC for the fibre cable and associated electronic equipment.
- For ducts as a substantial part of the fibre network, the concept of IRA if the stock of ducts is in a nearly steady state, FL-LRIC if stocks are in increasing demand and need to be newly built, and SRIC+ or HCA if the stock of ducts is in oversupply. If all three states are present in a given region, a brownfield approach could be used, or if the relative weights are not known, HCA may apply as a default solution.
- For a fibre network in a given region, a mixed approach may have to be used, in which the costs for the various inputs (fibre, electronic equipment, ducts) are combined on the basis of a weighted average. The cost of the duct component may then be determined according to the brownfield approach or HCA as a default solution, while the cost of fibre itself and electronic components should be based on FL-LRIC.

1.2.6 Question 8

Would it be, in your view, appropriate to value assets differently depending on their replicability? Would the application of different valuation methods, depending on the replicability of the assets, be appropriate irrespective of the cost model used (e.g. LRIC or FDC)?

We consider ducts and the copper subscriber line network as non-replicable. The fibre access network is mostly not replicable; in limited regions it can be replicable which, however, has no influence on the valuation method.

In response to Question 3 we stated regarding the costing approaches to these assets the following:

- FL-LRIC or the DCF approach is applicable to fibre, as this is an asset that will be in increasing demand and there will be continuing investment into it.

- Either SRIC+ or HCA is applicable to the copper subscriber line in fibre rollout areas, as there the stock of this asset is decreasing and there will be no further investment into it. In non-roll out areas, the IRA approach would be applicable.
- Either SRIC+/HCA, IRA or FL-LRIC/DCF are applicable to ducts according to whether in the relevant region ducts are in oversupply, in a nearly steady state situation or in undersupply. In regions where all three states apply and it is difficult to separately identify the different cases, the fall-back solution should be the Brownfield for which in turn cost according to HCA may be the default solution.

From this follows that there is no tight connection between replicability or non-replicability of the asset and the applicability of a particular costing concept. It is rather the state of demand for and supply of the asset in question that determines which concept is to be used. It holds, however, that if an asset is replicable and demand for it is increasing, FL-LRIC applies

1.2.7 Question 10

What would be, in your view, the appropriate method to value non-replicable legacy assets: (i) HCA (either LRIC or FDC), (ii) infrastructure renewal accounting (IRA) or (iii) other methods (please explain these methods and their suitability)?

We consider the copper subscriber line network as the relevant non-replicable legacy asset. We consider SRIC+ or HCA as default solution to be the appropriate costing approaches to this asset.

The justification for this has been provided in the conceptual discussion in Section 1.1 and in the answer to Question 3.

1.2.8 Question 11

What could be the appropriate method for those assets which can be replicated with a view to ensuring that competition on those assets is not distorted? Would CCA be suitable for that purpose?

Yes, the CCA approach would be suitable for the purpose. Typically, the approach would be implemented on the basis of a BU-LRIC model or, alternatively, using a DCF approach.

1.2.9 Question 12

Could copper be considered a replicable asset?

In responding to Question 8, we state that copper should be considered a non-replicable asset. The copper subscriber line network is at the end of its product life cycle and there is no further investment into that asset; instead there is disinvestment. For costing purposes it should be considered as a bottleneck or essential facility as long as there is still demand for the services provided by it.

1.2.10 Question 13

Could LRIC/CCA be appropriate to calculate the cost of fibre-based access products or is another cost model such as DCF better suited for this purpose?

As discussed in the section on costing concepts, the LRIC/CCA and DCF approaches are conceptually equivalent. Both approaches are suitable to calculate the cost of fibre-based access products (excluding, however, the duct input). The differences between the LRIC and DCF approaches are more of technical nature, i.e. the way the initial investment expenditure is arrived at or how expectations about future demand are formed. Further, the DCF approach depends more heavily on information to be obtained from the operator, for example the initial investment into the infrastructure. For the LRIC/CCA approach, due to its reliance on bottom-up cost modelling for which information available in the public domain can be used to a large extent, such a dependence on operator information is less pronounced.

1.2.11 Question 14

In which manner would replicability considerations enter into the modelling of fibre access prices? Should civil engineering infrastructure be subject to different valuation methods depending on whether such infrastructure is de facto used for fibre deployment? Which circumstances could hinder the use of existing civil engineering infrastructure to deploy fibre networks?

As stated earlier, the degree of replicability is not the concept which tightly fits the criteria on the basis of which the type of cost modelling to determine the prices of fibre access should be selected. The relevant criteria should rather be the states of market conditions, i.e. whether assets are in undersupply, in a nearly steady state situation or in oversupply. In particular in respect of the valuation of civil engineering infrastructure, these conditions should appropriately be taken into account, as stated in the answers to Questions 3 and 4.

When ducts are still occupied by copper, this could hinder their use to deploy fibre. This might then be a situation where there is undersupply of ducts, in which case there might be a case for enlarging the stock of ducts, and the particular costing model and valuation approach should be along CCA/FL-LRIC or DCF.

1.2.12 Question 15

Could fibre be considered as the MEA for copper? In this respect, could the fibre access network be considered as the most cost efficient method, using modern technology, of providing the same services, to the same level of quality and to the same customer base as is provided by the existing copper access network?

The large range of technological choices and expectations of future developments make any clear-cut evaluation difficult. Fibre is superior at higher speeds and therefore a fibre subscriber line could in such an application not be a one-for-one MEA for a copper subscriber line. It is not clear whether it is a MEA at lower speed over xDSL technology, in the sense of providing the same services, to the same level of quality, and to the same customer base, as is provided by the existing copper access. Furthermore, it is doubtful that as an MEA in this sense fibre would be cost effective.

What would be needed for a MEA evaluation is a reliable assessment of what the relation is between "value of service over fibre" to "value of service over copper". To determine this on the basis of technical capabilities is practically very difficult because on fibre so many diverse things are possible. The market has not yet provided reliable information on how it sees this relation. What should be expected, however, is that if such a market evaluation were available, the value of services that could be provided over copper would be a miniscule fraction of the value of services that a fibre line could provide.

1.2.13 Question 16

Would it be, in your view, appropriate to calculate the access prices for products along the same value chain according to the same cost models? Would this approach ensure consistency in the costing methodology?

For the purpose of consistency, this would be a desirable principle. The proviso is, however, that it is first necessary to establish what kind of market situation exists on the basis of which the type of cost model and valuation approach is to be selected, as stated in our responses to Questions 3 and 4. The principle should be applied if different access products are provided under similar market conditions. For example this should be the case if the access product is either a subscriber line or bit stream access for which the assets to be used are all available under the same market conditions. The endorsement of the principle should not be interpreted as meaning that the same kind of cost model and valuation approach should indiscriminately be applied in all circumstances. In the concrete, the applicability of the principle will depend on the specific case, and in particular it may depend on the availability of data.

2 Incentivising Access Prices

2.1 Conceptual Discussion

2.1.1 The interplay of copper and fibre access charges in influencing fibre investment

A copper incumbent will invest in fibre if total expected profits from such an investment exceed the expected profits from staying with copper. This decision is influenced by the copper and fibre wholesale access charges, because these are main factors influencing the profitability of both these technologies. High copper access charges (relative to relevant cost) and low fibre access charges (relative to relevant cost) make fibre investment less attractive to the extent that they would result in high copper profits relative to fibre profits.

Costs in this case are those costs that are relevant for the continuation or shutdown decision for copper and for the investment decision for fibre. These are the SRIC for copper in case the shutdown decision is expected soon and the IRA in case no shutdown decision is foreseen in the near future. In Chapter 1 we argued that for the case where the shutdown decision is foreseen the cost concept should be SRIC+ which would include an opportunity cost component to be determined on the basis of incentivising pricing. We also argued that if an independent estimate of SRIC+ is required, cost on the basis of HCA might be a default solution for it, lying as it does between SRIC and FL-LRIC.

For fibre the decision-relevant cost is a mix consisting of FL-LRIC for the fibre part and the Brownfield approach for the duct part. In respect of the Brownfield cost of ducts we argued in Chapter 1 that, if the information for determining the proper Brownfield cost is not available, cost on the basis of HCA can be used as default solution.

While the incumbent's decision to build out fibre would be favoured by a low copper access charge, the resulting low copper end-user prices could prevent such customers for switching to fibre, when it is available. Thus, after the fibre network has been built copper subscribers may not want to switch to fibre, as long as the price difference between copper and fibre is large and copper remains available.

In the WIK Consult April 2011 report "Wholesale Pricing, NGA Take-Up and Competition"), we put forward the proposition that a rate shock could be mitigated in the transition from copper to fibre by signalling that copper charges would come down through a glide-path, thereby encouraging the dominant firm to invest before copper prices decline significantly. This remains a relevant option. However, in its consultation of October 3, the European Commission has put forward an alternative "incentive pricing" scenario whereby incumbents would be allowed to keep wholesale copper access charges high, provided they credibly commit to a timetable for building out the NGA network and follow through on the build-out. We have investigated this scenario in the current report.

2.1.1.1 The relationship between access charges and retail price

The relationship between wholesale access charges and retail prices is not pre-determined but rather depends on the extent of downstream costs, the amount of competition and product differentiation. In general, however, the relationship is monotonic so that higher access prices in the same type of market are associated with higher retail prices. This holds because the wholesale access product is the main input for alternative operators and therefore determines their pricing policy. At the same time the incumbent provides the access to itself in order to provide the retail output. Selling wholesale is the next best alternative use of the access input for the incumbent to selling retail. As a result the wholesale access price is an opportunity cost also to the incumbent, and it will therefore influence his retail pricing. An additional factor is that higher access charges tend to reduce access-based competition so that the number of alternative operators will be negatively affected by higher access charges, again increasing retail prices. This could be counter-balanced by any competition from other technologies such as cable (the April 2011 WIK report incorporated cable as a competitor to FTTH) or from independent fixed-network investors in circumstances (apparently limited) in which such investors could profitably roll out fibre lines; but the generally monotonic relationship between access charges and retail prices is robust.

2.1.2 Charge control for wholesale access

2.1.2.1 Commitment to NGA build-out

Copper-based access charges should be lowered from today's level because, as explained in Chapter 1 of this report, the relevant cost measure has changed from LRIC to a lower one (IRA, HCA or SRIC). Lower copper access charges also provide the right incentives for an incumbent to invest in fibre. To the extent that the difference between the current copper access charges and the relevant cost concept for copper is large, copper access charges cannot easily be fully adjusted in a single step. So, a glide-path may be envisaged for the required charge reduction.

While lower copper access charges would provide incumbents with incentives to switch to NGA, the incumbents claim that they need the profits from the current highly priced copper in order to finance NGA investment and, as long as copper is available, copper subscribers will more easily switch to NGA if the price difference to NGA is smaller rather than larger.

The incumbent claim that they require additional profits from copper to finance fibre does not appear justified in that, if correctly set, cost-based fibre charges should provide an adequate return on fibre for investors independently of the copper price. However, there could be some justification as regards potential “rate shock” if copper prices are set at the level which incentivises investment in fibre. This creates the problem that at high copper prices NGA investment may not look profitable, because it cannibalises copper, while at low copper prices customers may not want to switch to NGA.

One solution that has been put forward by the European Commission is that the regulator could allow wholesale copper access charges to remain above the cost-based level provided the incumbent commits to a fibre build-out over a pre-specified period. Any delays in this build-out would then trigger a pre-specified reduction in the copper access charge. Thus, there would be an immediate reduction or glide-path of declining copper access charges that the incumbent could prevent only by investing in fibre

Such schemes would only incentivize NGA build-out if based on a credible commitment by the incumbent to do the build-out and a credible commitment by the regulator to keep following the policy that has been the basis for the incumbent’s commitment.

Both these conditions require that there are sanctions in place that induce the incumbent to follow through with the commitment and that the regulator will actually want to apply if the incumbent violates the commitment. In this context we also consider a suggestion that the incumbent put the excess profits from copper access charges into a special account in order to assure repayment in case commitment is not fulfilled.

Any commitment to NGA build-out should address the type of NGA investment, regions covered and the time frame for build-out. The NGA network to which the commitment applies should be limited to open fibre infrastructure (preferably one that can be unbundled). The geographic areas for the commitment should be chosen in a way which best supports the “incentive” to build, consumer welfare and practical considerations such as the ability to accurately calculate costs.

2.1.2.2 Commitment and verifiable investments

How can commitment be achieved and how can it be credibly implemented? In order to get a commitment to NGA build-out from the incumbent such a commitment has to be advantageous relative to the state with no commitment. The commitment should also be efficient so that the incumbent commits in those cases (and for those geographical areas) where the incumbent’s NGA investment is deemed desirable from the regulator’s perspective.

For example, a regulatory threat to reduce copper access charges in case of no commitment can induce the incumbent to commit. The reduction of copper access charges in case of no commitment will make the fibre build-out relatively more profitable but could also lead to a rate shock for copper customers if the incumbent actually pursues the build-out and shuts down the copper network. Since the rate shock may hurt the regulator, it is not clear that the regulatory threat of copper charge reduction is credible (or only credible in those regions where the incumbent's NGA investment would not be profitable anyhow).

Once the incumbent has committed to an NGA build-out, will the regulator penalize the incumbent by reducing the copper access charge and clawing back any profits made from the failed commitment if the incumbent does not stick to a commitment for fibre build-out? The same issue of credibility of the regulator's sanction re-emerges as before.

A glide path could reduce the problem of credible sanctions somewhat because the price reduction is gradual and therefore the rate shock problem less drastic. However, equally, a glide-path could initially reduce the penalty from failing to meet a commitment, thereby reducing incentives for the incumbent to follow through on its commitment.

Therefore, in order to implement commitment in such a way that regulatory sanctions for failing to live up to the commitment are both strong and credible, the incumbent would, in our opinion, have in case of failure to be forced to return excessive profits from copper access charges above costs to the copper access seekers. This can best be achieved if the excess money is collected in a separate account that is only released to the incumbent's discretion after commitment has been achieved.

2.1.2.3 Pricing options after commitment

Assume that the incumbent has entered into a commitment for NGA (fibre) build-out. We consider the following pricing options for the time after commitment and, in particular, for the transition phase, in which both copper and fibre services are offered.

1. $p_F = p_C =$ [Brownfield] $LRIC_F$. This means that both copper and fibre wholesale access are priced at the [Brownfield] LRIC for fibre. This is our interpretation of the EC's "MEA approach, i.e. entirely reflect the cost of fibre deployment".[13] [cf. EC Consultation, Question 30ii]

2. $p_F = p_C = p_\phi$. In this case, both copper and fibre are priced at some average cost, depending on the share s of fibre and (1-s) for copper. For example s[Brownfield] $LRIC_F + (1\text{-}s)C_C = p_\phi$. We will discuss this option for two possibilities:

13 In our view, fibre can only act as MEA for copper if it is either cheaper to deploy or if a quality adjustment can be made to the fibre costs in order to arrive at the copper cost. In either case the LRIC of copper would be an upper bound for the copper MEA. No quality adjustment could be made that would be solely based on cost data.

- 2a. C_C = today's relevant copper costs (SRIC+ or HCA) and s = the fibre share that the incumbent has committed to at the end of each regulatory period;
- 2b. C_C = current price of copper access and s = the actual fibre share reached.

3. p_F = [Brownfield] $LRIC_F$ and p_C = s[Brownfield] $LRIC_F$ + (1-s)C_C. In this case the price of fibre is determined by [Brownfield] $LRIC_F$ and the price of copper by an average of copper and fibre costs. [cf. EC, Question 30i]
4. p_F = [Brownfield] $LRIC_F$ and $p_C = LRIC_C$ in case of commitment and $p_C = \alpha_t LRIC_C$ in case of no commitment. In the latter case we have a glide path for the copper price but no averaging

We will now discuss the four options in sequence.

Option 1: Copper and fibre charge at the [Brownfield] LRIC of FTTH

Because it rewards the incumbent with high copper prices for some time this pricing option may provide a strong inducement for the incumbent to commit.

If this pricing is applied before FTTH is actually available it will lead to a substantial price increase for copper without the availability of fibre, and this high copper price may induce the incumbent to retard the fibre build-out (after commitment). After FTTH is actually available for potential subscribers this option will induce subscribers to switch, because NGA is offered as cheaply as copper. The incumbent may be less in a hurry to switch them, as long as there are switching costs for the incumbent (see technical appendix below). At the same time, customers will be comfortable with a shut down of the copper network.

Withdrawing this pricing if the incumbent does not follow through with the build-out after commitment could be a tough sanction on the incumbent but the regulator may only want to follow through if the price sanction is mild enough to avoid a rate shock, once the incumbent is back on track with his NGA investment.

In the limited number of exchanges, where alternative operators could do the NGA build-out, this pricing option could make it more profitable for alternative operators to invest in NGA, the threat of which in turn could trigger faster NGA build-out by the incumbent. However, excess profits on copper maintained by the dominant firm could increase its ability to fund and subsidise fibre roll-out, making the threat of entrant over-build less credible (the "stalemate" scenario).

This option has two main drawbacks. When interpreted as in Question 30ii of the EC Consultation it is not grounded in a defensible cost concept for copper and it most probably leads to substantial copper price increases at a time when fibre is not yet available. Retail and wholesale customers of the dominant firm would effectively pay excess contributions above cost to the dominant firm. It thus has negative consequences for consumer welfare and competitive neutrality.

Secondly, in view of competition from cable operators, mobile operators or alternative NGA investors, the resulting high copper prices may not be sustainable. In contrast, a defensible approach to fibre as MEA for copper would consist only of that fraction of the fibre LRIC that would correspond to the quality of services provided by copper.

Option 2: Same average price for copper and fibre

Option 2a: C_C = today's relevant copper costs (SRIC+ or HCA) and s = the fibre share that the incumbent has committed to at the end of each regulatory period

The starting price for both copper and fibre under this option could be an average of the costs found to be relevant for copper and the cost of fibre projected to be rolled out within the relevant period (e.g. 3 years). In order to avoid a rate shock after fibre build-out the starting price should not be too low; and the alternative price without commitment should be substantially lower, in order to induce the incumbent to commit to the fibre build-out. Thus, a lower bound for the average price should always be the copper access price that would rule without commitment.

Under this option, the incumbent may have an incentive to over-estimate the extent of fibre roll-out in order to increase the averaged charge for copper and fibre. Annual checks should therefore be conducted with adjustments in subsequent periods and with repayments of any overpaid funds should predictions be found to be incorrect.

After FTTH is available this pricing will provide copper subscribers with strong incentives to switch to fibre. Subscribers waiting to switch will suffer higher copper prices. The incumbent's incentive to switch customers depends on the cost difference between fibre and copper, but should be significant, once fibre is installed (see technical appendix below). The incumbent may want to shut down the copper network quickly, because that raises the average price to that of fibre.

Since wholesale access pricing cannot feasibly be adjusted any time the market share of fibre increases, the averaged prices will realistically have to be based on forecasts of the relative shares of copper and fibre customers and will have to stay put for some time. This has an influence on the incentives to switch in that the incumbent may want to retard any switch at the beginning of a review period and only accelerate at the end. Thus, deviating from the projected fibre share s will have to be penalized or rewarded ex post. The same issue holds for Option 3 below and is not repeated there.

In principle this pricing option (and Options 2b and 3) could be based on averaging at different levels of geographic aggregation. It can range from the individual exchange, where the fibre build-out occurs, to the whole region, for which the incumbent has entered the commitment to the whole country. The appropriate level of aggregation should, in our view, depend on practicality considerations and incentives provided. Practicality may call for a high level of aggregation so that there are not many different prices and not too frequent price changes triggered by changes in the shares of copper and fibre. Incentives may call for a lower level of aggregation so that there is a quick and visible feedback to changes in the shares. The level of aggregation may have to be dealt with by the NRA of each member state.

Under this pricing option the prices for copper and fibre may initially fall compared with the current copper price (depending on the geographic area covered by the scheme and proportion of fibre to which the incumbent commits), but will rise during the transition period. This can be interpreted as penetration pricing for fibre along with handicapping copper. It should be noted, however, that, at the wholesale level (from alternative operators or from himself), the incumbent in principle receives the fibre LRIC for each new fibre subscriber, because each new subscriber increases the share of fibre customers that is relevant for the price averaging.

This pricing option has a number of strong advantages. It provides the incumbent with good incentives to commit to fibre and to follow through with the build-out. At the same time it allows for fibre penetration pricing for both the incumbent and alternative operators depending on wholesale access. Last, it provides for a smooth transition for copper subscribers to fibre.

Option 2b: C_C = current price of copper access and s = the actual fibre share reached

The starting price under this option will be the old (higher) copper price to be averaged with the cost of fibre and weighted according to the actual fibre share reached.

This pricing has no influence on the copper price after the commitment is made but before FTTH is actually available, because for s = 0 the copper price is determined only by copper.

If both are done right approaches 2a and 2b should yield rather similar results. The disadvantages of approach 2b could be that excess profits would be maintained on copper and not entirely passed through in savings on fibre charges. In this context, retail and wholesale customers of the dominant firm would be worse off than in the case where copper costs are taken as the basis. However, realistically the initial price under approach 2a will also be substantially above copper access cost (HCA) because it will be based on a fibre subscriber share that will only be reached at the end of some commitment period.

Option 3: Only the price of copper is based on averaging, not the price of fibre

The starting price under this option will either be the price based on the costs found to be relevant for copper or the old (higher) copper price. In contrast, the fibre price is at fibre [Brownfield] LRIC. In order to induce copper subscribers to switch to fibre after fibre build-out, the starting copper price should not be too low and the alternative price without commitment should be substantially lower, in order to induce the incumbent to commit to the fibre build-out.

This pricing has no influence on the copper price after the commitment is made but before FTTH is actually available, because for s = 0 the copper price is determine only by copper.

After FTTH is available the incentives for the incumbent to switch customers from copper to fibre start out high but fall, as more customers are connected to fibre. In contrast, the incentives for subscribers to switch from copper to fibre increase in the number of subscribers who have already switched. If the original cost difference between copper and fibre is large the switching process may be slow to start (see technical appendix below). If the original cost difference between copper and fibre is small the switching process may be quick. This is the justification for continuing to use the old (high) copper access charges if the incumbent commits to fibre build-out.

While this option shares some of the advantages of Option 2 it has the main drawback that it has no built-in penetration pricing for fibre. It would also result in higher excess profits for the dominant firm paid by retail and wholesale customers than Option 2.

Option 4: The current price for copper in case of commitment, a glide-path when no commitment is reached

The incentives of this pricing option before commitment depend on when the glide path starts. If the path starts right away the incumbent is incentivized to enter commitment early, provided the regulator actually carries out the glide-path.

This pricing has no influence on the copper price after the commitment is made. After commitment is reached the incumbent will at least for some time continue to earn more by staying with copper than by moving to fibre, but that is going to be less than under any of the previous options. Also, the glide-path could be resumed if the incumbent does not do the build-out.

There are only limited incentives for copper subscribers to switch, once fibre is available, and there are no incentives for fibre penetration pricing.

Overall, this pricing option provides a strong threat to induce the incumbent to enter into a commitment. If the glide-path is actually carried out during delays in the commitment it will lead to a rate shock for customers switching from copper to fibre (see technical appendix below).

2.1.2.4 Addressing over-recovery: Reinvestment of excess profits from higher copper prices

With the possible exception of Option 2a, in which the costs of copper and fibre are averaged, all options discussed above involve the incumbent maintaining excess profits on the copper network, paid by contributions from its retail and wholesale customers.

The only circumstance in which such profits could be seen as justifiable, is if these funds were ring-fenced and dedicated to investments in NGA. One such mechanism could be for the incumbent to agree that the funds would be held in an "escrow" account until such time as the regulator was satisfied that they would be used to pay back investments. The money collected in such an account could be quite substantial and could be in the order of several Euros per customer per month. It would include payments from the incumbent's own retail copper subscribers (for imputed wholesale use of access).

As described above, establishing such a fund would represent a strong commitment device for implementing the fibre build-out. An escrow mechanism of this kind would therefore assume that the incumbent would be the only beneficiary.

A very different potential function of such an account would be to make such a scheme also available to competitors. In that case the money would need to be managed outside the "price regulation" regime as a separate fund. This scenario would therefore require the imposition of strict cost standards for both copper and fibre within the pricing regime, with the potential for national authorities to apply a transparent levy on the copper access charge that would be made available for investors in open fibre networks. The incumbent may be just one of those potential investors.

2.1.2.5 Pricing in regions with no commitment (no NGA build-out)

If also applied to those geographic areas where the incumbent does not commit the five pricing options behave as follows:

- Option 1: p_C = [Brownfield] $LRIC_F$. This is an exorbitantly high copper price.
- Options 2 and 3: p_C = HCA or p_C = current price of copper.
- Option 4: $p_C = \alpha_t LRIC_C$. In this case the price for copper declines until it reaches the envisaged end of the glide-path.

However, since commitment should be associated with a pricing concession towards the incumbent, the pricing outside commitment areas would rather follow the appropriate pricing approach and therefore look as follows:

- Options 1, 2, and 3: p_C = HCA as a default for copper.
- Option 4: $p_C = \alpha_t LRIC_C$. In this case the price for copper declines until it reaches the envisaged end of the glide path, which would be HCA as a default for copper.

Presumably, the incumbent will not commit to a fibre build-out for the whole country and will be more likely not to commit to fibre in lower density areas. The different pricing options will therefore lead to wholesale access price de-averaging (as shown in Figure 2-Figure 5 below).

2.1.2.6 Illustrative assessment of the options

In order to give a more concrete idea of the numbers involved in the various options we have taken cost data from WIK (2011). While they are chosen to be representative of an average European country, actual cost data estimated by actual NRAs may differ from these, both by geography and by method chosen. The costs are provided for 8 clusters of a hypothetical European country ("Euroland"), which are ordered by their density. For our illustrations we have chosen the first four clusters so that, for example, the Brownfield fibre LRIC (LRICf = 11.65€) refer to the four densest clusters. The figures also show the costs relevant for the decision to abandon copper (SRICc =1.95€ per month).

The wholesale prices corresponding to these WIK cost data over an assumed time frame of eight periods are shown in Figure 2-Figure 5. In all figures a glide-path is used as the default case for no commitment. The periods therefore begin after a commitment either has been made or not. There are seven periods after that, where the last two periods are after the shut-down of the copper network. Thus, it is assumed that it takes five periods from the fibre build-out (when fibre acquires some market share) to copper shut down. The periods therefore do not reflect years but rather the progress in switching customers to fibre. In all figures we also show the Brownfield LRIC for fibre and the SRIC for copper in order to enable comparisons of prices and costs.

Figure 2 captures pricing Option 1 with Pf = Pc = Brownfield LRICf = 11.65€. Here Pc is the copper price with commitment. In contrast, the copper price without commitment starts at 8.55€, which is the current average copper access charge in Europe, and after a glide-path of five years it ends at copper SRIC = 1.95€. In this case there is an obvious advantage from committing to fibre build-out and almost from the beginning of the glide-path fibre looks more attractive (in terms of price-cost margin) than copper without commitment.

Figure 2: Option 1 - Copper and fibre charge at the Brownfield LRIC of FTTH

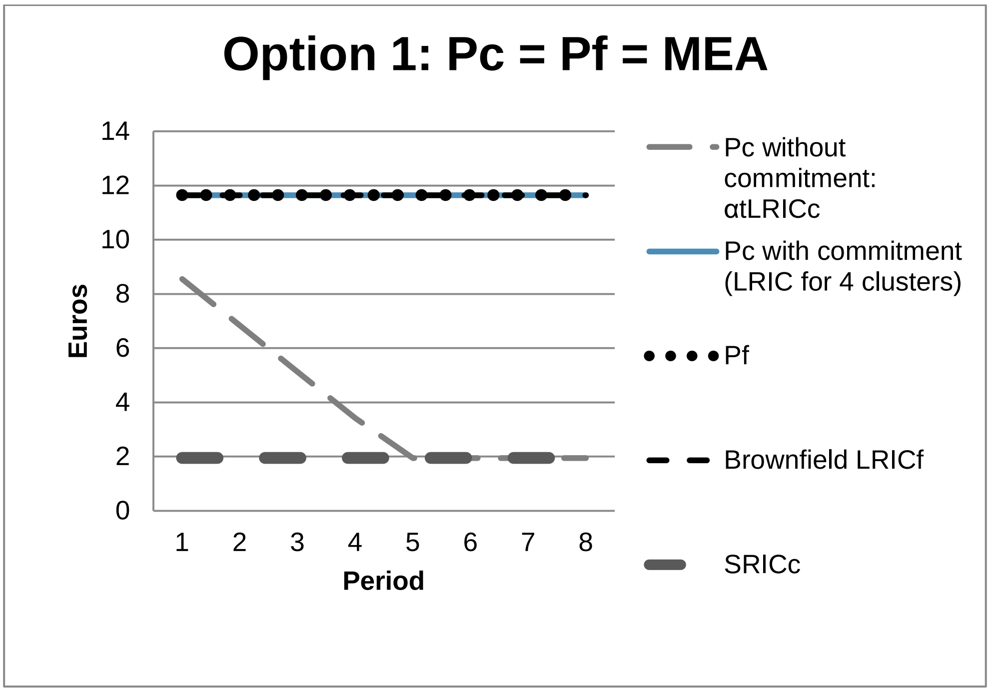


Figure 3: Option 2 - Same average price for copper and fibre

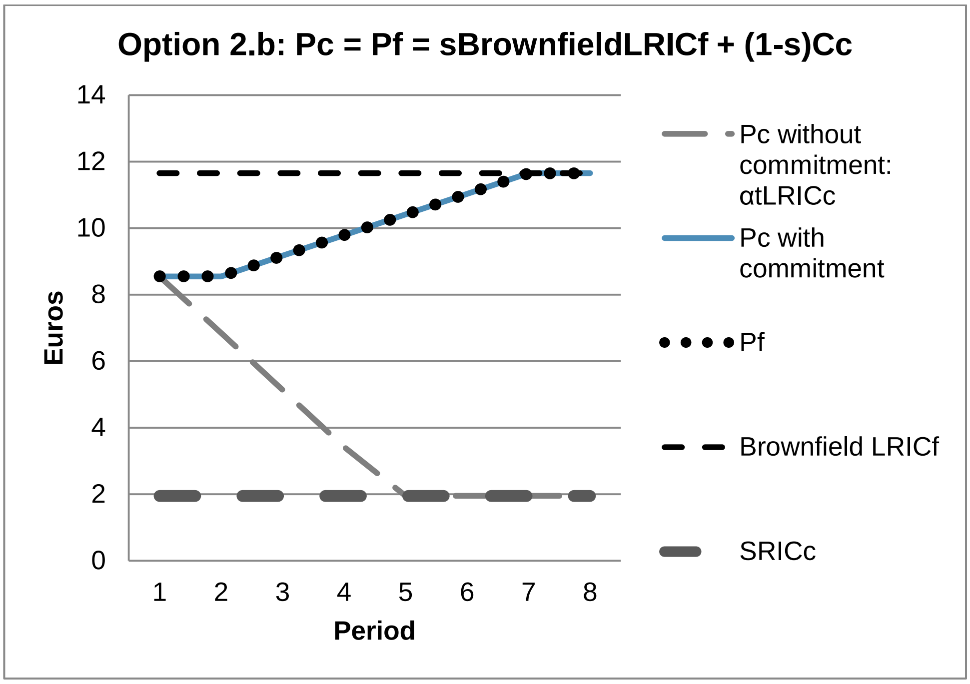
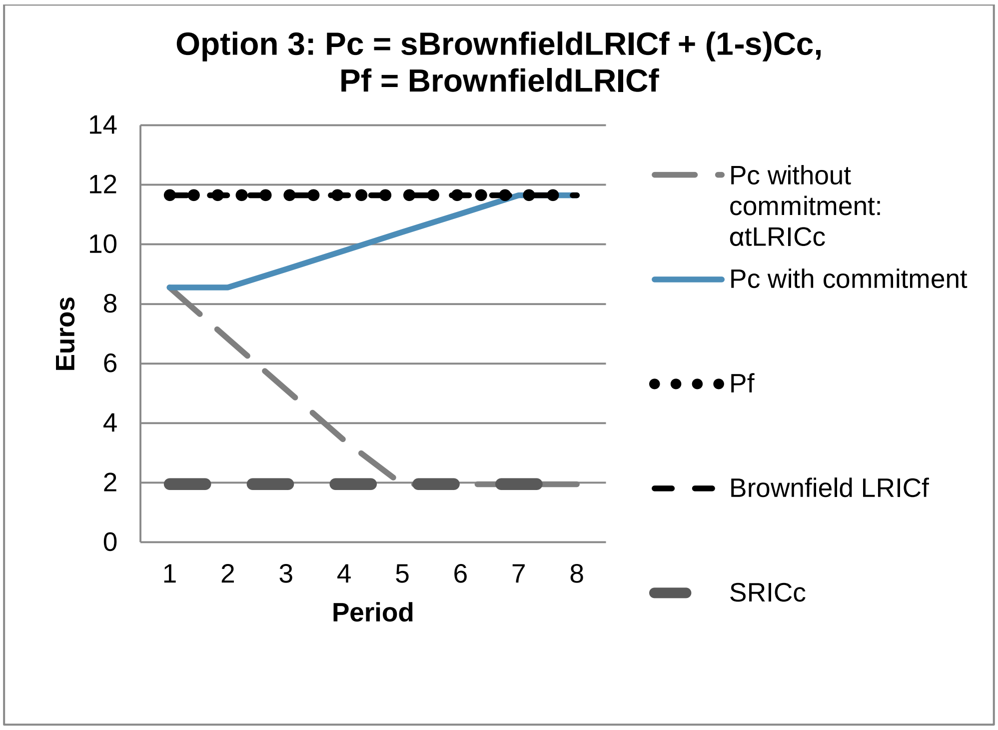


Figure 3 illustrates Option 2b, showing quite a different picture. While the case of no commitment is the same as before (and as in the other options), the case of commitment results in an increasing price for both copper and fibre that ends at LRICf. While the curve is shown to increase over time, it is the increased fibre share that triggers this increase. Thus, the curve could be flatter or steeper depending on the speed of fibre adoption by the customers. Note that the copper price is always well above the relevant copper cost, but the fibre price appears to be below the relevant fibre cost until the fibre share equals s = 1. However, it needs to be kept in mind that an increase in the fibre share has two effects for the incumbent. First, it provides the revenue (the price Pf) and then it triggers an increase in Pf and Pc that increases future revenues.

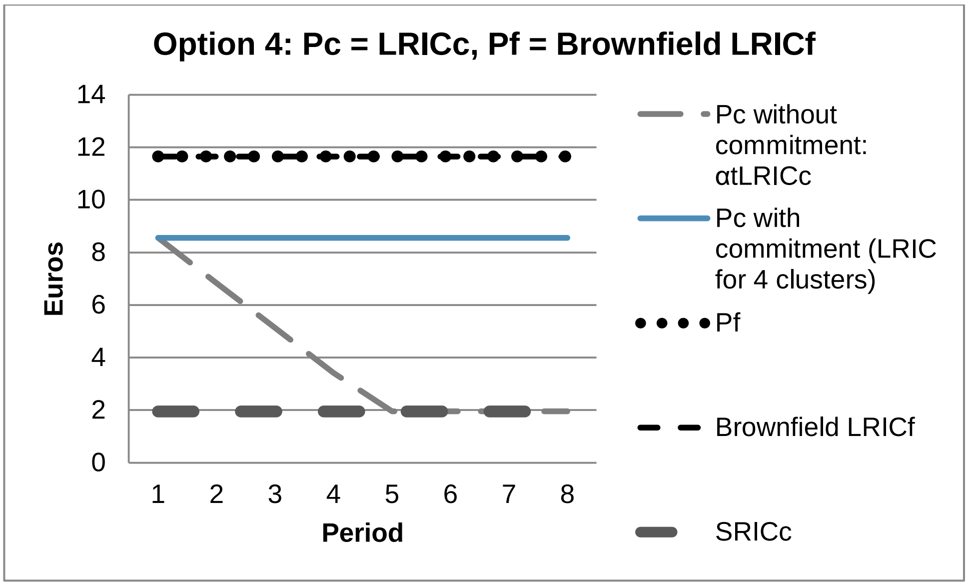
We have not separately shown Option 2a, where the copper and fibre access charge would be the result of averaging the copper and fibre costs. This could result in an initial small decrease below current copper charges followed by a rise. Whether the initial decrease would occur would depend on the coverage commitment that the incumbent would make for the end of the first access charge review period. The more extensive the commitment in terms of fibre share the higher would be the initial (copper) access charge.

Figure 4: Option 3 - Only the price of copper is based on averaging, not the price of fibre



While in Option 3, depicted by Figure 4, the copper price develops in the same way as under Option 2, the fibre price differs by always being at Pf = Brownfield LRICf = 11.65€.

Figure 5: Option 4 - The current price for copper in case of commitment, a glide-path when no commitment is reached



In Figure 5 Option 4 is shown with a copper price under commitment at the pre-existing European average price of 8.55€. That is way above the price without commitment (at least after completion of the glide-path) and should suffice as an incentive to commit. At the same time, the copper price with commitment remains well below the fibre price.

Comparing the four figures we find the following:

The distance between the copper prices with and without commitment is one important indicator of the strength of the incentive to enter into a commitment. This is largest under Option 1, followed by the two in this respect similar Options 2 and 3, while Option 4 comes in last. There may also be a difference between Options 2a and 2b in that initially the copper price may be lower under Option 2a than under Option 2b. In all cases the initial commitment incentive is quite low because under the glide-path the difference between the commitment and the no-commitment price only increases gradually, starting from zero. The incumbent, under a glide-path for the no-commitment case, could therefore have incentives to postpone commitment. As a result, the glide-path would either have to be steeper or a time deadline for commitment would need to be set by the regulator.

A second important indicator is the difference in profits to be made under copper or fibre deployment. The per unit profits are, in a crude way, approximated by the difference between p_F and Brownfield $LRIC_F$ on the one hand and p_C (in case of no commitment) and $SRIC_C$ (or HCA as the default) on the other. The difference between these two profits is the same for Options 1, 3, and 4. It has to be seen in a discounted value sense. Whether the difference in discounted values is positive or not depends on the length of the glide path and on the discount rate applied. If the length is sufficiently short and the discount rate not too high there will result a net profit from committing to a fibre build-out. This appears to be much less clear for Option 2, where the unit profit from fibre is negative at low fibre shares. However, since the price increases in the fibre share, the incremental marginal revenue per additional fibre subscriber is (under continuous adjustment of the shares) always equal to Brownfield $LRIC_F$.

The incentives for copper subscribers to switch to fibre, once it is available, depend on the difference in fibre and copper price. This difference, Δp, is approximated by the difference between the two wholesale prices under commitment. It is smallest ($\Delta p = 0$) for Options 1 and 2, followed by Option 3. Option 4 is last.

Table 1: Comparison of the pricing options

Option	Objective	Incentive to commit	Incentive to deliver	Migration incentive	Consumer welfare	Competitive neutrality
1	Fibre as MEA for copper (Brownfield LRIC)	Highest	Low	High	Least	Least
2a	Fibre = copper price = average of costs (Brownfield LRIC, HCA)	High	High	High	High	High
2b	Fibre = copper price = average of current copper price and Brownfield LRIC fibre	High	High	High	High	Medium
3	Copper averaged, fibre LRIC	High	Medium	Medium	Medium	Medium
4	Copper held at current charge	Medium	Medium	Medium	Medium	Medium

Overall, Options 2a and 2b appear to have the largest net advantages over the other options.

2.1.2.7 Geographic de-averaging

Types of geographic areas

For the purpose of discussing the appropriateness of geographic wholesale access charge de-averaging we distinguish between three types of geographic areas (clusters, exchanges).

First, there are those clusters/areas/exchanges, where FTTH is too costly to be installed.[14]In these areas broadband could only be provided by existing copper, fixed wireless access or cable, if at all. Here the question is if wireless technologies and cable should be encouraged by handicapping copper or if copper should simply compete on its own terms. Assuming the latter, competition may for certain periods results in the incumbent wanting to reduce copper retail prices so much that a price-squeeze would emerge under the regulated copper access prices. In this case, it would make most sense to use a retail-minus approach for copper wholesale access charges capped by the cost-based regulated LLU charge (or bitstream access charge). The reason for this cap is that it is most likely still above the costs of maintaining the copper network and it is unlikely that the copper network is going to be replaced or extended.[15]

Second, in a limited number of cases there are clusters/areas/exchanges, where alternative fibre investors could pre-empt incumbents or build duplicate fibre networks. Here the incumbent is likely to be induced to invest in fibre even if copper is currently still more profitable. The reason is that the incumbent will want to be ahead of other fibre investors. In this case, incumbents may invest in fibre without a specific incentive regime (i.e. permission to maintain copper prices above cost in exchange for commitment). High copper access charges could have an ambivalent effect in such circumstances. On the one hand, high charges may encourage independent fibre investors by increasing the opportunity cost of not investing in fibre and they would facilitate customer migration to fibre. However, on the other hand, by granting excess profits to the dominant firm that are not available to others, high copper charges may enable incumbents to subsidise investments in fibre and engage in penetration pricing in a way that competitors cannot match. In these circumstances, ring-fencing any excess charge above the cost of copper (for example through an explicit surcharge) may make sense, if such funds are made available to any potential investor in fibre.

Third, there are those clusters/areas/exchanges, where FTTH investment by the incumbent is viable, but not for alternative (duplicative) independent fibre investors. In this case the incumbent faces some potential NGA competition from cable but that can largely be dealt with through incremental upgrades and DSL. So, this is the area where the commitment processes described in this report would be most relevant. For most European countries we would expect this last type of areas to make up more than half of the population, while the second type of areas may be restricted to a few exchanges in densely populated cities particularly where cable is absent and the first type of areas will make up the remainder.

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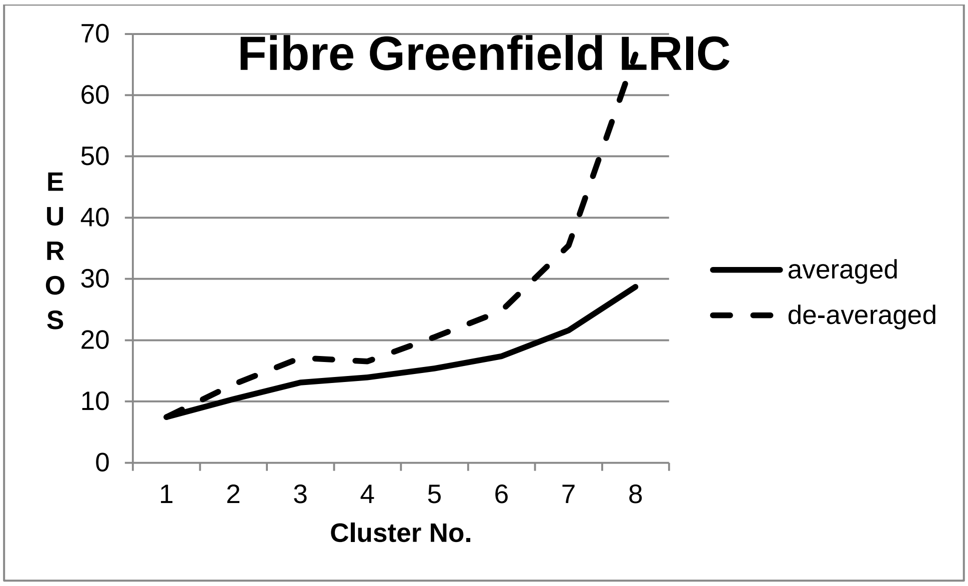
14 We may further divide here between those, where public subsidies make sense, and those, where subsidies would not pass a cost-benefit test.

15 Alternatively, an IRA or HCA approach may be used for the cap.

Illustration of cost differences

Figure 6-Figure 10illustrate cost differences between regions (represented by clusters) for the different technologies on an averaged and de-averaged basis. These numbers are again taken from the 8 clusters of “Euroland” as calculated in WIK (2011). Figure 6-Figure 8 provide the differences for Greenfield fibre LRIC, Brownfield fibre LRIC and approximated copper LRIC, while Figure 9-Figure 10 contrast the fibre and copper costs on an averaged and de-averaged basis. When prices are averaged, the assumption is that the same price will be set across the whole territory. However, the absolute level of the averaged price would depend on the extent of the roll-out i.e. if roll-out extends across all clusters, the averaged price would be higher than if the roll-out was limited only to urban areas.

Figure 6: Averaged versus de-averaged fibre Greenfield LRIC



What becomes very clear in Figure 6 is the very steep cost increase in the less dense clusters 7 and 8. This trend is tempered substantially by averaging. The Greenfield cost levels for fibre in Figure 6 are clearly higher than the corresponding Brownfield cost levels in Figure 7, but the shapes of the curves are quite similar so that the differences between averaged and de-averaged costs adjust about proportionally. Two insights are gained immediately from these figures. First, at current price expectations clusters 7 and 8 are out of reach. Second, averaging has the advantage that it tempers the tendency of de-averaged prices to become unaffordable.

Viewed by the difference between averaged rates and de-averaged costs, there appear to be obvious disincentives for an incumbent to invest in marginal clusters based on averaged access charges. However, investing in marginal clusters should push up the average charge overall, which means that all infra-marginal clusters would also have to pay the higher access charge. Thus, the marginal revenues from investing in higher clusters should correspond to the marginal costs. The extent to which this happens would depend on the speed with which averaged charges would follow the actual fibre build-out. A long lag would provide an investment disincentive, while a short lag would not. Going even further, a commitment incentive could be gained if the averaged access charge already beforehand includes all clusters the incumbent has committed to. If the incumbent fails to honour (all) of the commitment he would have to return excessive money collected for marginal clusters.

Figure 7: Averaged versus de-averaged fibre Brownfield LRIC

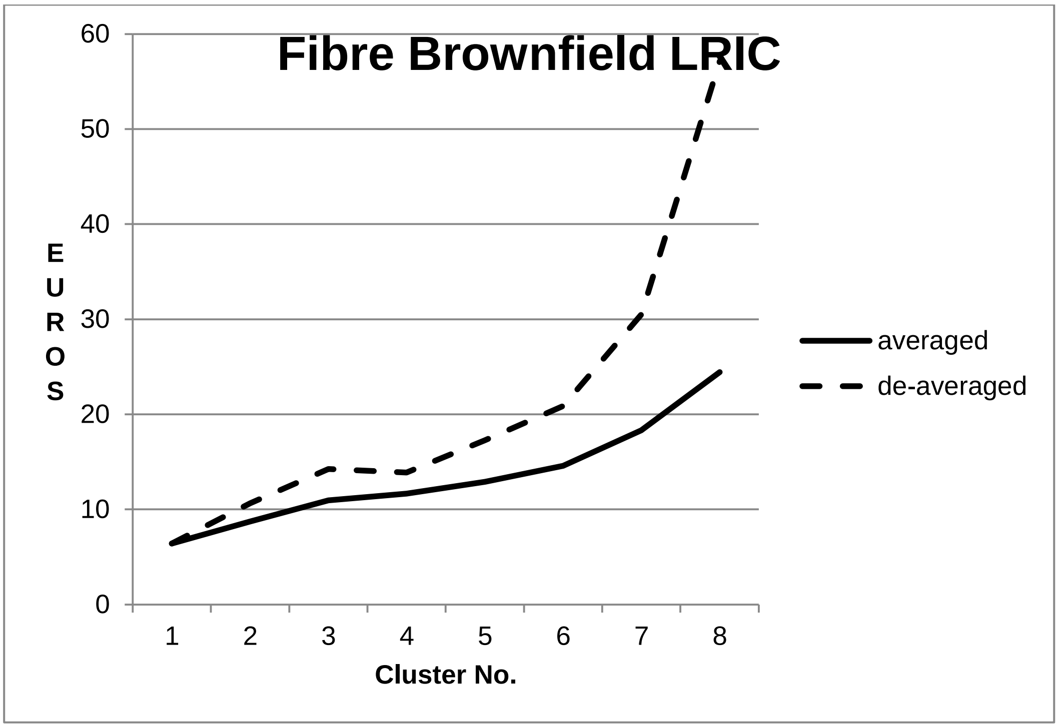
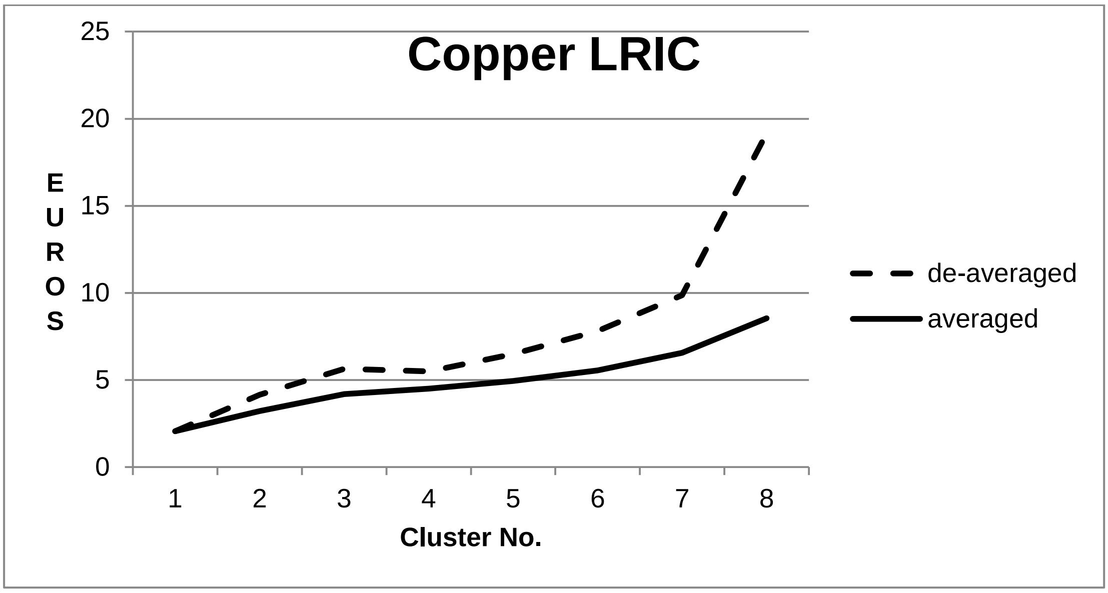
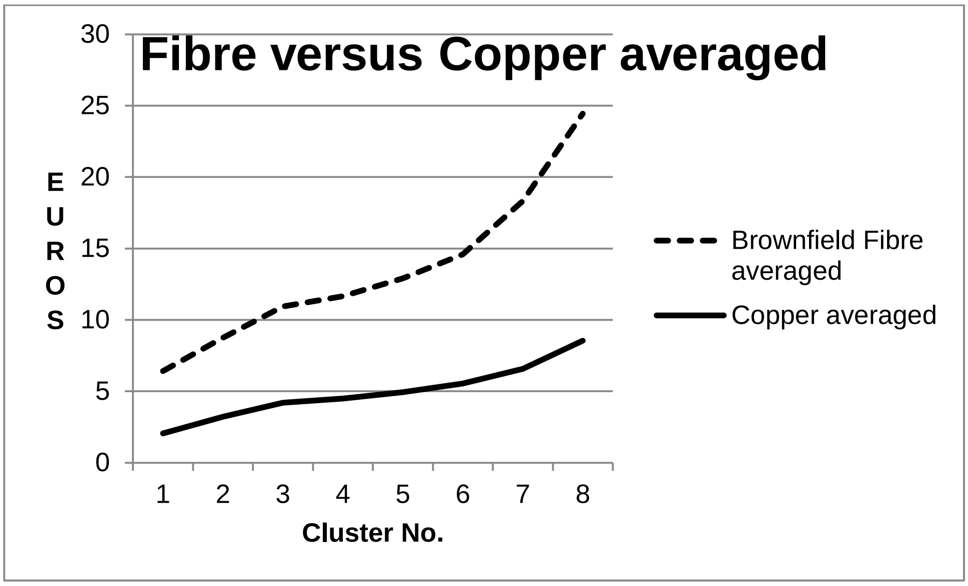


Figure 8: Averaged versus de-averaged copper LRIC



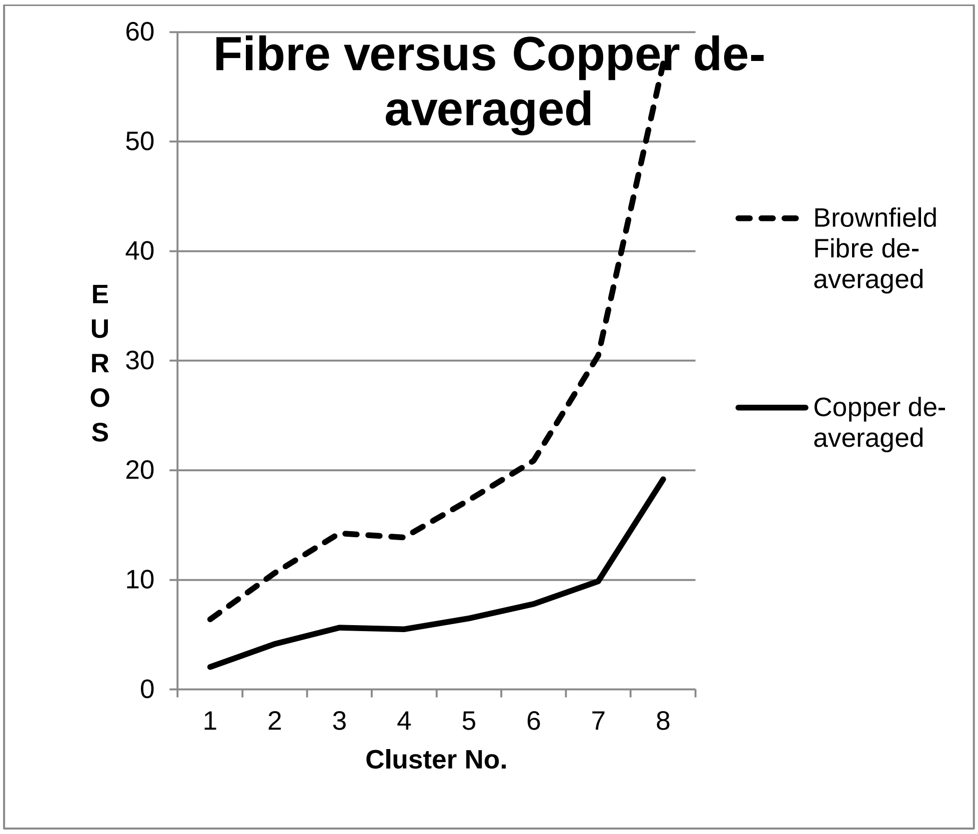
As in Figure 6-Figure 7 the data for averaged costs for copper in Figure 8 are taken as the cumulative average from Cluster 1 until the particular cluster. The average over all 8 clusters is given by the end point, which corresponds to the European average of 8.55€ per month. Figure 8 for copper shows much lower cost levels throughout and smaller relative cost increases for lower density areas than for fibre. Only cluster 8 is associated with a steep cost increase for copper. This difference is brought out clearly in Figure 9-Figure 10, which show that the difference between fibre and copper costs increases strongly, as one moves to higher clusters. Thus, not only does fibre become less attractive on its own merits but also in relation to copper costs. Correspondingly, any incentive policy for fibre build-out to reach higher clusters becomes not only more difficult but also more questionable from a social cost-benefit perspective.

Figure 9: Averaged fibre versus copper LRIC



This last feature is further revealed for the de-averaged differences between copper and fibre costs, as illustrated in Figure 10. These differences are substantially larger than the differences between the averaged cost levels. While the relative differences are large from the beginning (fibre costs being about double of copper costs even under copper LRIC assumptions) and increase for higher clusters (to about triple), it is the absolute cost difference that matters most. The differences go from about 4-5€for Cluster 1 to about 35-40€ for Cluster 8.

Figure 10: De-averaged fibre versus copper LRIC



The ambivalent effects of geographic de-averaging

Geographic de-averaging of fibre and/or copper can have quite ambivalent effects.

First, as seen in Figure 6-Figure 10, de-averaging according to geographic cost differences will strongly affect the cost differences (and thereby price differences) between copper and fibre for different geographic areas. In particular, there will be small cost differences between copper and fibre in dense areas and large cost differences between copper and fibre in rural areas. Inducing customers to switch will therefore be easier in dense areas than in less dense areas.

Second, because of lower access charges competition from access seekers will be fiercer in denser areas than in less dense areas, where access charges will be higher. Also, because of the low access charges duplication of fibre investment may become less likely in the dense areas.

Third, total fibre footprint may increase or decrease from de-averaging depending on whether the high de-averaged fibre price in less densely populated areas holds back customers from switching or whether the low averaged price (under no de-averaging) holds back the incumbent from investing.

Fourth, since fibre de-averaging would be on [Brownfield] LRIC basis, while copper de-averaging would most likely be on HCA as a default basis, the effects of de-averaging on fibre would be more drastic than on copper and that again could reduce the fibre footprint.

Because of the envisaged ambivalent effects of geographic de-averaging the decision about it may have to be made based on the specific situation in a particular member state. However, if geographic de-averaging is chosen it should always be accompanied by a retail-minus option. In case of de-averaging of wholesale access charges this would also allow the incumbent to use geographically uniform retail charges (with the consequence that wholesale access charges may have to be adjusted via retail-minus regulation). If no fibre de-averaging is chosen the relevant fibre LRIC should be based on the actual or planned economic footprint of fibre, not on the LRIC for the whole country.

2.1.2.8 Retail-minus option

Over the whole country there should be an additional retail-minus option for the access seekers. Thus, the wholesale access charge should always be the lower of the cost-based regulated access charge (including glide-path and/or averaging) and the retail-minus access price. This also allows the incumbent to compete with other access modes in high-density and low-density areas and to use penetration pricing for fibre if deemed necessary.

2.1.2.9 Rate shock from copper switch-off

Under all cost measures the cost of FTTH is higher than the cost of copper access. This is associated with a quality differential that justifies investment in fibre in spite of the cost difference.[16] A price increase for the switch from copper to fibre is therefore justified and has to be expected. How can that happen without hardships?

First, penetration pricing can reduce any rate shock by initially reducing the price difference. This may, however only attract the pioneering consumers and may no longer be available for the customers wanting to stay with copper.

Second, for those customers not valuing higher quality services available over fibre, the availability of lower grade services such as mobile could enable such copper subscribers to switch to this option rather than to higher-priced fibre.

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16 That is also why fibre cannot really be the MEA for copper without any quality adjustment.

Third, the incumbent (or fibre suppliers using wholesale access) could, at least for an initial period until customers have been accustomed to more advanced services, offer different fibre product classes at different prices. Among those classes there could be fibre products that could also be provided by copper and could be priced accordingly. The main point is that the higher level products have to be bought in sufficient quantity at sufficiently high prices in order to raise the average price to that required for fibre to be profitable.

Fourth, the incumbent may be willing to "subsidize" low-bandwidth customers to make them switch in order to speed up shutting down the copper network.

Fifth, over time the consumer appreciation for NGA services in comparison to copper services will likely grow so that a larger Δp becomes acceptable.

Sixth, as the share of remaining copper customers dwindles, the cost of supplying them will increase under any cost measure so that increasing their prices will be economically justified. That does not preclude subsidies for poor consumers.

Thus, there will not necessarily emerge any rate shock for copper customers faced with the opportunity to switch to fibre or even for those faced with a shutdown of the copper network.

2.2 Answers to the Questions

2.2.1 Question 19

What role do copper prices and a price differential to fibre access play with respect to NGA investment?

Copper prices are a main determinant for the incumbent's profitability before the switch to NGA. As long as the incumbent's current profits under copper are higher than the expected profits under fibre, the incumbent has no reason to switch to fibre. There are only two other factors influencing fibre investment that can even begin to compete in importance with the copper price. In the limited cases where viable, fibre investment by alternative operators provides a strong investment incentive for the incumbent. The other incentive comes from competition from other technologies such as cable, although cable competition is unlikely to initiate and has not (in practice) initiated full FTTH roll-out as a competitive response.

Taking into consideration these two other factors it remains that the price differential between the current copper access price and the expected fibre access price has to be large enough for fibre to generate enough profits relative to the current copper profits. This does not preclude that initially penetration pricing for fibre may prevail leading to little or no retail price differences between copper and fibre. Such penetration pricing would justify maintaining a retail-minus option for wholesale access charges.

2.2.2 Question 20

Would, in your view, a price increase for copper access products have an impact on the incentives of SMP operators and the economic capacity of alternative operators to invest in NGA?

A price increase for copper access products would have different impacts on the incentives of SMP operators and the economic capacity of alternative operators to invest in NGA.

For incumbents such a price increase would generally increase the profitability of copper (within limits because of the competition from mobile and cable services) and thereby reduce the attractiveness of fibre investments. It would, however, make it easier for the incumbent to convince customers to switch to fibre, once the fibre network has been built and copper and fibre are offered in parallel. It also would facilitate the forced move of customers under a shut-down of the copper network, once the fibre network is completed (for an exchange or area).

A price increase for copper access products would make NGA investment more attractive for alternative operators, because for them the profitability of copper generally sinks under higher copper access charges. However, these incentives are only relevant in those few areas, where alternative fibre investors can succeed even with low market shares. This could hold for very high-density areas. This incentive can then have a feedback effect on the incumbent, who may want to pre-empt the alternative operator so that the duplication does not materialize. Alternative operators could also be deterred from investing in fibre in dense areas because the high copper access charges deprive them of investible funds generated in other areas of the country, where they continue to compete as wholesale access seekers. High copper charges could also deter investment by entrants if they believe that high copper charges could be used by incumbents to cross-subsidise fibre investments and thereby enable them to offer “penetration” prices in a manner which cannot be matched.

2.2.3 Question 21

What results could be expected in case of a significant reduction in the copper access prices on consumers and operators, e.g. in terms of retail copper/fibre-based broadband prices and fibre investment incentives?

A significant reduction in copper access prices will lead to a retail price reduction for copper-based services of a similar order of magnitude as the access price reduction.

This will reduce profits from copper for the SMP operator and increase profits of alternative copper operators (by a smaller amount). This will make fibre investment look more attractive for the SMP operator. However, it will also lower the achievable retail price for fibre during any transition period, where consumers can choose between copper and fibre. The length of such a transition period (before the copper network is shut down) can therefore influence the extent to which the lower copper price actually incentivizes the fibre investment.

2.2.4 Question 23

Could a copper switch-off accompany a steered copper to fibre migration? In this respect, in what circumstances, in which areas and in what timeframe would a copper switch-off be appropriate?

Running the copper and fibre access network side-by-side is costly so that a shutdown of the copper network becomes necessary after some time. From an economic standpoint this should happen, when the economic benefits from having two networks are less than the economic costs. This is likely to be the case, once the fibre build-out is completed and all copper subscribers can be and have been connected to the fibre access network. Some of these customers may have to be forced to connect, where price incentives (e.g. no price increase and no switching costs) may have to be used.

2.2.5 Question 24

With regard to copper switch-off, how could those consumers be served which would also, post-migration, demand fixed narrow-band telephony services at a rate comparable to today's rates? Do you consider that the benefits associated with the provision of higher quality services could outweigh the associated potential price increase of basic internet and telephony services?

Already today there exist low price components adapting standard voice equipment (POTS a/b interfaces, ISDN S0 interfaces) to VoIP. DSL modems may be replaced by ONT respectively routers. The customer may keep all his terminal equipment, while the operators' CPE will emulate the required old standard interfaces.

As explained in Section 2.1.2.9 above, there will not necessarily emerge any rate shock for copper customers faced with the opportunity to switch to fibre or even for those faced with a shutdown of the copper network

However, price increases for narrow-band services may occur, because even those customers would need their own fibre line, once the copper network has been shut down. Telephone customers have enjoyed many price reductions in the past. It is not clear why there should never be any price increases. Also, narrow-band telephone customers have cheap mobile telephone options so that the hardship from fixed line price increases is less today than it used to be. Lastly, the incumbent may want to keep those customers and not actually increase the price for those services.

2.2.6 Question 25

How would NGA network migration occur in a world where multiple infrastructures exist and where it could not be taken for granted that copper customers migrate to fibre rather than cable and/or 4G? How would this uncertainty affect the investment incentives of the SMP/alternative operators?

There will certainly be some leakage of customers from copper to cable and 4G rather than to the NGA network. However, there will also be migration from cable and mobile to NGA. In circumstances in which fibre demand is highly uncertain due to the potential for traffic to migrate elsewhere, this constitutes an investment risk that may justify a risk premium for fibre access charges. However, at the same time, lower fibre access charges may make the NGA network more competitive and avoid leakage that might otherwise occur. This ambivalence is a strong reason for having a retail-minus rule for access charges in addition to the cost-based access charge.

For alternative operators the investment situation is more difficult, because they normally cannot expect to reach the same market shares as the incumbent. That is why they will only successfully invest in NGA if they have additional cost advantages over the SMP operator.

2.2.7 Question 29

How could an access pricing scheme that combines both copper and fibre be constructed in order to ensure efficient migration to fibre and achieve DAE targets?

Pulling together the arguments in the previous sections we come to the following suggestion:

The incumbent should be faced with wholesale pricing options that induce him to engage in a commitment to fibre build-out that reflects the viable area of coverage. The option will consist of differential pricing for commitment versus no-commitment.

In case of no commitment the copper price could follow a glide-path that begins with the current copper wholesale access price and ends at a copper price equal to a measure of copper cost deemed correct for a geographic area, where copper remains the incumbent’s access technology choice. The relevant cost concept in areas where fibre is viable would be HCA or SRIC+. There could be a differentiation between those areas where there will definitely be no fibre from those where there should be fibre but the incumbent does not commit. The length of the glide path and its steps should depend on the difference between the pre-existing (LRIC-based) copper price and the relevant new cost measure (with HCA as the default). The larger the difference, the longer the time given for glide-path. The steeper is the path the higher is the incentive to commit to fibre build-out. The regulator (or the EC) should pre-specify the point in time, when the glide-path should start. This point in time should coincide with the time to be given the incumbent for entering into a binding commitment. This could be a year from the passage of the required framework by the EC. The commitment would have to include specific targets for fibre build-out in terms of dates and coverage. Actual fibre customer uptake will be triggered by the dynamic pricing mechanism, which may, however, also contain fibre share targets in order enforce the correct price averaging (with penalties if the required fibre share is not achieved).

In case of commitment, the pricing should follow Option 2 above. That means that the initial copper access charge should equal the average of the cost of copper and fibre, as long as the incumbent fulfils his commitment. This could (under Option 2a) result in an initial reduction, depending on the level of the fibre commitment made by the dominant firm. Over time the copper price would gradually increase in line with the increasing proportion of fibre in the network, and the same would hold for the fibre access charge.

There should be a retail-minus option for copper and fibre access charges for the case that the incumbent wants to price copper or fibre at retail in such a way that a price squeeze would emerge under the regulated access charges. This could happen under penetration pricing for fibre. This could then lead to divergent access charges for copper and fibre.

In order to enforce the commitment for fibre build-out we suggest to include the following: In case the incumbent does not live up to the commitment any funds generated by the incumbent above the funds that would have been generated (at the same outputs) under the no-commitment case should be returned to the access seekers who overpaid. The excess funds may therefore first have to go into an escrow account. This escrow account will be put at the full discretion of the incumbent after the commitment is fulfilled. If the incumbent fails to live up to the commitment for fibre build-out the copper price reverts to the glide-path price relevant for the no-commitment case. In addition, the funds accumulated in the escrow fund would revert back to the wholesale access seekers, who overpaid for access.

Should this model of using an escrow account as a means for enforcing commitment be deemed unacceptable it would have to be replaced by an acceptable one with similarly strong commitment properties.

2.2.8 Question 30

Could a pricing scheme for copper be envisaged that rewards fibre investors at those exchanges where a credible commitment is made to carry out NGA investments? In this respect, could prices for copper access at those exchanges (or in those areas) where fibre investments are carried out be calculated on the basis of i) the average cost of copper and fibre access, ii) the MEA approach, i.e. entirely reflect the cost of fibre deployment?

Yes, as stated in our answer to Question 29, a pricing scheme for copper can be envisaged that rewards fibre investors at those exchanges where a credible commitment is made to carry out NGA investments, or indeed to reward investors for NGA investments reaching a percentage of area or of users.

However, as explained in more detail in Sections 2.1.2.5 and 2.1.2.6 above, copper access at those exchanges (or in those areas) where fibre investments are carried out should not be calculated on the basis of

i) the average cost of copper and fibre access, <u>unless the price of fibre is set at that same level</u>;

ii) the MEA approach, as defined in this question (i.e. entirely reflect the cost of fibre deployment).

Copper access charges on the basis of the average cost of copper and fibre access, while fibre is priced on a [Brownfield] LRIC basis, share some of the advantages of our preferred approach (described in the answer to Question 29). However, they have no built-in penetration pricing for fibre, would perpetuate excess profits for the dominant firm on copper, and may avoid customer rate shocks only after fibre has gained a significant market share.

Copper access charges on the basis of the MEA approach (as characterized in this question) are not grounded in a defensible cost concept and they would most probably lead to substantial copper price increases at a time when fibre is not yet available. In fact, in view of competition from cable, mobile or alternative NGA investors, the resulting high copper prices may not be sustainable. In contrast, a defensible approach to fibre as MEA for copper would take only that fraction of the fibre LRIC that would correspond to the quality of services provided by copper.

2.2.9 Question 31

With regard to question 30, what would be an appropriate time-frame for such an incentive pricing scheme, i.e. how long should high copper prices apply and by which time should fibre investments be finalised?

According to a previous study by WIK-Consult (WIK, 2010), we would expect the time frame from the beginning of the build-out to full penetration of the commitment areas to be within a range of 8 to 10 years. The incentive pricing scheme would have to fit into this time frame by a realistic assessment of the NRA. Regular (e.g. annual) checks would be needed to ensure that investment plans were on track.

2.2.10 Question 32

In case a glide path for copper based access prices were to be used, what would be the appropriate length and intermediate steps of such a glide path?

The length of the glide path and its steps should depend on the difference between the current copper price and the relevant new copper cost measure. The larger is the difference the longer would the glide-path have to take.

2.3 Other Issues of Concern

2.3.1 Incentives for co-investment

A regulatory interference in favour of co-investment could be advisable if the incumbent has (from a social perspective) insufficient incentives for co-investment.

Incentives for the incumbent to engage in co-investment could be

- That co-investment could lead to less competition in the market. However, while co-investment may reduce the number of competitors in the market (because it may exclude wholesale access seekers and duplicative NGA investment), it may increase competition in the market by lowering the marginal costs of the co-investing firms (Nitsche and Wiethaus, 2011).
- That co-investment eliminates the danger of being pre-empted (and the danger of duplication)
- That co-investment may be associated with less regulation
- That co-investment reduces the investment risk for the incumbent

In contrast, the downsides for the incumbent are

- That co-investment leads to higher costs (per loop) if the multi-fibre model is used
- That co-investment is potentially associated with inferior access. This would hold if an FTTH PON single fibre model is used so that all but one investor will depend on access that is similar to wholesale access.
- That the incumbent will have less say in the investment and operating decisions than under single ownership. Also, there could be disputes, when ownership and usage shares diverge.

On balance these arguments make co-investment look attractive for the incumbent only in those few areas, where duplicative investment is viable. However, even there the small scale of potential rivals makes the threat of duplication quite small. Co-investment looks much less attractive to the incumbent in areas, where FTTH is viable but no duplication.

From the regulator's perspective, co-investment could be attractive in very densely populated areas in order to avoid duplicative investment and overall in order to enable facilities-based competition and therefore reduce heavy-handed regulation. In the less dense areas co-investment will likely reduce coverage if it is of the multi-fibre type.

Regulatory incentives for co-investments could be created by allowing the incumbent to use the excess profits from copper access charges **only** for co-investment. However, it is unclear, how this money would be divided among co-investors. Also, what about alternative operators who do not participate in co-investment? It may therefore be preferable to divide the money between co-investment and initial reductions in fibre access charges (in order to allow for penetration pricing).

Given such incentives co-investment should then result from private negotiations that could include the above aspects. Regulators should create an environment, where such negotiations can take place.

2.4 Technical Appendix

2.4.1 Effects of access pricing in the transition period

We would like to know, what incentives the various wholesale access pricing combinations of copper and fibre create for incumbents to switch customers from copper to fibre and what incentives they create for customers to make the switch. In the following analysis this question is only answered for the transition period, once the decision to switch to fibre has been made and the build-out to fibre has been done for a specific exchange. The period begins when the switch of customers from copper to fibre actually occurs and ends when the copper access network has been shut down.

We will start with the incentives for incumbents, which depend on the revenue consequences and cost consequences of such a switch. Since several of the pricing suggestions depend on weighted averages of copper and fibre customers (in an exchange area or in a larger geographical area) we consider switches in the share of customers rather than changes in the absolute number of customers. This is legitimate, as long as the sum of copper plus fibre customers that depend on the incumbent (as retail customers or via wholesale) remains constant. It neglects competition with cable and mobile services. We also only look at wholesale prices and not at the implied retail prices (and profits).

2.4.2 Effects on the incumbent's incentive to induce customers to switch from copper to fibre

Normalizing the total number of customers to 1 total revenue is $R = sp_F + (1\text{-}s)p_c$, where s is the share of fibre customers and p_F and p_c are the wholesale access prices for fibre and copper. The change in revenue induced by a change in the share of fibre is then given by $dR/ds = p_F + s(dp_F/ds) + (1\text{-}s)(dp_c/ds) - p_C$. Thus, if the prices of copper and fibre are unaffected by the change in customer shares the revenue change simply becomes $dR/ds = p_F - p_C$. For example, assume that wholesale access charges for both copper and fibre equal LRIC. In that case if LRIC does not change with the shares we normally would expect $dR/ds = LRIC_F - LRIC_C > 0$. However, genuine LRIC does change with the share change.[17] In particular, $dLRIC_F/ds < 0$ and $dLRIC_C/ds > 0$. This could make the sign of the revenue change ambiguous, something we would expect at high levels of s, when $LRIC_c$ could become quite high.

Before going through some specific pricing suggestions including those contained in the EC consultation let us consider the cost implications of a change in s at the exchange level. We assume that the incumbent has already done the basic fibre build-out in that particular exchange and that he has to make the decision which customers to connect to fibre and to disconnect from copper. We understand that there can be various build-out strategies about connections to fibre. We assume that the network provider installs fibre cables in or very near all potential customers so that the actual connection of a new customer only requires activation, electronic switch-over and new customer premises equipment (the latter may be paid by the customer or - as we assume here - by the network provider). This contrasts with the case that the network provider would lay new fibres for any new customer. For the switch away from copper the costs saved by the incumbent are mostly maintenance costs for lines and (sometimes more importantly) for ports. While it is likely that the costs saved by turning off the copper line

17 Regulators often set LRIC charges for some time based on target quantities of output, while the true LRIC would change with actual quantities.

are of the same order of magnitude as the costs of activating a fibre line, the CPE costs (estimated at €3.48 per customer per month in WIK, 2011) are likely to dwarf both these costs. In the following we will therefore assume that the net cost changes from a customer switch to fibre is equal to the additional CPE cost for fibre and that the other costs and cost savings net out. Thus $dC/ds = CPE_F$.

Now the profit change from a change in s becomes

$$d\pi/ds = dR/ds - dC/ds = p_F + s(dp_F/ds) + (1-s)dp_c/ds - p_C - CPE_F.$$

We can now look at the four pricing options discussed in the main text above:

(1) Both copper and fibre wholesale access are priced at the LRIC for fibre

If fibre access is literally taken as the MEA for copper access we get $p_C = p_F = LRIC_F$. This again would provide little incentive for switching customers to fibre. In this case one could also argue that the access charge should stay constant independent of s.

If we assume that this price itself does not change in s we get

$$d\pi/ds = p_F - p_C - CPE_F = - CPE_F.$$

Thus, on the wholesale level the incumbent would lose money from the switch. This would suggest that the wholesale customer should pay for the CPE cost. However, even in this case the switch would be only profit neutral so that this pricing would not provide for any incentive to speed up the switch.

(2) The same price for fibre and copper derived from some cost average over both access technologies

This means $p_F = p_C = p_\phi$.

Now, the averaged price could well change with a change in s. However, it is unclear in what direction the change will go. If one takes a genuine LRIC approach to fibre, the $LRIC_F$ will decline according to $LRIC_F(s=1)/s$. Here $LRIC_F(s=1)$ represents the LRIC at s = 1. This follows from the assumption that virtually all costs for fibre deployment are incurred, once the decision is made to employ fibre in an exchange area. In contrast, copper can be expanded much more incrementally so that the increase in s of $LRIC_C$ would be less steep than the decline of $LRIC_F$. This suggests a decline in weighted average costs as s increases $dp_\phi/ds < 0$. If that is true we get

$$d\pi/ds = s(dp_\phi/ds) + (1-s)dp_\phi/ds - CPE_F = dp_\phi/ds - CPE_F < - CPE_F.$$

In this case the disincentive to switch customers to fibre would be even stronger, and there would remain a disincentive even if wholesale buyers (or end-users) paid for CPE_F.

In contrast, if both, the regulatory cost basis for copper and for fibre remain constant over the range of s and if the cost of copper is below the cost of fibre we get $p_\phi = sC_F + (1\text{-}s)C_C$ and therefore $dp_\phi/ds = C_F – C_C$. As a consequence

$$d\pi/ds = C_F – C_C - CPE_F.$$

In this case, which will likely hold within any regulatory review period, we may get an incentive for the incumbent to switch customers to fibre provided the cost difference between fibre and copper is large enough. It should be large enough because C_F will already contain the CPE cost along with other cost differences.

(3) <u>The price of fibre is determined by $LRIC_F$ and the price of copper determined by an average of copper and fibre costs</u>

Here we assume that $p_F = LRIC_F$ and $p_C = sLRIC_F + (1\text{-}s)C_C$, where C_C is a copper cost measure derived by the regulator (LRIC, historic cost, IRA or the like).

Now we get

$$d\pi/ds = LRIC_F + s(dLRIC_F/ds) + (1\text{-}s)(sdLRIC_F /ds+ LRIC_F + (1\text{-}s)dC_C /ds - C_C) - sLRIC_F - (1\text{-}s)C_C – CPE_F$$

$$= (2 – 2s)(LRIC_F – C_C) + (2s –s^2)dLRIC_F/ds + (1\text{-}s)^2dC_C/ds – CPE_F .$$

Starting at $s = 0$ this burns down to $d\pi/ds = 2(LRIC_F – C_C) + dC_C/ds – CPE_F$. Because $LRIC_F$ already contains CPE_F we have $LRIC_F> C_C + CPE_F$ and also $dC_C/ds > 0$. Thus, $d\pi/ds > 0$ at $s = 0$.

Arriving at $s = 1$ it becomes $d\pi/ds = – dLRIC_F/ds – CPE_F$. Since dC_C/ds should be small in the neighbourhood of $s = 0$ and since $dLRIC_F/ds$ is fairly small in the neighbourhood of $s = 1$, we can say that the profit incentive to switch to fibre is large at low levels of s and could become negative near $s = 1$.

(4) <u>A glide-path for the copper price</u>

In this case we have $p_F = LRIC_F$ and $p_C = \alpha_tLRIC_C$. Here α_t is the glide factor with $d\alpha_t/dt< 0$ for $0 \leq t \leq T$, where T is the end of the glide path period. With reference to Hoernig et al. (2011) we assume $\alpha_0 = 1$ and $\alpha_T = 0.2$ so that $\alpha_TLRIC_C = SRIC_C$.

This implies $\pi(s,t) = sLRIC_F + (1\text{-}s)\alpha_tLRIC_C – CPE_F$. As a result $\partial\pi/\partial s = LRIC_F - \alpha_tLRIC_C – CPE_F$. The incentives for the incumbent to switch customers here are larger for smaller values of α_t. Furthermore, $\partial\pi/\partial t = (1\text{-}s)LRIC_C(\partial\alpha_t/\partial t) \leq 0$, meaning that profit from copper decreases in t, while the profit from fibre is unaffected by t. Thus, the incentive to switch customers increases over time.

2.4.3 Effects on the end-users' incentives to induce customers to switch from copper to fibre

Consumers will voluntarily switch from copper to fibre if the price increase Δp (including some fixed switching costs which we neglect) that they suffer from the move is smaller than the WtP increase, ΔWtP, that they enjoy from the move. The larger is ΔWtP – Δp the more likely and the faster the move will occur. Assuming that Δp is the same for all customers, the speed and extent of switching will depend on the distribution of WtP among customers. Here we assume that there is an initial distribution of preferences such that at zero price differences a large percentage but not all customers will switch and that at large values of Δp almost no customers will switch. Further, we assume dΔWtP/dt> 0 for all customers and dΔWtP/ds > 0 for all customers. The first should hold because new applications for fibre will be developed over time and the second will hold because non-subscribers learn the benefits of fibre from existing subscribers. While both of these assumptions imply some acceleration effect, this may be tempered because at higher s the remaining copper customers have low ΔWtP.

For simplicity we assume that retail competition assures that the retail mark-ups for copper and fibre are the same. That implies that the retail price differences mimic the wholesale price differences. In order to find the incentives for consumers to switch we therefore have to check the wholesale price differences under the various pricing schemes first.

(1) <u>Both copper and fibre wholesale access are priced at the [Brownfield] LRIC for fibre</u>

In this case Δp = 0 so that almost all consumers will quickly switch to fibre and the remaining copper customers will be induced to switch via the high s as well as over time.[18] Comparing these incentives with those of the incumbent we conjecture that customers are going to switch, although the incumbent may or may not like it. The question here is if the incumbent will therefore shy away from building out such an exchange in the first place.

(2) <u>The same price for fibre and copper derived from some cost average over both access technologies</u>

In this case Δp = 0 so that almost all consumers will quickly switch to fibre and the remaining copper customers will be induced to switch via the high s as well as over time. Comparing these incentives with those of the incumbent we conjecture that customers are going to switch, although the incumbent may or may not like it. The question here is if the incumbent will therefore shy away from building out such an exchange in the first place.

18 The absolute value of p_ϕ is important for the end-users' potential switch to other providers such as cable or 4G.

(3) The price of fibre is determined by LRICF and the price of copper determined by an average of copper and fibre costs

In this case $p_F = LRIC_F$ and $p_C = sLRIC_F + (1-s)C_C$

This implies $\Delta p = (1-s)(LRIC_F - C_C)$. At the beginning there is an initially potentially large $\Delta p = LRIC_F - C_C$. However, as s increases Δp becomes smaller and eventually vanishes.

Assuming that some copper customers will initially switch even at a large Δp this will likely become a self-propelling process. Here the incentives for the incumbent are reverse, starting with high incentives.

(4) A glide-path for the copper price

In this case we have $\Delta p = LRIC_F - \alpha_t LRIC_C$. Here we have some price change to begin with and it will increase over time. Under rational expectation this would make the customers switch early if at all. Otherwise, copper customers may get stranded with copper.

Overall, we find that during the transition process the incentives for customers and the incumbent for switching may run contrary to each other. However, given the fact that an incumbent has built out fibre at an exchange the main driving force may be the end-users and the incumbent may be interested in an overall maximal profit for the whole transition period (given that afterwards the wholesale price is going to be $p_F = LRIC_F$).

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