Rate-base adjustment for inflation in energy networks regulation

A report for Energiavirasto

02/10/2023

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INTRODUCTION

We have been commissioned by Energiavirasto (EV), the Finnish energy regulatory authority, to assess some aspects related to the treatment of capital expenditure and the asset base in the economic regulation of energy network activities in Finland.

In particular, we have been asked to:

- assess how the current revenue-cap methodology accounts for inflation,
- identify any possible bias regarding the current treatment of inflation, and
- recommend ways to overcome this bias (if any).

To do so, we first illustrate the different approaches adopted by regulators to define and adjust over time the component of the allowed revenue intended to cover capital expenditure.

The rest of the document is organised as follows. In Section 1, we outline a conceptual framework for defining the value of the assets used to provide the network services and adjusting it for inflation. In Sections 2 and 3, we identify and review the main approaches currently used at international level for the treatment of inflation in setting the component of the allowed revenue intended to cover capital expenditure. In Section 4, we report on the result of a review of the relevant academic literature. Section 5 presents our understanding of the methodology currently used by EV to set the component of the allowed revenue intended to cover capital expenditure. In Section 6, we present our considerations on possible ways forward.

1. ALLOWED REVENUES AND CAPITAL EXPENDITURE

Regulators typically determine the level of the allowed revenue of a regulated business – e.g. a network company - in order to cover both (efficient/prudently incurred) operation and maintenance costs (OPEX) and capital costs (CAPEX)[1]. The latter is intended to provide returns on the 'Regulatory Asset Base' (RAB), the set of assets, possibly approved by the regulator, which is deemed necessary for the provision of the network services. The value of the RAB is usually referred to as the 'Regulatory Asset Value' (RAV)

The allowed revenue intended to cover CAPEX is itself composed of two components:

[1] Tariffs for regulated services charged to grid users, and therefore to energy consumers, typically also include other items, such as surcharges to fund the support of renewable energies or other activities of general interest, as well as duties and taxes.

- a component to cover depreciation[2] of the RAB, i.e. to cover the capital invested in the assets used to deliver the network services in a specific period, ('return of capital')[3];
- a component to cover the cost of capital, i.e. to compensate for the capital invested in the business ('return on capital').

Every year, the RAV is typically adjusted by:

- subtracting the depreciation of the assets in the RAB over the previous year; and
- adding the value of the new assets (approved by the regulator and) included in the RAB.

Depending on the methodology used by the regulator, the RAV could also be revalued, typically at the beginning of each year. We will return to this aspect in Section 3.

In a specific year, the return on capital is defined as the product of:

- the RAV at the beginning of the year; and
- the applicable rate of return on capital.

The latter is generally a weighted average of the costs of the two main sources of capital: equity capital and debt capital. The 'Weighted Average Cost of Capital' (WACC) can then be expressed as:

(1) $WACC = \alpha_E * r_E + \alpha_D * r_D * (1-t)$

where:

- α_E and α_D are, respectively, the shares of equity and debt in the value of the business, with $\alpha_E + \alpha_D = 1$;
- r_E is the rate of return on equity required by the investors to invest in the business;
- r_D is the rate of return on debt required by the lenders to lend money to the business;
- t is the applicable corporate tax rate. Its inclusion in the formula recognises the fact that the interest paid on the debt capital is generally a deductible cost for tax purposes and therefore the actual cost of debt for the business needs to be reduced accordingly.

Most regulators in Europe adopt some form of incentive-based regulation to regulate network activities. Incentive-based regulation rests on the regulator setting the value of some of the regulatory parameters for a predefined, multi-year period, the so-called 'regulatory period'. The length of the regulatory period varies across jurisdictions, typically between three and eight years[4].

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[2] Strictly speaking, depreciation measures the 'consumption' of an asset over time, as the asset is used during its economic life.

[3] Depreciation may take different profiles over time (e.g., straight-line depreciation, in which the asset is depreciated at a constant rate over its economic life). The discussion of the possible depreciation profiles is beyond the scope of the present Report.

[4] An eight-year regulatory period is coming to an end in Great Britain as part of the RIIO-2 regulatory mechanism.

At the beginning of each regulatory period, regulators set the value and, possibly, the trajectory of the regulatory parameters over such a period. The incentive for the regulated business to improve its efficiency stems from the fact that, if it is able to reduce its costs more than what the regulator expected and embedded into the trajectory of the allowed revenues, it could keep (a share of) the extra savings.

Even when incentive-based regulation is not used, regulators may still decide to predefine the level of some regulatory parameters for a period of time.

2. A FUNDAMENTAL QUESTION: BACKWARD-LOOKING OR FORWARD-LOOKING REMUNERATION

A fundamental question regarding the component of the allowed revenue to cover CAPEX is whether such a component should aim at:

- allowing the network business to recover the costs of its investments over the economic lives of the assets (backward-looking remuneration); or
- providing the network business with the financial resources to replace the existing assets once they reach the end of their economic (or usable) lives (forward-looking remuneration).

In a static world, with no inflation or technological development, the two types of approaches would coincide, as the cost of replacing the assets at the end of their economic lives would be equal to the value of the existing assets when they were included in the RAB.

However, in a non-static world, the two types of approaches have different implications.

Backward-looking remuneration approaches aim at remunerating the network business and, therefore, their investors for the financial resources invested in current assets. By the time these assets reach the end of their economic lives, the network business will have recovered the funds invested in them, including an appropriate rate of return on these funds. The new assets, replacing the ones which have reached the end of their economic lives, will require new funds, which will again be recovered, including an appropriate rate of return, over the assets' economic lives. In reality, investments in network businesses do not happen in discrete cycles, as this schematic description might suggest. However, the fundamental characteristic of the backward-looking remuneration approaches is that they aim at recovering the cost and remunerating the investment in existing assets, while new assets will require new funds (which might well be provided by reinvesting the funds returned on existing assets. However, see Box 2 below).

Forward-looking remuneration approaches, on the other side, do not explicitly aim at remunerating existing assets, but rather at providing the financial resources for replacing them at the end of their economic lives. In doing so, they provide

revenues to the network business, which might well be used to remunerate existing investors, but without any guarantee that they could be sufficient for this purpose[5].

The choice between backward-looking and forward-looking remuneration is therefore not just a philosophical question, but it has very practical implications. For example, as the future costs to replace the existing assets once their economic lives have come to an end is uncertain, also considering the typical long lives of these assets (up to 50 years for cables), the forward-looking remuneration will aim at an uncertain and most probably moving target – providing the resources necessary to replace existing assets at the end of their economic lives. This might imply frequent changes in the network tariffs and/or uncertainty for investors on the extent to which they will be able to recover their investments. We will return to this point in the next Section.

3. THE TREATMENT OF INFLATION

Another dimension of choice for the regulators is whether to use nominal or real rates of return (e.g. WACC) and to what extent the RAV is revalued over time.

In what follows, we will define as:

- Nominal rate of return (NRoR), the rate of return emerging from formula (1) (for the WACC), or any equivalent formula, using the market (nominal) values for the rates of return on equity and on debt capital;
- Real rate of return (RRoR), the rate of return obtained from the NRoR by subtracting an appropriate indicator of inflation[6].

With respect to the RAV, different approaches are possible:

- the 'Historic cost' approach, where the RAV is not adjusted for inflation, with each asset in the RAB valued on the basis of its (construction/acquisition) cost at the time when it was first included in the RAB;
- the 'Indexed-RAV' approach, in which the RAV is updated annually by indexing it, using an appropriate inflation rate;
- the 'Replacement cost' approach, where the RAV is re-evaluated every year by estimating what it would cost to replace the assets in the RAB at current costs (for equivalent assets).

Different combinations of approaches to the rate of return and to the RAV valuation are possible. However, not all of them provide a fair and consistent remuneration of CAPEX, avoiding inherent under- or over-remuneration (e.g. because of double counting of inflation).

In particular, the regulatory practice seems to have used two types of approaches:

[5] Historically, with low inflation rates and the cost of assets moving in line with general inflation, forward-looking approaches might have well provided sufficient funds to recover the investment in existing assets, including an appropriate return on the invested capital. However, this is not an intrinsic guarantee of forward-looking remuneration approaches.

[6] With reference to a time horizon corresponding to the maturity embedded in the NRoR.

- The ‘financial-type’ approaches, aiming to provide investors with a fair return on the capital invested in network assets (backword-looking remuneration). The allowed return includes a financial provision that compensates investors for inflation and assure that the general purchasing power of the capital invested in network assets is maintained over time.

  In this type of approaches, the RAV is initially set at historic costs. Then, three different approaches of this type are possible and have been used by regulators around the world:

  - The ‘nominal-rate-of-return’ (NRoR) approach. This approach combines a NRoR with an unindexed RAV. Compensation for inflation is provided through the rate of return.
  - The ‘real-rate-of-return’ (RRoR) approach. This approach combines a RRoR with an indexed RAV. Compensation for inflation is provided through the indexation of the RAV;
  - The ‘hybrid’ approach[7]. This approach combines a NRoR with an indexed RAV, but also includes a negative revenue adjustment. Because compensation for inflation is provided through both the RAV and the rate of return, the negative revenue adjustment (usually via the depreciation component) is needed to prevent double compensation for inflation;

  It can be shown that the RRoR approach and the NRoR approach, if the former is implemented using the same inflation rate to obtain the RRoR from the NRoR and annually to revalue the RAV, provide the same overall return over the economic life of the asset, while the profile of the return over time is different. This is shown in Box 1.

Box 1. A comparison of RRoR and NRoR

The following example illustrates the equivalence, in term of compensation for a regulated business, of the NRoR approach and the RRoR approach, as long as, in the RRoR approach, the same inflation rate is used to obtain the RRoR from the NRoR and annually to revalue the RAV.

The example presented in the following table considers a 5% (risk-adjusted) annual NRoR (e.g., WACC) and a 2% general inflation rate (changes in the Consumer Price Index - CPI), resulting in a RRoR of 3%. The acquisition cost and the economic life of the asset are assumed to be, respectively, 100€ and 8 years.

In the NRoR approach, the RAB is valued at the historical cost and remains constant over the economic life of the asset. In the RRoR approach, the RAB is initially valued at the historical cost, but then revalued annually using the general inflation rate (CPI).

A straight-line depreciation is applied. However, unlike the NRoR approach, the RRoR approach implements an annual revaluation of the depreciation allowance.

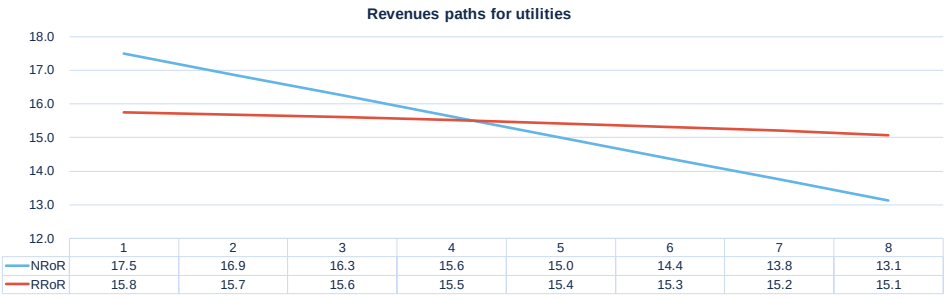
[7] This approach is much less common than the other ones and, as far as we know, among the main jurisdictions, it is used only in Australia.

Every year, the RAV is determined deducting the depreciation accumulated at the end of the previous year from the historical cost (indexed or un-indexed depending on whether the RRoR approach or the NRoR approach is adopted). Therefore, in each column of the following table, historical costs and RAV are expressed as values at the beginning of the year, while depreciation and accumulated depreciation refers to values at the end of the year.

year	0	1	2	3	4	5	6	7	8
Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
Customer Price Index (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
Capital expenditures	-100								
NRoR approach									
Historical cost		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Depreciation		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Accumulated depreciation		12.5	25.0	37.5	50.0	62.5	75.0	87.5	100.0
RAV (beginning of the year)		100.0	87.5	75.0	62.5	50.0	37.5	25.0	12.5
Return on capital		5.0	4.4	3.8	3.1	2.5	1.9	1.3	0.6
Cash flow	-100	17.5	16.9	16.3	15.6	15.0	14.4	13.8	13.1
NPV (@nominal WACC)	**0**								
IRR	**5.0%**								
RRoR approach									
Indexed historical cost (CPI)		102.0	104.0	106.1	108.2	110.4	112.6	114.9	117.2
Depreciation		12.8	13.0	13.3	13.5	13.8	14.1	14.4	14.6
Accumulated depreciation		12.8	26.0	39.8	54.1	69.0	84.5	100.5	117.2
RAV (beginning of the year)		102.0	91.0	79.6	67.7	55.2	42.2	28.7	14.6
Return on capital		3.0	2.7	2.3	2.0	1.6	1.2	0.8	0.4
Cash flow	-100	15.8	15.7	15.6	15.5	15.4	15.3	15.2	15.1
NPV (@nominal WACC)	**0**								
IRR	**5.0%**								

As shown in the table, the NRoR approach and the RRoR approach are equivalent, in net present value terms, in the compensation that they provide to a regulated business. In both cases, investors recover their capital plus a 5% nominal rate of return over the economic life of the asset.

However, the NRoR approach and the RRoR approach differ in terms of the allowed revenue profile over the economic life of the asset, with the NRoR approach returning the invested capital sooner than the RRoR approach, as showed in the following graph.



This could lead to different tariff levels for final consumers over time.

The financial-type approaches ensure economic cost recovery. Investors recover their invested capital plus a risk-adjusted return over the economic life of the asset.

- The 'physical-type' approaches aim to provide businesses with adequate financial resources to maintain the same level of physical assets on a permanent basis (forward-looking remuneration). In this type of approaches, the RAV is initially set at historic costs and adjusted using a replacement-cost methodology, taking account, in this way, of the changes in (asset) prices over time. A RRoR in applied. Therefore, compensation for (asset specific) inflation

is provided only through the re-evaluation of the RAV. In this type of approaches, the RRoR is typically determined deducting a measure of (general) inflation from the NRoR[8].

The physical-type approaches are equivalent to the financial-type approaches in terms of overall remuneration of the investors if the asset-specific implied inflation rate (reflecting the changes in the replacement costs from year to year) in the physical-type approach equals the rate of inflation used to calculate the RRoR from the NRoR and annually to revalue the RAV in the financial-type RRoR approach.

However, when the implied asset-specific inflation rate and the rate of inflation used to calculate the RRoR and annually to revalue the RAV differ, the physical-type approaches result in over- or under-remuneration of existing assets. This is shown in Box 2.

Box 2. An example of the 'physical-type' approach

The following example illustrates the possible impact of the use of a physical-type approach on the return on investments. It uses the same assumption on the interest rate as in the example presented in Box1. However, the annual change in the replacement costs of the asset is assumed to be approximated by a 1% asset-specific inflation rate.

The RAV is annually re-evaluated using replacement costs and straight-line depreciation is used with reference to the re-evaluated RAV.

year	0	1	2	3	4	5	6	7	8
Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
Customer Price Index (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
Asset-specific inflation rate		1%	1%	1%	1%	1%	1%	1%	1%
Replacement value	100.0	101.0	102.0	103.0	104.1	105.1	106.2	107.2	108.3
Capital expenditures	-100								
"physical" approacjh (Real WACC based on CPI * Replacement cost)									
Replacement value		101.0	102.0	103.0	104.1	105.1	106.2	107.2	108.3
Depreciation		12.6	12.8	12.9	13.0	13.1	13.3	13.4	13.5
Accumulated depreciation		12.6	25.5	38.6	52.0	65.7	79.6	93.8	108.3
Rate-base (beginning of the year)		101.0	89.1	77.0	64.7	52.0	39.2	26.0	12.6
Return on capital		3.0	2.6	2.3	1.9	1.5	1.2	0.8	0.4
Cash flow	-100	15.6	15.4	15.1	14.9	14.7	14.4	14.2	13.9
NPV (@nominal WACC)	**-4**								
IRR	**3.9%**								

As shown in the table, a rate of change in replacement costs which is lower than the general rate of inflation leads to the business not achieving the expected remuneration. This is because the annual change of the RAV, through the use of the replacement-cost approach, does not compensate for the rate of inflation which is deducted from the NRoR to determine the regulatory RRoR.

On the contrary, if the rate of change in replacement costs is higher than the general rate of inflation, investors enjoy an over-remuneration of their investment.

In this context, over-/under-remuneration represents the increased/ decreased general purchasing power (measured through the CPI) of the capital tied-up in the network assets.

[8] The horizon over which the inflation is considered should be consistent with the maturity taken as a reference to determine the NRoR.

Furthermore, the physical-type approaches require assumptions about replacement costs, the determination of which limits the objectivity of cost-based price calculation. Different assumptions may impact differently on the RAV over time, and thus on the predictability of its level in the future. This contributes to increase the risk of the investment in network assets.

Commonly used replacement cost methodologies include:

- 'Like-for-like Replacement' methodology, which uses the current cost of replacing the same asset as in the RAB;
- 'Modern Equivalent Asset' methodology, which uses the current cost of a new asset that has the same capabilities as the asset currently in the RAB; and
- ''Optimised Modern Equivalent Asset' methodology, which uses the current cost of purchasing a new asset that delivers the same services as the asset currently in the RAB.

The main argument proposed in favour of the physical-type approaches is that setting allowed revenues based on the replacement costs of the assets would ensure that sufficient financial provision is being made (through the depreciation allowance) to replace existing assets as they reach the end of their economic lives. This would assure that the "asset-specific" purchasing power of the investment is maintained over time. However, as asset costs tend to increase over time, no replacement cost methodology automatically ensures this result. In fact, with increasing asset costs, the financial provision is not sufficient to finance the new asset, and, therefore, businesses are not protected from the need to raise additional capital (equity or debt). This is shown in Box 3.

Box 3. Financial provision to replace existing assets

The following example illustrates that, with asset costs increasing over time, the physical-type approaches do not ensure that the allowed revenue over the economic life of the asset is sufficient to cover the cost of replacing the asset at the end of the period.

The example uses the same assumption on the rate of return as in the example presented in Box 1. However, we assume that the annual change in the replacement costs of the asset is 5%.

year	0	1	2	3	4	5	6	7	8
Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
Customer price inflation (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
Asset-specific inflation rate		5%	5%	5%	5%	5%	5%	5%	5%
Replacement value	100.0	105.0	110.3	115.8	121.6	127.6	134.0	140.7	**147.7**
Capital expenditures	-100								
"physical" approach (Real WACC based on CPI * Replacement cost)									
year	0	1	2	3	4	5	6	7	8
Replacement value		105.0	110.3	115.8	121.6	127.6	134.0	140.7	147.7
Depreciation		13.1	13.8	14.5	15.2	16.0	16.8	17.6	18.5
Accumulated depreciation		13.1	27.6	43.4	60.8	79.8	100.5	123.1	147.7
Rate-base (beginning of the year)		105.0	96.9	87.6	77.3	65.6	52.6	38.2	22.2
Return on capital		3.1	2.8	2.6	2.3	1.9	1.5	1.1	0.7
Cash flow	-100	16.2	16.6	17.0	17.5	17.9	18.3	18.7	19.1
NPV (@nominal WACC)	13								
IRR	8.2%								
Cumulated cash flows at the end of the period									**141.4**

As shown in the table, the financial provision at the end of the period (measured as cumulated cash flows) is not sufficient to replace the asset[9]. This is because the RAV (and the annual depreciation) adjustment occurs step-by-step during the economic life of the asset (considering the annual changes in the replacement costs), while the new asset will be bought at the cost prevailing at the end of the economic life of the current asset (higher than the replacement costs of previous years).

Financial provisions sufficient to replace the asset could be obtained by re-evaluating every year (at current replacement cost) not only the depreciation allowance of that year, but all the depreciation allowances of the previous years. However, we are not aware of any implementation of such an approach, that would be anyhow very complex to manage.

Moreover, the physical-type approaches are also supported by the following additional arguments[10]:

- setting regulated tariffs "*using the current or replacement costs of assets ensures that the resulting regulated prices are comparable to those of competitors, helping promote entry on equal terms*". However, this apply only for markets where competition is possible, not for natural monopolies;
- as replacement costs reflect the current "market value" of the asset, physical-type approaches would provide correct price signal to consumers and lead to more efficient use of the infrastructure. However, what constitutes a tariff level conveying correct price signals to grid users involves other considerations beyond the total allowed revenues, the achievement of which typically requires a second-best tariff structure.
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4. THE RELEVANT ACADEMIC LITERATURE

The academic literature on the adjustment for inflation of the component of the allowed revenue to cover CAPEX is relatively fragmented. The topic is usually addressed in the context of the RAV-setting and depreciation methodologies. Notably, inflation is usually dealt with through the relationship between the method to set the RAV and the allowed rate of return.

Alternative RAV-setting (and depreciation) approaches[11] are typically assessed with reference to:

- The compensation for regulated companies

[9] This holds even if all the "extra" provision which comes from the replacement value methodology re-evaluation is annually re-invested at the nominal interest rate.

[10] See, for example, Economic Consulting Associates for ACER (2018), "Methodologies and parameters used to determine the allowed or target revenue of gas transmission system operators (TSOs). Final report"

[11] The relevant literature typically refers to the following main approaches:

- The "Historical cost" approach: the RAV is set based on historical acquisition costs of each asset (the NRoR approach in previous Sections of this document).
- The "Current-cost" approach: the RAV is determined i) through the indexation of historical costs (the RRoR approach) or ii) using replacement cost methodologies (the 'physical-type' approaches).

Different depreciation methodologies may be employed. However, straight-line depreciation is usually associated with both approaches (in literature and in practice).

While protecting final customers in terms of service reliability and affordability, regulation should allow (efficient) regulated companies to earn a fair return on their investments. The regulator set the fair return considering the risk level of the investments. Therefore, regulators typically aim to allow regulated companies to obtain a return on the invested capital that "*equals the cost of capital (that is, the firm earns normal profits) and the net present value of the investments equals zero. This principle can thus be termed 'net present value (NPV) neutrality*" [12].

This is a main principle throughout the literature on RAV-setting and depreciation methods. Schmalensee (1989)[13], among others[14], bases his research on depreciation and profitability under rate-of-return regulation on the NPV neutrality criterion, concluding that: "*if a regulated firm is allowed to earn its actual (nominal) [...] cost of capital on the depreciated original cost of its investments, and if actual earnings equal allowed earnings, then the net present value of all investments is zero for any method of computing depreciation".*

Furthermore, the literature in this area also investigates the relationship between RAV-setting and depreciation methodologies, on the one hand, and regulated rate of return, on the other hand[15].

Rogerson (1992)[16], for example, compares the "original cost" (NRoR) approach with "Inflation-adjusted original cost" (RRoR) approaches, stating that: "*both original cost and Inflation-adjusted original cost methods can provide compensatory returns to investors as long as the investment is fully depreciated within the service life of the regulated firm, and that returns under one form of regulation can be replicated under the other by a suitable change in the depreciation rate*".

- The allocation of costs over time

  As seen in Section 3, the use of different RAV-setting and depreciation methodologies may result in different revenue profiles for regulated companies. This implies different tariff levels for final consumers over time. The academic literature delivers no clear recommendation on the best allocation of costs over time[17]. Cost allocation over time may be particularly relevant in "*contestable markets with decreasing asset prices (as is particularly likely for many of the*

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12 "*This principle does not imply that in practically implemented systems of regulation, including incentive regulation, each investment must be NPV neutral ex post. Rather, it requires NPV neutrality to be expected ex ante on average, that is, there are no systematic, expected above- or below-normal profits.*" Küpper, Pedell (2016), "*Which asset valuation and depreciation method should be used for regulated utilities? An analytical and simulation-based comparison."*

13 Schmalensee (1989), "An expository note on depreciation and profitability under rate-of-return regulation.";

14 See, for example: i) Brennan (1991). "*Depreciation, investor compensation, and welfare under rate-of-return regulation*." and ii) Burness, Patrick, (1992), "*Optimal depreciation, payments to capital, and natural monopoly regulation*.

15 See, among others: i) Schmalensee (1989), "*An expository note on depreciation and profitability under rate-of-return regulation*."; ii) Swoboda (1996), *"Zur Anschaffungswertorientierung administrierter Preise (speziell in der Elektrizitatswirtschaft)"; and iii)* Küpper, Pedell (2016), "Which asset valuation and depreciation method should be used for regulated utilities? An analytical and simulation-based comparison."

16 Rogerson (1992), "Optimal depreciation schedules for regulated utilities."

17 See, for example: i) Brennan (1991). "*Depreciation, investor compensation, and welfare under rate-of-return regulation*."; ii) Rogerson (1992), "*Optimal depreciation schedules for regulated utilities.*"; and Burness and Patrick (1992), "*Optimal depreciation, payments to capital, and natural monopoly regulation.*"

assets used in telecommunications)" [18], because of the relationship between incumbent's prices and the prices that a new entrant could offer. However, this is not the case of electricity transmission and distribution sectors, which are natural monopolies.

Therefore, within the scope of this Report, the choice of the cost allocation over time could be considered a merely 'political' one (e.g. because it impacts on inter-generational equity between customers).

Finally, it is worth mentioning a 2012 study on the German water sector[19], which provides a thorough comparison of the financial-type and the physical-type approaches, as defined in this Report. In this context four alternative approaches are compared:

- The nominal-rate-of-return (NRoR) approach;
- The real-rate-of-return (RRoR) approach;
- RAV re-evaluation using a replacement cost methodology combined with a real rate of return calculated using an asset-specific inflation rate (a variant of the physical-type approach); and
- RAV re-evaluation using a replacement-cost methodology combined with a real rate of return calculated using a consumer price index (an alternative variant of the physical-type approach).

The study concludes, among other things, that:

- only the first three approaches are consistent with the NPV neutrality criterion. The combination of RAV re-evaluation using a replacement-cost methodology and a real interest rate based on a consumer price index is therefore inconsistent. The study does not clearly recommend a specific approach. However, it states that the selection of an asset-specific inflation index is 'arbitrary' and could lead to uncertainty and lower transparency (if compared with other methodologies that rely on consumer price indexes);
- if assets' costs increase over time, even the physical-type approach does not automatically ensure that sufficient financial provision is being made (through the depreciation allowance) to replace existing assets as they reach the end of their economic lives. This weakens the main argument typically used in favour of physical-type approaches[20].

Relevant academic literature therefore delivers no clear recommendation on the RAV-setting and depreciation methodologies. However, in our opinion, arguments in favour of the financial-type approaches outweigh those in favour of the physical-type approaches, especially in the context of non-contestable markets such as the electricity transmission and distribution sectors.

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[18] Küpper, Pedell (2016), "*Which asset valuation and depreciation method should be used for regulated utilities? An analytical and simulation-based comparison.*"

[19] Bundesverband der Energie- und Wasserwirtschaft/Verband kommunaler Unternehmen (2012), "*Leitfaden zur Wasserpreiskalkulation*."

[20] See, for example: Economic Consulting Associates for ACER (2018), "*Methodologies and parameters used to determine the allowed or target revenue of gas transmission system operators (TSOs). Final report.*"

5. THE ENERGIAVIRASTO METHODOLOGY

On the basis of the documentation that we have been provided[21], we understand that EV currently uses a methodology to set the remuneration of network assets which does not exactly correspond to any of the approaches referred to in the previous Sections.

In fact, as far as we understand:

- At the beginning of each 'methodology period'[22], the RAV is re-evaluated using a unit price list (UPL). Unit prices in the UPL correspond to the latest actual unit investment costs for equivalent assets.
- During the methodology period:
  - the RAV is not re-evaluated or revalued:
  - straight-line depreciation[23] is used annually to adjust the RAV. Annual RAV depreciation is calculated on the basis of the latest UPL, which is not updated or indexed during the methodology period;
  - however, for the purpose of determining the return-of-capital component of the allowed revenue, depreciation is annually indexed for inflation using the Consumer Price Index (CPI)[24];
  - the RAV is not adjusted annually, except for depreciation and the value new assets being included in the RAB;
  - new assets included in the RAB are added to the RAV on the basis of the unit prices in the latest UPL;
- A nominal WACC is applied to the RAV to obtain the return on capital.

This methodology was applied for the 4th and 5th regulatory periods (2016 – 2019 and 2020 – 2023); the RAV was set in 2016 with reference to a UPL based on 2014 and 2015 prices and not re-evaluated since then[25].

A new up-to-date UPL is planned to be used to determine the RAV for the 6th regulatory period (2024 – 2027) and the value of any new asset added to the RAB over that period. This new UPL is based on actual investment costs during the period from mid-2020 to early 2022. However, the more recent upward trend in unit investment costs means that, by the time it is applied from 2024, the new UPL will already be out of date, with UPL's unit prices under-estimating the actual investment costs at the beginning and during the next regulatory period. This might

[21] Energiavirasto (2015), "*Regulation methods in the fourth regulatory period of 1 January 2016 – 31 December 2019 and the fifth regulatory period of 1 January 2020 – 31 December 2023. Electricity distribution network operations. High-voltage distribution network operations*".

[22] The "methodology period" may span across more than one regulatory period. The current methodology period covers an 8-year period (2016-2023), while regulatory periods last only 4 years (2016-2019 and 2020-2023). The re-evaluation of the RAV was last performed at the beginning of the current methodology period starting in 2016; it is expected to be repeated in 2024.

[23] This is a depreciation approach where annual depreciation is kept constant over the economic life of the asset.

[24] CPI indexation is used only for the purpose of determining allowed revenues; whereas the RAV age-adjustments are determined using non-indexed depreciation values (calculated on the basis of the latest UPL).

[25] Due to an amendment to the electricity legislation, the UPL for electricity DSOs was updated in 2022, in the middle of the 5th regulatory period. The new UPL was then applied for 2022 and 2023.

discourage network companies to invest and/or might result in the under-remuneration of any investment made in the next regulatory period. The impact on the remuneration of existing asset already in the RAB depends on the relationship between their actual (historic) costs and the unit prices in the new UPL.

If our understanding is correct, it seems that EV's methodology for the remuneration of the network assets within each methodology period:

- promotes efficient investments by regulated companies, to the extent that they will be remunerated on the basis of the unit prices in the latest UPL, and not on the basis of the actual investment costs. The actual investment costs would then be used as reference for the next UPL which, once used to re-evaluate the RAV, would transfer any achieved efficiency gain in investments to consumers;
- however, as indicated above, might discourage investments over the years, if actual (efficient) investment costs increase over time or are in any case higher than the unit prices in the UPL used to evaluate the new investments for their addition to the RAV. This is because, in this case, the reference to a UPL reflecting past unit prices means that the new assets will be under-remunerated; and
- is somewhat similar to the NRoR approach, in which, as illustrated in Section 3, a NRoR is applied to a RAV which is not indexed, year on year.

With respect to this last feature, the EV's methodology departs from the standard NRoR approach in two respects:

- in the re-evaluation of the RAV at the beginning of each methodology period (by applying unit prices in a new UPL to the assets in the RAB). Such a re-evaluation might increase or decrease the RAV with respect to the RAB's historic-cost valuation, which is what would be applied in a standard NRoR approach. Therefore, to the extent that the latter could be deemed to provide investors with an appropriate remuneration on the invested capital, the re-evaluations of the RAV at the beginning of each methodology period ends up over- or under-compensating the network companies and their investors, depending on the relationship between historic investment costs and the unit prices in the UPL.

  In this regard, whenever successive UPLs show increasing unit prices, or unit prices which are higher than (efficient) historic asset costs, the RAV re-evaluation at the beginning of a methodology period results in over-compensation of network companies (with respect to their investment costs) and implies that grid users, and therefore energy consumers, end up paying more than it would have been the case under a standard financial type approach. On the contrary, whenever successive UPLs show decreasing unit prices, or unit prices which are lower than (efficient) historic asset costs, the RAV re-evaluation at the beginning of a methodology period results in under-compensation of network companies (with respect to their investment costs) and implies that grid users, and therefore energy consumers, end up paying less than it would have been the case under a standard financial-type approach. This is illustrated in Box 4.

Box 4. EV's methodology: RAV re-evaluation

The following example illustrates the possible impact on the return on investments of the methodology used by EV and described in the text, under different sets of assumptions regarding the changes in the UPL's unit prices between subsequent methodology periods. For illustration purposes, we assume 4-year methodology periods. The other assumptions are the same as those used for the example presented in Box 1.

If UPL's unit prices increase between subsequent methodology periods (MPs) when a new UPL is used, the re-evaluation of the RAV at the beginning of a new methodology period (5th year in our example) would result in the over-compensation of network businesses in the subsequent years. This is shown in the table below. This is due to some degree of over-compensation for inflation.

	Methodology period		MP1				MP2			
	year	0	1	2	3	4	5	6	7	8
	Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
	Customer price inflation (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
	Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
	Asset-specific inflation rate		2%	2%	2%	2%	2%	2%	2%	2%
	Replacement value	100.0	102.0	104.0	106.1	108.2	110.4	112.6	114.9	117.2
	Capital expenditures	-100								
	EV methodology (Fixed replacement value * Nominal WACC)									
	Replacement value		100.0	100.0	100.0	100.0	108.2	108.2	108.2	108.2
	Depreciation		12.5	12.5	12.5	12.5	13.5	13.5	13.5	13.5
	Accumulated depreciation		12.5	25.0	37.5	50.0	67.7	81.2	94.7	108.2
A	Regulatory depreciation allowance (CPI indexed depreciation)		12.5	12.8	13.0	13.3	13.5	13.8	14.1	14.4
	Rate-base (beginning of the year)		100.0	87.5	75.0	62.5	54.1	40.6	27.1	13.5
B	Return on capital		5.0	4.4	3.8	3.1	2.7	2.0	1.4	0.7
C=A+B	Cash flow	-100	17.5	17.1	16.8	16.4	16.2	15.8	15.4	15.0
	NPV (@nominal WACC)	**6**								
	IRR	**6.5%**								

On the contrary, if UPL's unit prices decrease between subsequent methodology periods when a new UPL is used, the re-evaluation of the RAV at the beginning of a new methodology period may result in the under-recovery of investment for network businesses in the subsequent years. This is shown in the table below. This is due to some degree of under-compensation for inflation.

	Methodology period		MP1				MP2			
	year	0	1	2	3	4	5	6	7	8
	Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
	Customer price inflation (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
	Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
	Asset-specific inflation rate		-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
	Replacement value	100.0	98.0	96.0	94.1	92.2	90.4	88.6	86.8	85.1
	Capital expenditures	-100								
	EV methodology (Fixed replacement value * Nominal WACC)									
	Replacement value		100.0	100.0	100.0	100.0	92.2	92.2	92.2	92.2
	Depreciation		12.5	12.5	12.5	12.5	11.5	11.5	11.5	11.5
	Accumulated depreciation		12.5	25.0	37.5	50.0	57.6	69.2	80.7	92.2
A	Regulatory depreciation allowance		12.5	12.8	13.0	13.3	11.5	11.8	12.0	12.2
	Rate-base (beginning of the year)		100.0	87.5	75.0	62.5	46.1	34.6	23.1	11.5
B	Return on capital		5.0	4.4	3.8	3.1	2.3	1.7	1.2	0.6
C=A+B	Cash flow	-100	17.5	17.1	16.8	16.4	13.8	13.5	13.1	12.8
	NPV (@nominal WACC)	**-1**								
	IRR	**4.8%**								

- in the indexation of the regulatory depreciation allowances (the return-of-capital component of the allowed revenue). This feature may contribute to increase the risk of over- or under-compensation for network companies. The indexation of the regulatory depreciation allowances may in fact result in over- or under-compensation for inflation when, respectively, consumers' prices increase or decrease over time. This is illustrated in Box 5.

Box 5. EV's methodology: indexation of the regulatory depreciation allowances

The following example illustrates the possible impact on the return on investments of the indexation of the regulatory depreciation allowance envisaged in the EV methodology, under different sets of assumptions regarding the changes in the CPI rate. To isolate the effect of the indexation of the regulatory depreciation allowances, we assume an asset specific inflation rate equal to 0% over the 8 years' timeframe (no RAV re-evaluation takes place in year 5). The other assumptions are the same as those used for the example presented in Box 1.

If consumer prices increase during the considered timeframe, the indexation of the regulatory depreciation allowances results in an over-compensation of network businesses. This is shown in the table below.

	Methodology period		MP1				MP2			
	year	0	1	2	3	4	5	6	7	8
	Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
	Customer price inflation (CPI)		2%	2%	2%	2%	2%	2%	2%	2%
	Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
	Asset-specific inflation rate		0%	0%	0%	0%	0%	0%	0%	0%
	Replacement value	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Capital expenditures	-100								
	EV methodology (Fixed replacement value * Nominal WACC)									
	Replacement value		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Depreciation		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
	Accumulated depreciation		12.5	25.0	37.5	50.0	62.5	75.0	87.5	100.0
A	Regulatory depreciation allowance		**12.5**	**12.8**	**13.0**	**13.3**	**12.5**	**12.8**	**13.0**	**13.3**
	Rate-base (beginning of the year)		100.0	87.5	75.0	62.5	50.0	37.5	25.0	12.5
B	Return on capital		5.0	4.4	3.8	3.1	2.5	1.9	1.3	0.6
C=A+B	Cash flow	-100	17.5	17.1	16.8	16.4	15.0	14.6	14.3	13.9
	NPV (@nominal WACC)	**2**								
	IRR	**5.6%**								

On the contrary, if consumer prices decrease during the considered timeframe, the indexation of the regulatory depreciation allowances results in an under-compensation of network businesses. This is illustrated in the table below.

	Methodology period		MP1				MP2			
	year	0	1	2	3	4	5	6	7	8
	Nominal WACC		5%	5%	5%	5%	5%	5%	5%	5%
	Customer price inflation (CPI)		-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
	Real WACC based on CPI		3%	3%	3%	3%	3%	3%	3%	3%
	Asset-specific inflation rate		0%	0%	0%	0%	0%	0%	0%	0%
	Replacement value	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Capital expenditures	-100								
	EV methodology (Fixed replacement value * Nominal WACC)									
	Replacement value		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Depreciation		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
	Accumulated depreciation		12.5	25.0	37.5	50.0	62.5	75.0	87.5	100.0
A	Regulatory depreciation allowance		**12.5**	**12.3**	**12.0**	**11.8**	**12.5**	**12.3**	**12.0**	**11.8**
	Rate-base (beginning of the year)		100.0	87.5	75.0	62.5	50.0	37.5	25.0	12.5
B	Return on capital		5.0	4.4	3.8	3.1	2.5	1.9	1.3	0.6
C=A+B	Cash flow	-100	17.5	16.6	15.8	14.9	15.0	14.1	13.3	12.4
	NPV (@nominal WACC)	**-2**								
	IRR	**4.4%**								

6. CONSIDERATIONS ON THE WAY FORWARD

As illustrated in the previous Section, the methodology which EV has been using over the last two regulatory periods and which is under consideration for the next regulatory period does not fully conform to any of the approaches typically used by regulators and presented in Sections 2 and 3 above. Moreover, as also indicated in the previous Section, such a methodology might result in network companies

being over- or under-compensated for their investment costs, depending on whether the unit prices in the successive UPLs increase or decrease over time and are higher or lower than actual (efficient) historic investment costs. This creates uncertainty for network companies when they assess their investment prospects, which might increase the risk premium required by investors and therefore the cost of capital of network companies. Moreover, as also indicated in the previous Section, the current methodology might also discourage investments if investment costs increase over time.

EV has therefore expressed concerns about the suitability of such a methodology; in particular, that it implies that inflation is not correctly accounted for in setting the remuneration of network companies' investments, and therefore that such companies over- or under-recover their investment costs.

6.1. EV's methodology update: a proposal

If such a reading of EV's concerns is correct, it means that, at least implicitly, EV uses some sort of 'financial' approach, i.e., an approach which ensures the recovery of investment costs, as a methodological benchmark.

As the methodology adopted so far by EV conforms to the NRoR approach, except for:

- the re-evaluation of the RAV at the beginning of each methodology period, and
- the indexation of the regulatory depreciation allowances;

the most obvious way to align EV's methodology to one of the approaches currently used by regulators, and avoid over- or under-remuneration of the network assets, would be to eliminate the re-evaluation of the RAV at the beginning of a new methodology period and to end the annual indexation of the regulatory depreciation allowance.

In this way, the methodology would be fully in line with the NRoR approach, thus ensuring proper remuneration of the assets and that the general purchasing power of the funds invested in the business is maintained over time[26]. The avoidance of the RAV re-evaluation at the beginning of a methodology period would also reduce the risk for the network businesses (of possible increases or decreases in the RAV) and therefore, conceivably, the rate of return that investors in the network activities require.

in aligning EV's methodology to the NRoR approach, alternatives over two dimensions should be considered:

a) whether the switching to historic costs would apply to all assets or only to new assets; and

b) whether an incentive to efficient investment, by at least partly referring to UPL's unit prices, should be maintained.

[26] It is worth noting that investors, beyond obtain an appropriate rate of return, are typically interested in maintaining the general purchasing power of the funds invested in network businesses, not to the purchasing power with respect to specific assets or asset classes.

a) Reverting to historic costs

With respect to the first dimension, two alternatives seem to be possible:

a.1) Switching to a model fully based on historic costs

In order to compute the RAV at the beginning of the next regulatory period, each existing asset in the RAB would be re-evaluated at its (age-adjusted) historic cost. Likewise, new assets (from 2024 onwards) would be valued at actual construction/acquisition cost. This would ensure full consistency with the NRoR approach and ensure that no over- or under-remuneration will occur starting from the beginning of the next regulatory period.

However, the switching to such a model might have a possibly significant impact:

- on the level of the RAV of current assets, that, given the replacement cost trend over most of the past years, would likely suffer an important reduction from one year to the next, with possible impacts in term of network companies' value on the market.
- on the overall remuneration of current assets. The impact on the allowed revenue level and distribution over time is not obvious and should be carefully evaluated over the whole lifetime of the investment.

Furthermore, records of the actual historic costs of very old assets may not be available or be not totally reliable. This would raise some implementation issues, that could be overcome only with some degree of discretion (e.g. employing UPLs that were in place when each investment occurred) that may undermine the credibility of the methodology.

a.2) Switching to a model based on historic costs only for new investments

At the beginning of the next regulatory period, the RAV for existing assets will not be re-evaluated and will continue to be set using the last (2016) UPL. Only new assets (from 2024 onwards) will be valued at historic cost.

This would ensure a smoother transition to the NRoR approach, avoiding potentially substantial step-changes in the RAV and therefore in the remuneration of network companies.

The choice between the two alternatives is a matter of judgement on the speed of the transition to the new approach, carefully evaluating the effects on investment remuneration and tariffs levels.

b) Maintaining incentives for efficient investment

With respect to the second dimension, some incentives to promote efficient investment for new assets could be maintained, irrespective of the alternative chosen in relation to the first dimension. In fact, in both cases, new assets could be valued not purely at actual construction/acquisition costs, but by referring to a weighted average of such costs and the relevant unit prices in a UPL. However, in order for such an approach not to distort investment decisions, EV would have to update the UPL every time investment costs materially change (e.g. EV could proceed with a UPL update if the costs of main investment inputs, such as raw materials and labour, materially increase over a pre-defined period of time).

On this last point, a distinction needs to me drawn between the incentives to promote efficient investments, on the one hand, and a fair remuneration of the invested capital, on the other hand. These are two different aspects, although often closely linked in the way in which regulation is implemented.

Efficiency in investment could be promoted by setting the allowed revenues to cover CAPEX not (totally) based on actual (historic) investment costs. Network companies would then be able to keep (part of) the savings that they are able to achieve by being more efficient in their investment than the costs used to determine the allowed revenue. This would be the incentive for investment cost efficiency. The strength of the incentive could be calibrated in the trade-off between such a strength and risk allocation. If allowed revenue were set totally independently from actual investment costs, the incentive for investment cost efficiency would be the strongest, but also the risk of under-recovery of the investments for network companies if they ended up investing at (much) higher costs than those used to determine the allowed revenue. A more balanced approach would be one in which the allowed revenue is determined as a weighted average of a (fixed) reference investment cost – e.g. unit prices in an indexed UPL – and actual investment costs. In such a case, the incentive for investment cost efficiency would be lower, as the network company would retain only a fraction of the investment cost saving with respect to the reference level, but also the exposure to the possible under-recovery of investment costs would be reduced, in case they turned out to be higher than the reference level would be mitigated[27].

A different aspect is the fairness of the remuneration of CAPEX, in the sense of a remuneration which is high enough not to discourage investments altogether, but which also avoids the ex-*ante* expectation of over-remuneration. Some degree of over-remuneration is an intrinsic possibility in any incentive-based approach, as it is exactly what drives regulated companies to pursue (investment) cost savings. However, such an over-remuneration should not be inherent in the reference cost level used (partly) to set the allowed revenue. Similarly, such a reference investment cost level should not imply under-remuneration of even a normally efficient network company. In this case, in fact, investment would be discouraged altogether, despite any incentivising property of the approach.

Therefore, while the incentivising properties of an approach rests on the allowed revenue being not totally based on actual investment costs, and therefore at least partly based on a (fixed) reference cost level, the fairness of the approach, and avoiding that it discourages investments altogether, rests on the reference cost level used for setting the allowed revenue providing a reasonable return to a normally efficient network company.

Once the two dimensions outlined above have been decided upon, EV could, with respect to the other regulatory parameters:

- Continue to apply a straight-line depreciation methodology;
- Avoid proceeding with the re-valuation of the RAV based on the UPL unit prices at the beginning of the next methodology period (in 2024);

[27] A scheme similar to the approach proposed in the text, to incentivise more efficient, innovative solutions to electricity system needs, was presented by the Florence School of Regulation at the 9th European Infrastructure Forum in Copenhagen in June 2013.

- Abandon the indexation of depreciation allowances (used to set the return-of-capital component of the allowed revenues for network companies);
- Continue to apply a NRoR to a RAV which, in the future, will not be re-evaluated, but only updated (downward) to reflect the depreciation of the assets currently in the RAB and (upward) for new assets added to the RAB (valued at construction/acquisition costs or at a weighted average of these costs and the unit prices in a UPL, as outlined above).

6.2. Possible alternatives

Beyond the ones proposed above, alternative ways forward could be envisaged, which however would, in our views, be inferior in the way in which they address the identified concerns.

For example, it could be possible to maintain the use of UPLs for regularly re-evaluating the RAV and therefore move towards a "physical-type" approach. In this case, a RRoR would have to be used. To obtain it from the NRoR, a suitable inflation index would have to be employed. As the NRoR typically refers to long-term maturities[28], a forecasted inflation rate over a similar horizon would be required. This is typically not available and proxies would have to be identified (e.g. forecasted inflation in policy documents). Moreover, as indicated in the previous Sections, investment cost recovery for network companies would only be ensured if the change in unit prices in the UPLs equalled the inflation rate used to obtain the RRoR from the NRoR (typically the CPI rate). Therefore, if the UPLs internalised technological developments (i.e., the latest investments used as a benchmark for the UPLs employ newer technologies than the ones embedded in the existing assets in the RAB), this equality would be unlikely to hold.

Alternatively, one could use a NRoR, thus avoiding the need to remove inflation in order to obtain a RRoR, and apply it to a regularly revalued RAV, using a general inflation index or the UPLs. We have already commented on the possible drawback of using the UPLs. In any case, an approach which combine a NRoR with a regularly revalued RAV would then require some form of correction to avoid the double-counting of inflation and, therefore, in the presence of rising prices, over-remuneration of network companies. The resulting methodology would be of the hybrid-approach type, with the additional complexity of having to define the correction coefficient (typically applied to depreciation).

[28] Ideally, the reference maturity for the NRoR used would have to reflect the length of the regulatory period, i.e., the period over which the regulator fixes the level of the return on capital. However, the regulatory practice varies a lot on this point.

ABOUT DFC ECONOMICS

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