

**Funding of Investment for Asset Replacement and Expansion of
Regulated Infrastructure Industries:
theoretical criteria and parameters to ensure adequate capital.**

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**Deon Joubert CA(SA)
Corporate Specialist, Eskom
Tel: +27 11 800 4308
Mobile: +27 83 258 1489
Email: deonf.joubert@eskom.co.za**

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LIST OF ABBREVIATIONS AND ACRONYMS:

| | |
|--------|----------------------------------|
| CAGR: | compound annual growth rate |
| Capex: | capital expenditure |
| CAPM: | capital asset pricing model |
| Cum.: | cumulative |
| CWIP: | capital works in progress |
| Depr.: | depreciation |
| DRC: | depreciated replacement cost |
| ESI: | electricity supply industry |
| HC: | historical cost |
| IDC: | interest during construction |
| IEA: | International Energy Agency |
| LCOE: | levelised cost of electricity |
| LRMC: | long run marginal cost |
| NEA: | Nuclear Energy Agency |
| NPV: | net present value |
| O&M: | operating and maintenance |
| PE: | primary energy |
| RAB: | regulatory asset base |
| RCN: | replacement cost new |
| ROA: | return on assets |
| SOE: | state owned entity |
| WACC: | weighted average cost of capital |
| WUC: | works under construction |

EXECUTIVE SUMMARY

Most infrastructure industries, including the Electricity Supply Industry (ESI), have a few common characteristics namely they are highly capital intensive; the assets take long to construct and bring into operation; the assets have very long operational lives; the effect of inflation over the long asset life can create a variety of funding and pricing problems when it comes to replacement of the assets or expansion of capacity; the prices for the products/services often are regulated.

The concept of 'cost-reflectivity' is a cornerstone for the sustainability of an industry such as the ESI. The achievement of cost-reflectivity is especially vulnerable in this type of industry, given that the asset-intensity means that a large portion of the costs are 'sunk' costs¹. Without cost-reflective revenues and prices a company will not be sustainable. There are few alternatives – essentially, either taxpayer subsidies thus higher tax rates than otherwise, or lack of adequate electricity infrastructure. Both unfortunately cause worse macro-economic consequences than cost-reflective prices.

However, even if cost-reflective prices are achieved and maintained, there could be other problems. Due to the long asset lives, even quite moderate inflation rates can significantly increase the cost of an asset that is acquired to replace another asset that has reached the end of its long operation life – with the replacement asset easily costing five to ten times more than the original asset. If this is not anticipated and prepared for, a variety of problems could occur such as price shocks and funding problems. Price shocks are not only disruptive to consumers, it also poses risks to funding – i.e. lenders, who might be uncertain regarding whether the required price adjustments to maintain cost-reflectivity would actually take place, would be cautious about investing in that environment. In order to address the price shock problem in a regulated environment, regulators often use the revenue methodology of 'real' return on inflation indexed or replacement asset values.

Whilst this regulatory approach certainly produces much more stable prices, it can cause other problems such as liquidity challenges. In addition, it does not on its own ensure adequate equity funding for replacement of the existing assets or for expansion of capacity. A further challenge could arise due to the long construction lead-times typically involved with the acquisition of new assets, which requires funding to commence perhaps seven or more years prior to the asset becoming operational.

In the context of the asset intensity of the ESI, these liquidity and funding issues would have to be managed well, as lack of adequate capital could cause lack of adequate infrastructure capacity. It is also important that these issues are *seen* to be managed well – with the greatest proportion of capital being debt capital it is critical to avoid negative perceptions by credit rating agencies and lenders, which could result in reduced access to capital and in higher cost of capital, to the extent that it could still be obtained. In that respect a regulatory environment, framework and rules which are sound, credible, trusted, predictable, clear and supportive could contribute significantly to improving credit risk assessments and thus access to capital, and at reasonable cost.

Part of the overall management of these issues include the use of a moderate capital structure gearing ratio; a combination of new assets and older assets in the total fleet; attempting to match the profile of

¹ "Policy makers have a strong incentive to regulate prices at a level to compensate the regulated utilities only for their operating costs, not their fixed costs (i.e. sunk investment). This level provides sufficient incentives for a firm to continue operating ex-post their investment, but not sufficient incentive for them to invest further."

SOURCE: Guasch and Spiller, 1999, "Managing the Regulatory Process: Design, Concepts, Issues and the Latin America and Caribbean Story", World Bank Latin American and Caribbean Viewpoints, page 33

debt principal redemption and interest payments to the regulatory approach; the utilization of tax incentives.

In addition, with regard to ensuring adequate equity funding for the replacement of existing assets it is recommended that some of the equity returns not be deemed to be distributable but be re-invested in the company in a 'replacement reserve', as a form of 'capital preservation' or 'capital maintenance'. Similarly, regarding adequate equity funding for expansion of capacity, it is recommended that some of the equity returns be retained in a type of non-distributable 'expansion reserve'.

To assist with the funding challenges posed by large capital investments for which the cash outflow commences a number of years prior to the operational date, it is common regulatory practice to allow a return to be earned on the 'Works under Construction' (WUC) or 'Capital Works In Progress' (CWIP) during the construction process (which is compensated for in a discounted-present-value-neutral way by deducting the returns earned during the construction period, from the asset value used for regulatory purposes – thus reducing future regulatory depreciation and returns, hence future revenues / prices).

It is therefore clear that equity capital is a critical component of total capital. The presence of equity capital and equity returns serve as a 'buffer' to ensure that debt principal and interest would be repaid in the event of unforeseen events that reduce sales volume, sales prices, operating costs, plant technical performance etc. A sufficient proportion of equity capital is therefore required to 'unlock' debt capacity.

Adequate equity returns are also critical ('adequate' being, reflecting the true cost of equity). None of the described equity reserve mechanisms are possible if equity returns are too far below adequate. In addition to the obvious function of compensating investors for the risk-adjusted opportunity cost of having invested (thus also incentivising future investments), equity returns are required as a 'buffer' to meet the shortfall on debt interest in the case where regulated revenue is based on a 'real' return; to compensate for the effect of inflation on the provision of funding for replacement of assets; to accumulate the required equity funding for expansion of capacity.

With the exception of a relatively small and temporary impact due to the use of the regulatory practice of allowing a return to be earned on the WUC or CWIP during the construction process, none of the mechanisms described imply an increase in revenue / prices. 'Cost-reflective' revenues remain the cornerstone; however these are set with reference to 'efficient' and 'prudent' costs and asset utilisation. This does not imply 'perfection' – it is rather a test of reasonableness, in the particular context. However if the norm of efficient, prudent and reasonable is not achieved it could imply that some of the costs would not be recovered through revenue. This would of course reduce the equity returns. Given the number of issues for which sound equity returns are required it would be a serious matter for a shareholder to address with the company management.

Failure to apply appropriate mechanisms could likely result in dire consequences, if not in the short term then inevitably in the medium to longer term. However, in general these matters are perhaps more predictable and manageable than sometimes thought. Solutions are possible, but are much easier to implement if there is sufficient time – which requires long term forward strategizing and planning. It also requires an understanding of these dynamics. It is hoped that this paper might contribute in that regard.

END

1. INTRODUCTION

1. History provides various examples of significant instability in regulated prices (greater than input cost movements). History further provides examples of regulated entities suffering severe/terminal financial distress whilst providing essential infrastructure products/services, within acceptable parameters of technical performance and cost efficiency, in quantities required by the consumers – due to attempts to control such price instability. This might indicate that some traditional regulatory approaches are inherently more vulnerable to price instability, and/or sometimes found unprepared for events which might not be inherently unpredictable. A sound appreciation of any such inherent characteristics would at least provide pre-warning, and (more beneficially) might enable pro-active mitigation, which might include adopting an inherently more stable regulatory approach – whereas incomplete appreciation could result in revenue outcomes that in extreme cases cause failure of regulated entities, and in less extreme cases, failure to attract investment capital (a key objective of economic regulation) – thus hampering infrastructure development.
2. A previous paper analysed this matter by examining regulated infrastructure entities' life-cycle financial dynamics / outflow-inflow (inflow being a function of economic regulation). It used the electricity industry as an example of a typical regulated infrastructure industry. It derived theoretical criteria/parameters for optimal product pricing for regulated infrastructure industries which meet the criteria of long term financial-economic sustainability as well as price stability. However it focused on pricing related to existing investments, over their full life-cycle, and only briefly dealt with matters such as funding for replacement, and for expansion / growth of infrastructure.
3. This follow-up paper continues from that basis. It further examines the matter of funding for replacement and expansion / growth, and whether there are implications for pricing e.g. whether 'premiums' are required on prices for existing products / services, and whether there are other mechanisms to ensure adequate capital. Based on this examination it derives theoretical criteria / parameters to ensure adequate capital for replacement and for expansion / growth. In so doing it attempts to make the outcomes and consequences more understandable, predictable and manageable. Whilst in practice there are always additional dynamics and 'noise factors' that will have to be taken into account, a sound theoretical basis would be a good foundation for these additional issues. In contrast, if the practical issues are added to an unsound or incomplete theoretical basis it might lead to unexpected outcomes and the conclusion that there are more random, unpredictable and unmanageable factors at work than there actually are.
4. Merton Miller once said "*.... we at Chicago have always believed: nothing is **more** practical than **good theory***"². Whereas the objective of this paper is to offer a perspective on sound and good theory, it will obviously not claim to be without flaws, errors or omissions. Rather, it offers certain perspectives and endeavours to stimulate discussion and further analysis.

² Merton H. Miller, Robert R. McCormick Distinguished Service Professor, Graduate School of Business, The University of Chicago, 1990 Nobel Prize Winner. Quoted from a reference on the book "The Quest for Value" by G. Bennett Steward, III, 1991.

2. Sustainability, cost-reflectivity and price stability

5. A previous 2012 paper titled *“Optimal pricing for sustainability of regulated infrastructure industries”* (using the electricity industry as an example) explained:
- a) That (and why) the levelised life cycle cost / levelised cost of electricity (LCOE³) is the correct reasonability test/reference point for the generation component of the retail prices, in order for such prices to be ‘cost-reflective’, and
 - that anything below that is not ultimately sustainable (unless, as the only alternative, company and personal tax rates are increased in order to pay for electricity production – which is a macro-economic model with much worse outcome in terms of economic growth, employment, etc.).
 - b) That the typical regulatory ‘revenue building blocks’/‘costs plus return’ approach results in revenue (over an asset’s life cycle) with the *same* discounted NPV as when prices are set at LCOE (if the regulatory ‘rate of return’ / Return on Assets is equal to the risk adjusted cost of capital / WACC), and
 - that in the case of a fleet of old and new assets (of similar technology), such a regulatory approach would result in an *average* price for all such assets of *equal* to the LCOE of a new asset (for similar technology), and
 - that such *average* prices would be the same, whether the regulatory model was based on (a) a ‘nominal’ rate of return on assets valued at historical cost, or (b) a ‘real’ rate of return on assets valued at replacement value.
 - c) That the only difference between prices set on (a) historical asset values, (b) replacement values and (c) LCOE is the life cycle profile of such prices, particularly in an inflationary environment – with the life cycle profile on the basis of historical costs being severely front-loaded; on replacement values being only slightly front-loaded; on LCOE being completely flat, and
 - that particularly the historical costs approach can result in severe price shocks when new assets are added (even in a ‘fleet’ situation), and thus
 - that the reason for the regulatory revenue model based on a ‘real’ rate of return on assets valued at replacement value, is to avoid such shocks and to smooth price movements.
 - d) That none of the above approaches recover more than the cost of the existing assets, over their life cycles – thus, that consumers do not pay a ‘premium’ over the cost of the electricity from the existing assets for the purpose of future capacity expansion, on any of these approaches.
6. The paper demonstrated that, when correctly applied, the discounted present value of the life cycle revenue stream whether based on historical asset values, replacement values, or LCOE is always equal

³ *“The calculation of the LCOE is based on the equivalence of the present value of the sum of discounted revenues and the present value of the sum of discounted costs. The LCOE is, in fact, equal to the present value of the sum of discounted costs divided by total production adjusted for its economic time value. Another way of looking at LCOE is that it is equal to the price for output (electricity in our case) that would equalise the two discounted cash-flows. In other words, if the electricity price is equal to the levelised average lifetime costs, an investor would precisely break even on the project.....undiscounted price stays the same throughout the operating lifetime of the plant.”*

SOURCE: International Energy Agency, Nuclear Energy Agency, Organisation for Economic Co-Operation and Development (2010) *Projected Costs of Generating Electricity*, 2010 Edition. Pages 33-35

to the original acquisition cost of the asset⁴ – i.e. the revenue would cover the annual costs of fuel, operating and maintenance in the same year that it is incurred, and the discounted present value of the ‘free cash flow’ will be equal to the original acquisition cost of the asset⁵. Hence the statement above that none of the above approaches recovers more than the cost of the existing assets, over their life cycles. Therefore, it would also be accurate to describe the price levels resulting from any of the described approaches as ‘cost-reflective’.

7. The paper illustrated that, in recovering the original acquisition cost of the existing assets, it enables the repayment of the debt principal that was raised to fund the original asset, as well as to pay the interest on the unredeemed balance of such debt, over the operational life cycle of the original asset. Similarly, it enables the ‘recovery’ of the original equity capital that was raised to fund the original asset (i.e. the equity capital which was invested in the tangible asset is progressively liquidated back to cash) and, similar to the debt interest, enables the ‘un-liquidated’ equity capital to earn a return.
8. By virtue of repaying the debt principal related to the acquisition of the original asset, ‘new’ debt capacity is created to enable the funding of the debt portion of the capital that is required in order to replace the original asset, at the end of its operational life. Similarly, by virtue of liquidating back to cash the equity capital which was invested in the original tangible asset, the cash equity would again be available to fund the non-debt portion of the capital that is required in order to replace the original asset.
9. At first glance it might therefore seem that if revenue / prices are cost-reflective, whether based on any of the above approaches (i.e. historical asset values, replacement values, or LCOE), all potential funding and other revenue and finance related problems would be solved, as it would enable payment of all operational costs (fuel, operating and maintenance), as well as repayment of the funding (principal as well as return / interest) related to the original assets, and would enable ‘new’ funding i.e. raising of the capital that is required, in order to replace the original asset at the end of its operational life.
10. It would further seem that the only potential difficulty that might be encountered with either the historical asset value approach or the replacement value approach is the inherent ‘front-loading’ of the revenue profile i.e. annual revenue / prices are higher in the beginning when the asset is new, than at the end of its operational life. This is due to the progressive redemption of the debt principal over the operational life of the asset, which causes the annual interest cost (which is charged on the unredeemed debt balance) to also reduce. This redemption of the debt principal is mirrored in the progressive depreciation of the asset⁶, on which the regulatory ‘return on assets’ is earned. Therefore,

⁴ Assuming that the regulatory ‘rate of return’ / Return on Assets is equal to the risk adjusted cost of capital / WACC, and assuming that the original acquisition cost is deemed prudent and efficient. Similarly, with regard to operating costs (fixed costs) and fuel costs (variable costs) the paper assumed that it would be optimized i.e. prudent and efficient to the extent possible at any particular time and therefore that all such costs are recovered, and furthermore are recovered during the same time periods in which they are incurred.

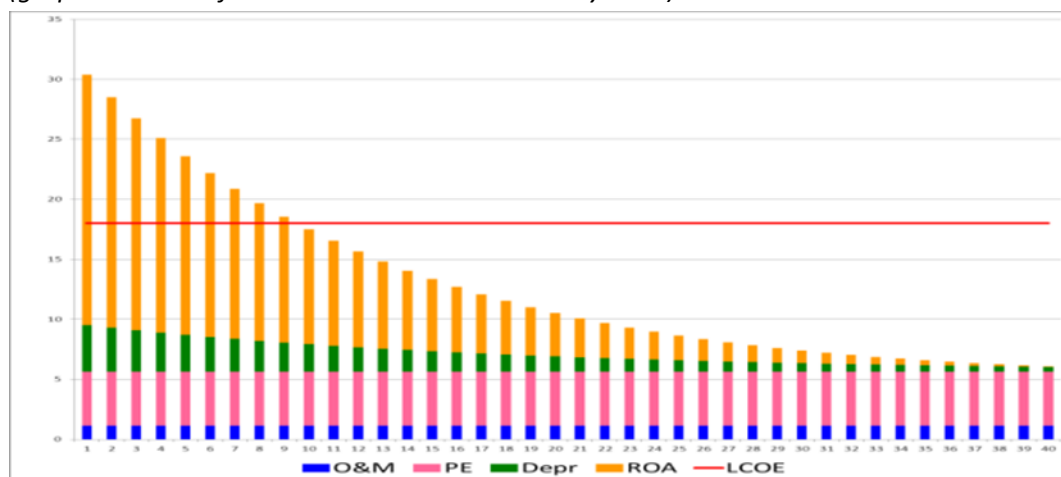
⁵ This paper uses the pre-tax cost of capital. Obviously the post-tax calculations could be affected by issues such as actual tax charges reflecting temporary and permanent timing differences, and by whether these are directly reflected in regulated revenue or averaged, etc. This paper does not further elaborate on the potential impact of such tax issues.

⁶ It would also be possible to mirror the depreciation in an annual redemption of equity capital. Usually though, the equity capital is not repaid to the shareholders on an annual basis but instead accumulated in cash in the entity. However, as cash it is able to earn a return, therefore the revenue that is earned on the operational asset need not

in the typical ‘cost-of-service’ regulatory approach, the annually reducing cost of the capital i.e. interest on debt and cost of (return on) equity is exactly represented by the annually reducing regulatory ‘return on assets’. This results in an annual reduction in revenue and thus prices, hence the inherent ‘front-loading’ of the revenue profile. Graph 1 shows a typical power station life cycle revenue / price profile, with revenues based on ‘nominal’ return on historic asset values.

Graph 1: Typical power station life cycle revenue / price profile⁷ – revenues based on ‘nominal’ return on historic asset values

(graph converted from ‘nominal’ to ‘real’ currency units)



(40 years, at 6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

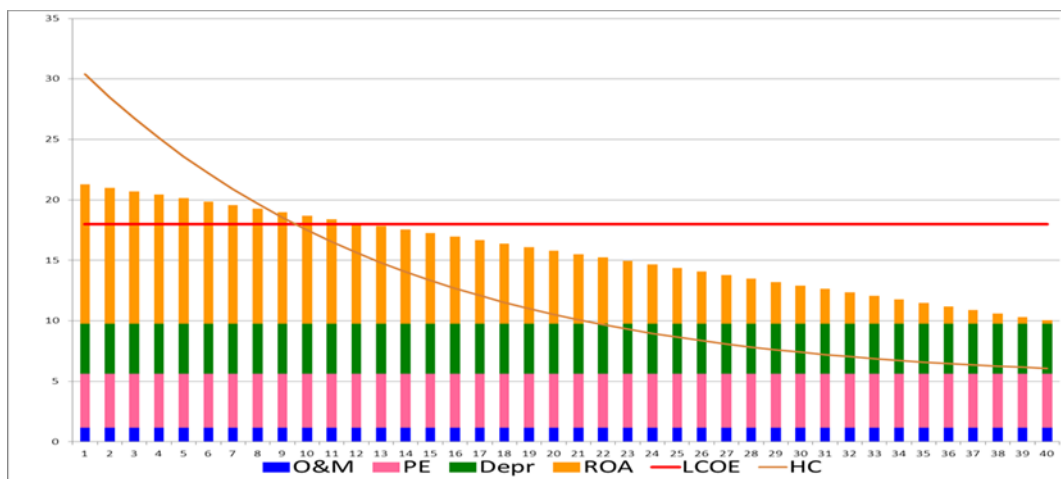
11. However, in a nil inflation environment (and in an inflationary environment, if revenue is based on ‘real’ return on indexed or replacement asset values) this ‘front loading’ would be more moderate – i.e. there is less of a difference, between annual revenue / prices in the beginning when the asset is new, and at the end of its operational life. This also implies that when an asset is replaced (with an asset of similar technology – so assumed for the purpose of explaining this principle), the initial annual price level that is required for the replacement asset would not be as much higher than the price level that was required for the previous asset at the end of its operational life. Graph 2 below illustrates both the ‘nominal’ revenue profile in a nil inflation environment, as well as the ‘real’ revenue profile in an inflationary environment with revenue based on ‘real’ return on indexed or replacement asset values.

Graph 2: Typical power station life cycle revenue / price profile – revenues based on ‘real’ return on indexed or replacement asset values

(graph converted from ‘nominal’ to ‘real’ currency units)

provide that part of the return anymore. Hence the return on the equity portion of the total capital invested in the operational asset will follow the same path as that of the debt interest, even if the equity capital is not redeemed.

⁷ For the purpose of the graphs the primary energy cost and operating and maintenance cost are assumed to remain flat in ‘real’ terms i.e. to increase only at the rate of inflation, in nominal terms.

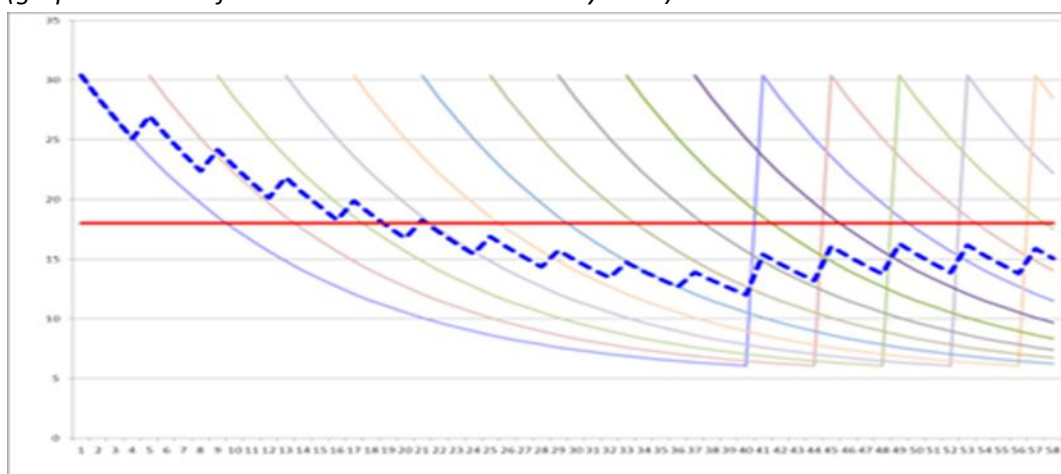


(40 years, at 6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions. Historical Cost total revenue line provided for comparison)

12. The averaging effect of a fleet of similar assets of different ages would however 'smooth' the average price profile of the revenue methodology based on 'nominal' return on historic asset values, even if it is used in an inflationary environment. Graph 3 also indicates that the average price tends towards LCOE⁸, when the 'fleet of assets' achieves a good mix of older and newer power stations.

Graph 3: Averaging effect of multiple assets on life cycle revenues / prices – revenues based on 'nominal' return on historic asset values

(graph converted from 'nominal' to 'real' currency units)



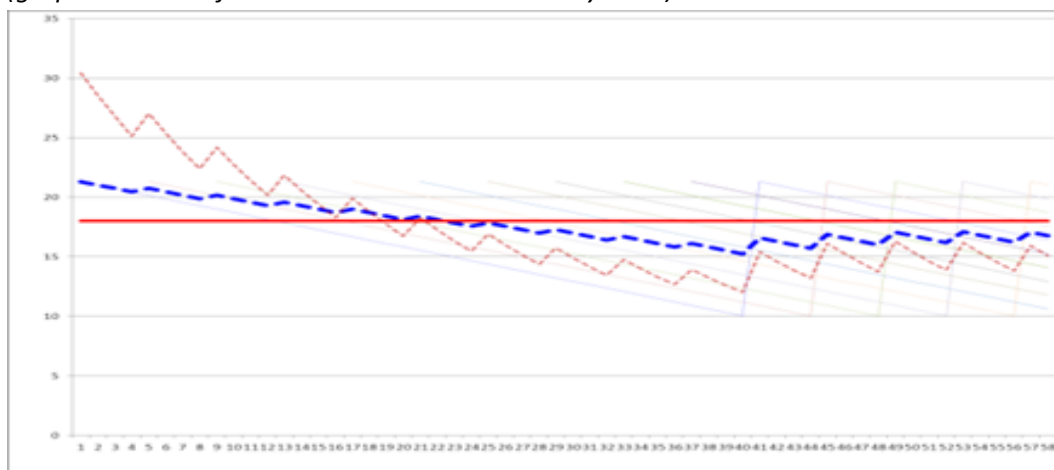
(6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

13. When the 'fleet effect' is combined with the inherently smoother life cycle price profile of the regulatory revenue methodology of 'real' return on indexed or replacement asset values, the average price is even smoother – as indicated by the bold dotted line in Graph 4 below. For comparison the graph also shows the average price line obtained on the approach of 'nominal' return on historic asset values.

⁸ The average tariff appears to stabilise at a level slightly below the LCOE, however this is an anomaly which is caused in the modelling by the initial high average tariff (above LCOE). This reduces the capital balance invested (compared to LCOE), which reduces the ROA amount and thus the average tariff in its 'stable' phase – similar to how the monthly repayment on car financing would be lower if a bigger initial deposit / down-payment is made.

Graph 4: Averaging effect of multiple assets on life cycle revenues / prices – revenues based on ‘real’ return on indexed or replacement asset values

(graph converted from ‘nominal’ to ‘real’ currency units)



(6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

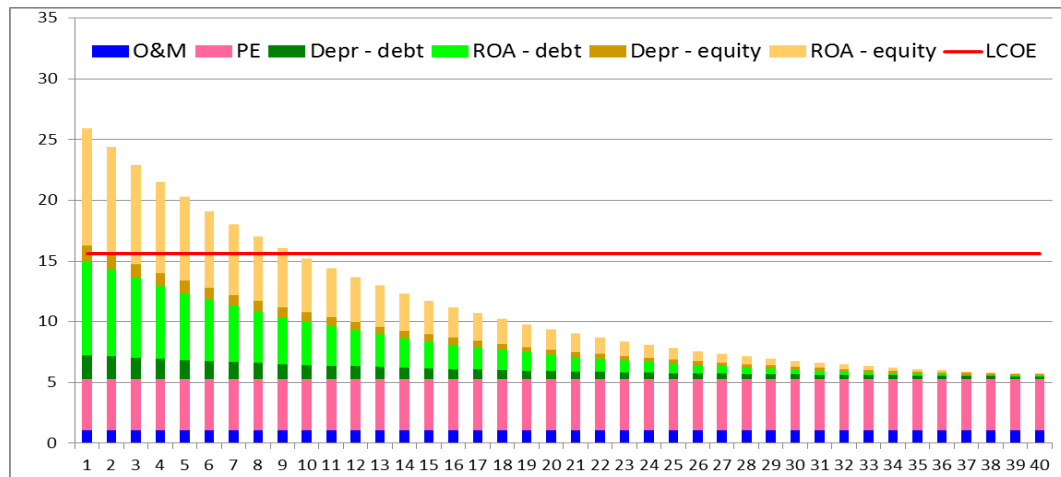
14. Hence the observation that at first glance it might therefore seem as if all potential funding and other revenue and finance related problems would be solved through cost-reflective prices, whether based on any of the described approaches.

3. Pricing below cost-reflectivity

15. Clearly though, significant problems would occur if (ostensibly) any of the regulatory approaches are applied, but the price level is set below the level that is required by an accurate application of the approach i.e. below ‘cost-reflective’ (i.e. consumers are not paying the full cost of electricity). The reduced revenue would be insufficient to cover all of the costs as described namely the operational costs (fuel, operating and maintenance), as well as repayment of the funding (principal as well as return / interest) related to the original / existing assets. As such it would imply potential default in payment on one or more of these items i.e. it would not be possible to pay the fuel cost, and / or the operating and maintenance cost, and / or the debt principal and interest.
16. If prices are only moderately below ‘cost-reflective’ the return on equity is reduced or eliminated, although it might still be possible that all other costs can be paid. A further moderate reduction in prices might imply that the company incurs annual income statement losses, but if moderate it should still enable debt principal to be repaid. However, at that price level the equity invested in the asset will not be gradually converted to cash but will be gradually reduced or eliminated. Any further reduction in prices beyond that level will imply that it would not be possible to pay the fuel cost, and / or the operating and maintenance cost, and / or the debt principal and interest. For Graph 5 below the revenue components of ‘ROA’ and ‘Depreciation’ have been split to reflect the portions relating to the debt-funded part of the asset and the equity-funded part of the asset. In addition the equity-related ‘depreciation’ component has been grouped with the equity-related ROA component – to provide a graphical illustration of the first two items in the ‘hierarchy of default’ (when revenues are below the aggregate of all components), as explained above.

Graph 5: Implications of revenue below cost-reflective

(revenues based on 'nominal' return on historic asset values. Graph converted from 'nominal' to 'real' currency units)



(40 years, at 6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

17. Obviously, if the revenue / price is below the cost-reflective level (i.e. consumers are not paying the full cost of electricity), it does not imply that the costs will somehow automatically adjust and merely 'disappear'⁹. If revenue / price is below that level it must imply that the costs are paid for in another way.
18. One option could be that the shareholders of the company pay. If the prices are only moderately below 'cost-reflective' the shareholders pay by virtue of incurring a reduced or completely eliminated return on equity / investment (i.e. an 'opportunity cost'). If the prices are further below 'cost-reflective' to the point that the company incurs annual income statement losses the shareholders will also lose a portion of the equity capital i.e. the equity capital will be reduced by the same amount as the annual loss.
19. If prices are even further below 'cost-reflective' it might imply that it would not be possible to pay the fuel cost, and / or the operating and maintenance cost, and / or the debt principal and interest – at which point the suppliers, creditors and lenders also pay (in addition to the shareholders). In practice this will not only start happening after the shareholder capital (equity) has been completely eliminated thus when the company's liabilities exceed its assets i.e. is technically insolvent (at which point of course it is technically impossible for suppliers, creditors and lenders to avoid losses). In practice a company will start defaulting long before the level of total insolvency, due to the fact that most of the reduced but remaining equity will not be represented by cash but will be represented by tangible and illiquid assets. Had the remaining equity been cash it could have been utilized (for a further period) to meet debt obligations and other costs. In practice however, the cash portion will have been exhausted by that time – hence defaulting will commence even whilst technically the company is not yet insolvent.
20. As an alternative to the shareholders, suppliers, creditors and lenders paying as described above, the taxpayers of the country could pay through government contributions e.g. grants and subsidies –

⁹ For the purposes of this paper it is assumed that operating costs (fixed costs) and fuel costs (variable costs) are already optimized i.e. prudent and efficient to the extent possible at any particular time.

which, *ceteris paribus*, imply increased tax rates. This option (of higher tax rates) of course is likely to have very negative macro-economic consequences regarding economic growth, job creation etc.¹⁰

21. In the case of a state-owned company, the effect of the shareholder paying as described above is that the taxpayers of the country are also paying – through loss of the equity capital invested in the SOE and through incurring ‘opportunity costs’ in the form of the reduced earnings and company tax received from the SOE, which would otherwise have been inflows to the central fiscus.
22. The option where neither the consumers pay (i.e. by virtue of ‘cost-reflective’ prices), nor the taxpayers, nor the shareholders (hence that suppliers, creditors and lenders pay) is clearly not viable or sustainable – suppliers will simply not provide their products and services and lenders will not lend, if there is such risk of non-payment. Similarly, if shareholders earn a return which is below the true risk-adjusted cost of capital and if they do not recover the full invested capital over the operational life of the asset, it will result in shareholders not investing further – on that project or any future project. If an unacceptable level of such risk was perceived at the start of the investment the shareholders would not have invested in the first place. Therefore this option will effectively imply that the consumers will not have the product namely in this case, electricity. Consumers will then pay through not having electricity (the cost of unserved energy¹¹), or will pay the cost of alternative self-generated electricity or other energy sources.

4. Potential problems, notwithstanding cost-reflective prices

23. By implication as long as prices are cost-reflective these problems will be avoided. It might also seem as if all potential funding and other revenue and finance related problems would be solved. However, in the description up to this point there are a few issues that have not yet been dealt with:
 - a) What is the effect on the revenue ‘front-loading’, if it is not a nil-inflation environment?
 - b) What is the effect on the funding for the existing asset, if it is not a nil-inflation environment?
 - c) What is the effect on the funding for the asset that will replace the existing asset, if it is not a nil-inflation environment?
 - d) The described approaches result in revenues / prices that only cover all the costs related to the existing assets i.e. there is no revenue ‘premium’ or ‘surplus’. Furthermore, without increasing revenues / prices from that level, the funding situation could be managed so as to ensure that exactly sufficient capital (debt and equity) would be raised for the acquisition of the next asset

¹⁰ “Continued sub-economic pricing (prices below long-run marginal costs) in the industry ironically run the risk of increasing real costs in the economy (by reducing allocative efficiency).”

SOURCE: Steyn, G. (2003) *Administered Prices: Electricity: A Report for National Treasury*. Page 28

¹¹ “Also, it is widely accepted that that the social cost of overinvestment (higher electricity cost) is small relative to the social cost of underinvestment (shortages and blackouts that can have hugely disruptive effects with severe economic and social consequences). Thus, if some deviation from the optimum level of capacity is inevitable, society should err on the side of overinvestment.”

SOURCE: Kessides, I.N., Bogetic, Z. and Maurer, L. (2007) *World Bank Policy Research Working Paper 4197: Current and Forthcoming Issues in the South African Electricity Sector*. Page 33

that will replace the existing asset. However, how is the capital raised for an additional asset that is required in order to expand capacity so as to meet growth in demand?

- e) Whether a new asset is acquired (a) in order to replace an existing asset, or (b) in order to expand capacity, the funding situation could be managed so as to ensure that there would be sufficient debt and equity capital. What is the effect when the new asset is not a 'turn-key' acquisition from a third party, but is self-constructed over a number of years prior to the asset becoming operational?
- f) What role, if any, would credit ratings still play if the described approaches are implemented?

24. These are the issues that will be covered in the rest of this paper. As explained in the Executive Summary and Introduction, this paper examines these issues from a theoretical perspective and derives theoretical criteria / parameters to ensure adequate capital for replacement and for expansion / growth. In practice there will be additional dynamics and 'noise factors' which will have to be taken into account, however relative to the theoretical criteria / parameters these are 'on top of' and not 'in place of' – i.e. they do not make the theory redundant or non-valid, but are additional practical considerations. A sound theoretical basis would be a good foundation for these additional issues. In contrast, if the practical issues are added to an unsound or incomplete theoretical basis it might lead to unexpected outcomes and the conclusion that there are more random, unpredictable and unmanageable factors at work than there actually are.

5. The effect on revenue / price 'front-loading', if it is not a nil-inflation environment

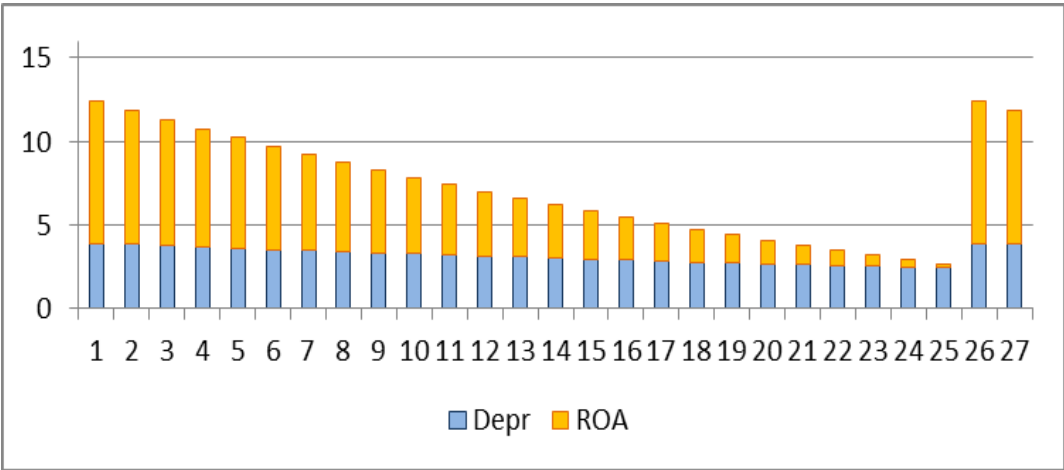
25. The Electricity Supply Industry (ESI) have a few characteristics which are common to most infrastructure industries namely:
- a) highly capital intensive;
 - b) the assets take long to construct and bring into operation;
 - c) the assets have very long operational lives;
 - d) the effect of inflation over the long asset life can create a variety of funding and pricing problems when it comes to replacement of the assets, or expansion of capacity;
 - e) the prices for the products/services often are regulated (however the basic principles for sustainability as discussed in the paper would apply, even if they operated in competitive markets).
26. Due to the high asset intensity, the price of electricity is mostly a function of the original acquisition cost of the asset – i.e. typically 60% or more of the retail price (it is quite easy to observe in an analysis of the LCOE). Due to its weight in the total retail price, the behavior of the components of the price which relate to the acquisition cost of the asset can cause the total retail price to behave in a similar way.
27. As explained in Chapter 2, the progressive depreciation of the asset results in an annually reducing regulatory 'return on assets'. Consequently the annual revenue would be higher in the beginning when the asset is new, than at the end. However, in a nil inflation environment this 'front loading' would be more moderate – i.e. there is less of a difference, between annual revenue / prices in the beginning

when the asset is new, and at the end of its operational life. This also implies that when an asset is replaced (with an asset of similar technology – so assumed for the purpose of explaining this principle), the initial annual price level that is required for the replacement asset would not be as much higher than the price level that was required for the previous asset at the end of its operational life. This moderate ‘front loading’ would be even further muted if there were multiple assets of different ages i.e. the averaging would have a ‘smoothing’ effect on the price profile.

28. This moderate ‘front loading’ can however become quite severe if inflation is not nil. In fact due to the typically long asset lives even quite low rates of inflation can cause significant ‘front loading’. For example, if asset lives are 25 years or longer, inflation rates of 2% p.a. would be sufficient to cause this effect – as shown in Graph 6 below, the annual ‘asset related’ revenue components of ‘Depreciation’ and ‘ROA’ (required to repay the principal of the capital and to pay the required interest / return) starts at a value of 12.43 and ends at a value of 2.65 (in ‘real’ terms).

Graph 6: Life cycle revenue profile over 25 years at 2% inflation. Revenues based on ‘nominal’ return on historic asset values

(graph converted from ‘nominal’ to ‘real’ currency units)

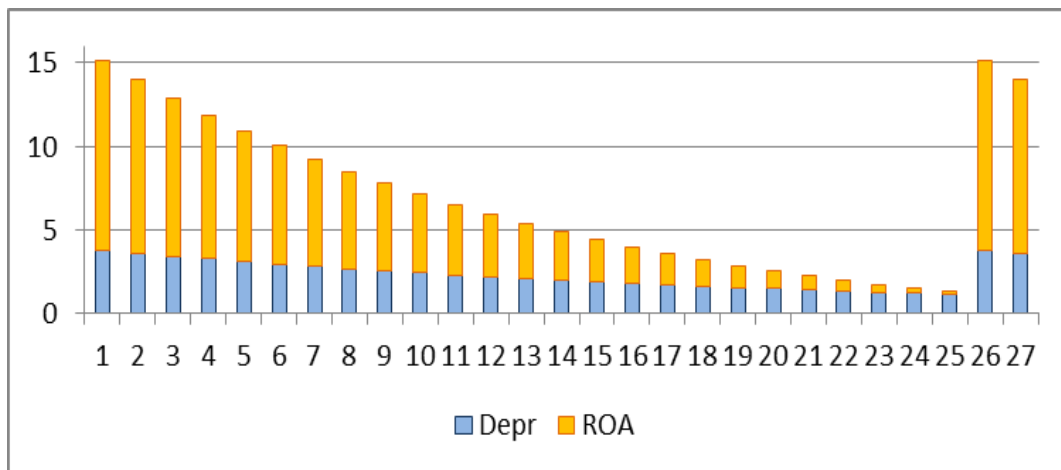


(years 26 and 27 reflect first two years of the replacement asset – note inherent adjustment)

29. With longer asset operational lives and higher inflation rates the effect is much more pronounced. As shown in Graph 7 below, at inflation rates of 5% the annual revenue (required to repay the principal of the capital and to pay the required return / interest) starts at a value of 15.12 and ends at a value of 1.32 (in ‘real’ terms).

Graph 7: Life cycle revenue profile over 25 years at 5% inflation. Revenues based on ‘nominal’ return on historic asset values

(graph converted from ‘nominal’ to ‘real’ currency units)

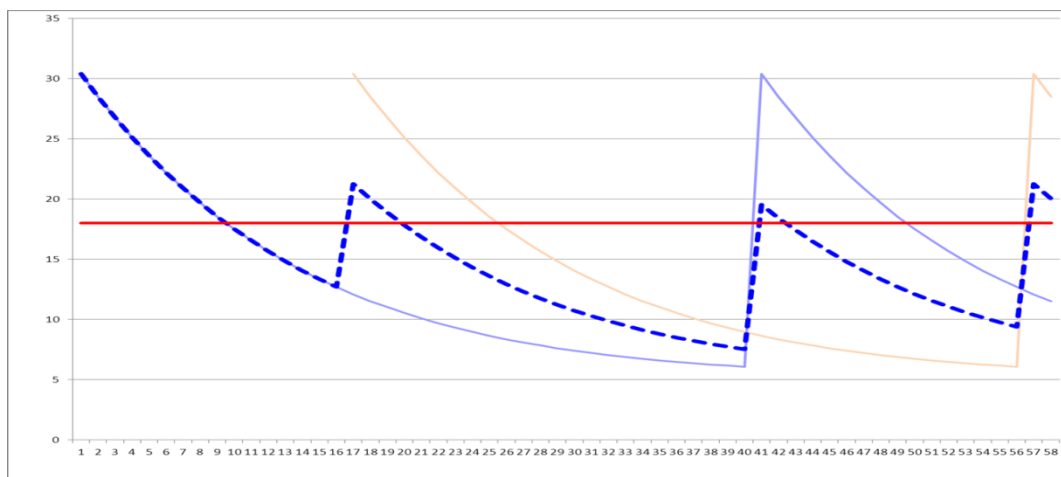


(years 26 and 27 reflect first two years of the replacement asset – note inherent adjustment)

30. When the recovery of primary energy cost and of operating and maintenance cost is added the total revenue graph reflects a similar ‘front loaded’ life cycle profile. Graph 1 illustrates the total revenue profile.
31. The implication of the inherent ‘front-loading’ that occurs even with inflation rates of 2% and 5% over 25 years, is that when a new asset of similar technology is acquired to replace the previous one there will be a severe revenue / price adjustment between the very low revenues / prices of the previous asset at the end of its operational life, and the very high revenues / prices for the new asset at the start of its life.
32. The required inherent price adjustment could create problems for consumers who had become used to and structured their businesses according to the previous low prices. The risk that consumer resistance could result in regulated revenues that do not adjust adequately could cause discomfort with credit rating agencies and lenders, leading to difficulty to obtain debt capital and (to the extent that it could still be obtained) to higher debt cost. If attraction of / access to capital is affected significantly enough it could prevent the new investment from taking place.
33. In practice however, as explained in Chapter 2 (e.g. Graph 3), the very severe price adjustment (when one asset is replaced with another of similar technology) is usually moderated to some extent due to the averaging effect of multiple assets.
34. However, as is often observed in practice, it does happen that even multiple assets can reflect much of the same dynamics as single assets – e.g. when investment takes place in ‘spurts’ or groups. The outcome still is excessive price volatility, as illustrated by the dotted line in Graph 8 below.

Graph 8: Averaging effect of two assets on life cycle revenues / prices – revenues based on ‘nominal’ return on historic asset values

(graph converted from ‘nominal’ to ‘real’ currency units)

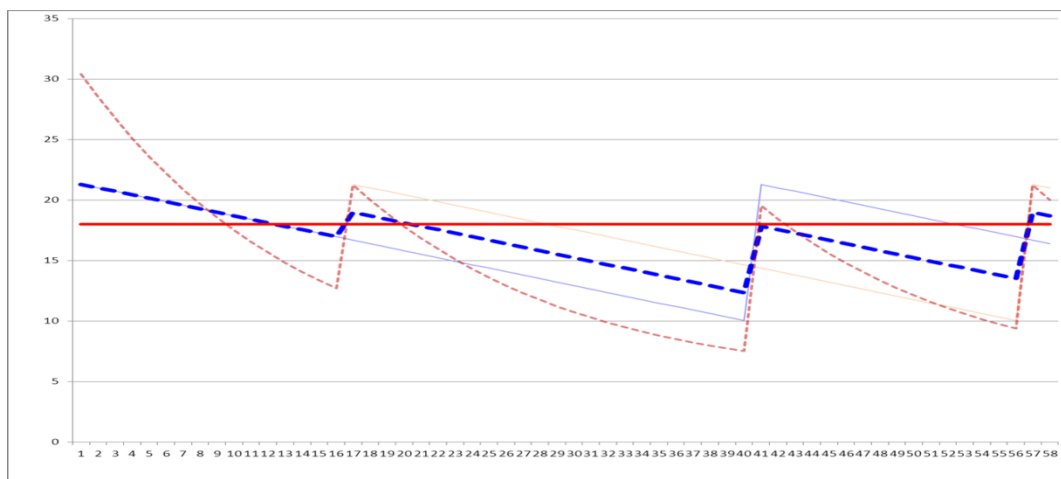


(6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

35. It is due to these dynamics that regulators resort to the approach of applying a 'real' rate of return on 'inflation indexed' or 'replacement value' assets. The inclusion into revenue of the lower 'real' rate of return, whilst the capital is actually priced at the higher 'nominal' rate, obviously implies that on this approach there would (initially) be a shortfall between the 'nominal' cost of capital (i.e. the actual annual debt interest paid which would reflect the 'nominal' rate) and the 'real' cost of capital which is recovered annually through the regulated revenue. The compensation takes place through the annual shortfall being capitalized for regulatory purposes. The capitalized amount is thereafter recovered by being depreciated annually (with the depreciation charges being recovered through regulated revenue), and with the undepreciated capital (i.e. 'unrecovered' capital) earning the regulated percentage return.
36. The same result is achieved by merely indexing the depreciated asset values at the same rate of inflation as is used for the conversion from a 'nominal' rate to a 'real' rate of return, which is the approach followed by many regulators. In practice however the application of the 'indexation' approach over a very long asset life (e.g. 40 years or more) could be difficult due e.g. to non-availability of accurate accounting records over this long period, thus the 'inflation indexation' is often replaced with a type of 'replacement value' approach i.e. 'modern equivalent asset'. The outcome will be similar, on the assumption that over the long term the inflation indexation of the assets, and the changes in the replacement values, will track each other.
37. If correctly implemented the discounted net present value of the future revenue stream on this approach is equal to the original acquisition cost of the asset. This is also the case if the approach is applied of using a 'nominal' rate of return on depreciated historical cost asset values, hence the discounted net present value of the future revenue streams on the two approaches are identical. However the result of this approach is that the inherent 'front-loading' of the life cycle revenue profile is very much reduced. In practice it usually solves the 'inherent price adjustment' problem, even without significant reliance on the averaging effect of multiple assets, as illustrated by the bold dotted line in Graph 9 below. For comparison the graph also shows the average price line obtained on the approach of 'nominal' return on historic asset values.

Graph 9: Averaging effect of two assets on life cycle revenues / prices – revenues based on 'real' return on indexed or replacement asset values

(graph converted from 'nominal' to 'real' currency units)



(6% inflation rate. Horizontal line is Levelised Cost of Electricity, for the same assumptions)

38. Whilst this average price is not as 'smooth' as with multiple-assets (e.g. Graph 4 of Chapter 2), it is a significant improvement compared to the profile produced by the 'nominal' return on historic asset values.
39. Price shocks increase investment risks in an industry with inherently high risks already. An improvement in price stability is possible, by following these approaches. It would increase certainty regarding the adequacy of future revenue streams and thus contribute to the attraction of capital, which is critical to a capital-intensive industry.

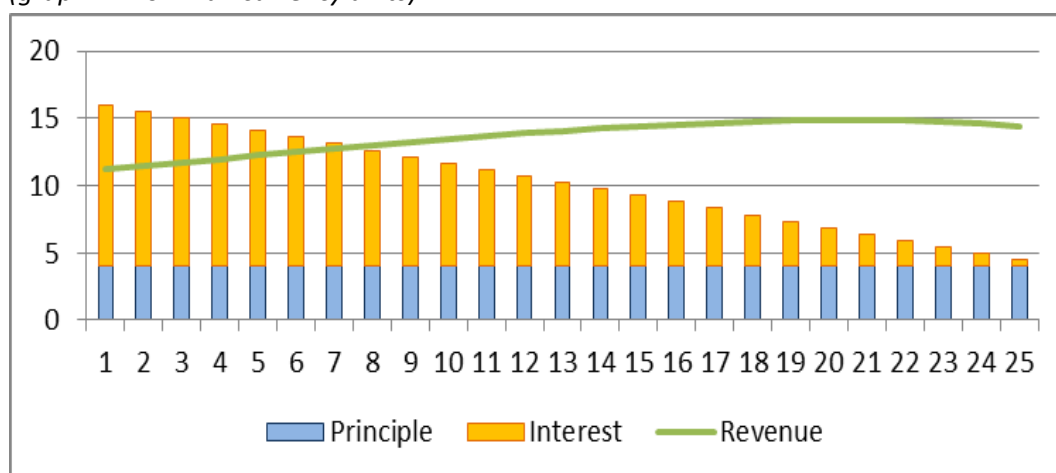
6. The effect on the funding for the existing asset, if it is not a nil-inflation environment

40. As has been explained in this paper, the correct application of any of the approaches for setting of revenue will result in 'cost-reflective' revenues and prices as it would enable payment of all operational costs (fuel, operating and maintenance), as well as repayment of the funding (principal as well as return / interest) related to the original assets.
41. With regard to the repayment of the funding, it was further explained that a 'test' for 'cost-reflectivity' was that the discounted present value of the life cycle revenue stream is equal to the original acquisition cost of the asset. By implication such 'test' will only apply to the full life cycle revenue stream i.e. the equivalency with the original acquisition cost of the asset will not be achieved if only portions of the life cycle revenue are used for the calculation.
42. However, the use of the 'nominal' rate of return on depreciated historical cost asset values will also achieve equivalence on an annual basis (disregarding timing differences between the actual redemption of debt principal and the depreciation of the regulated asset i.e. assuming that the debt principal is redeemed at the same rate and over the same period, as the asset is depreciated). This follows from the use for regulatory revenue setting of the same debt interest rate, as is actually incurred. This will have the result that the actual annual debt interest cost is matched by the debt portion of the 'return on assets' component of revenue. It will further have the result that the actual annual principal redemption of the debt will be matched by the 'depreciation' component (adjusted to the debt ratio of total capital) of revenue. If this is maintained for each year of the asset's operational

life cycle it follows that the annual revenues will enable the annual debt principal and interest obligations to be repaid exactly i.e. without annual shortfall or surplus.

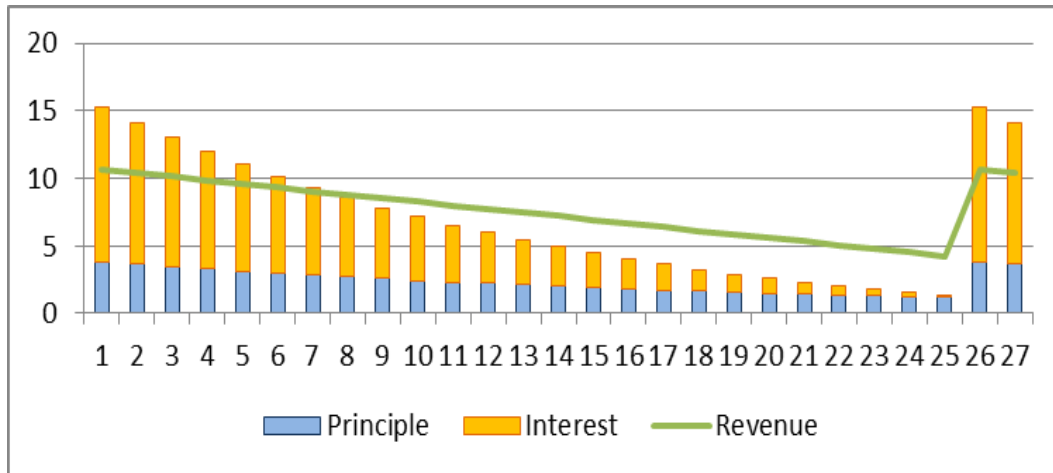
43. A similar situation will prevail regarding the equity returns and equity capital, with the difference that the cash outflows in terms of dividends and capital redemption are more discretionary.
44. A problem could however arise if the approach for setting regulated revenue is based on applying a 'real' rate of return on 'inflation indexed' or 'replacement value' assets, in an inflationary environment. As explained above, the utilization of the lower 'real' rate of return, whilst the capital is actually priced at the higher 'nominal' rate, implies that there would (initially) be a shortfall between the 'nominal' cost of capital (i.e. the actual annual debt interest paid which would reflect the 'nominal' rate) and the 'real' cost of capital which is recovered annually through the regulated revenue. This shortfall is recovered over time by being capitalized and depreciated, and with the 'unrecovered' capital earning the regulated rate of return. However in the short term and especially with a new asset it could have the result that the actual annual debt interest payment to the lenders (which is based on the 'nominal' interest rate) exceeds the 'return on assets' component of regulated revenue which is based on the 'real' debt interest rate.
45. For example the lender of a capital amount of 100 might charge a nominal interest rate of 12%, hence the annual actual interest cost in year 1 will be 12. However in that same year the debt component of the regulated 'return on assets' (on the 'real' return approach and assuming 5% inflation rate) will be 6.67%. The total revenue of the regulated entity will thus include an amount for payment of debt interest of only 7 (6.67%, on 100 + 5 inflation adjustment) whereas the actual annual debt interest cost in year 1 will be 12. There is therefore a revenue shortfall of 5, or 41.7% of the actual interest cost (this percentage shortfall is worse if real interest rates are low). This revenue shortfall will reduce the return on equity ('profit') by the same amount (assuming that there was such profit to start with i.e. that the capital structure includes a portion of equity – e.g. 40% – and that the revenues were set at a level to provide a return on such equity capital). Therefore, the regulatory approach of dealing with price shocks in an inflationary environment could clearly cause financial difficulty for the investor. Graph 10 below illustrates the shortfall between the revenue and the actual debt interest cost that could occur until the 8th year of a 25-year asset life, for the example described. Graph 11 reflects the same data, but with graph converted from 'nominal' to 'real' currency units.

Graph 10: Revenue based on 'real' returns approach, whilst debt reflects nominal rate
(graph in 'nominal' currency units)



(25 years, 5% inflation rate, 12% interest rate)

Graph 11: Revenue based on 'real' returns approach, whilst debt reflects nominal rate
(graph converted from 'nominal' to 'real' currency units)



(25 years, 5% inflation rate, 12% interest rate)

46. There are however a few mitigating strategies which could be taken to reduce this impact:

a) The use of a moderate gearing ratio:

If the capital structure contains sufficient equity capital, the (intended) equity returns which had been included into the regulated revenue would function as a 'buffer' to meet the shortfall on debt interest – i.e. actual equity returns would then be less than the intended returns due to the intended equity returns absorbing the difference between actual interest cost and regulated debt returns (at the expense of the shareholders). Sufficient equity capital would also ensure that from a cash-flow perspective a greater amount of cash would remain after the annual redemption of the debt principal.

However if the capital structure is too highly geared / leveraged there would be very little 'equity return buffer' to meet the shortfall on debt interest, thus such shortfall could translate directly to annual losses on the income statement. In addition the cash flow situation would be worse with a highly geared capital structure as a greater portion of the cash would be utilized for the annual redemption of the debt principal.

b) The combination of new assets and older assets:

Whereas there could initially be financial difficulties with a new asset especially if geared too highly, the situation reverses in the longer term. At some point during the asset's operational life cycle the returns earned on the capitalized / accumulated interest shortfalls as well as the redemption of that capital through the depreciation mechanism will result in earnings and cash inflow that exceed the annual redemption of debt principal and the debt interest payments. These positive cash flows are required in order to compensate for the initial weak inflows, in order to achieve a discounted present value that is equal to the original acquisition cost of the asset. However it could also be used to counter the weak inflows in the initial years of a new asset. Thus, two or more similar assets that differ in age by an appropriate margin could be a very useful mitigation strategy.

- c) The matching of the profile of cash outflow for debt principal redemption and interest payments to the regulatory approach:

The lenders could be requested to match the cash outflow of annual debt obligations to the revenue inflows of the particular regulatory approach. In effect it would mean that the lenders would be increasing the debt annually through further loan advances for the initial number of years, to be recovered through higher payments over the latter years i.e. a 'back-loaded' debt redemption profile. Lenders might be reluctant to accede to such request and generally would prefer to obtain the inflows in a 'front-loaded' profile. However if the general regulatory environment is highly rated, trusted, credible and predictable, with a long track record of sound regulatory decisions, it might be possible to obtain some concessions in this regard. If this is possible it will assist with only the cash flow situation – the full nominal interest cost will still be accounted for as incurred, thus the income statement will still reflect the effect of the higher 'nominal' interest cost compared to the lower revenue which is based on the 'real' interest / return.

In the case of an asset that obtains its inflows through a bi-lateral contract e.g. a Power Purchase Agreement it would depend on the soundness of the counter-party. If such counter-party operates in a regulated environment and its revenues are a function of a regulatory decision, it would again depend on the assessment of that environment.

- d) The utilization of tax incentives:

As mentioned before, the modelling and analysis for this paper is done on a pre-tax basis. Therefore the tax cost is included and recovered through the revenue by the 'gross-up' of the cost of the equity capital to a pre-tax value. Many regulatory revenue models follow this approach. However it could be that the actual tax charges reflect timing and permanent differences, e.g. on a new investment it might be possible to claim the tax deductions quicker than is implied through the 'gross-up' approach. This would assist to relieve the cash flow pressure at exactly the time where it is at its greatest.

47. In practice it might be a combination of all of these mitigating actions. There might be other options as well, not covered in this paper.

7. The effect on the funding for the asset that will replace the existing asset, if it is not a nil-inflation environment

48. It was explained in Chapter 2 that the correct application of the described regulatory revenue approaches would enable repayment of the original debt principal related to the acquisition of the original asset, hence would create new debt capacity to enable the funding of the debt portion of the capital that is required in order to replace the original asset at the end of its operational life. Similarly, by virtue of liquidating back to cash the equity capital which was invested in the original tangible asset, the cash equity would again be available to fund the non-debt portion of the capital that is required in order to replace the original asset. It was explained that this applied whether the regulatory revenue approach was based on a 'nominal' return / historic asset value approach or a 'real' return / indexed or replacement asset value approach.

49. Even in an inflationary environment the debt funding should be feasible, on condition that the revenue has adjusted in proportion to the higher (inflated) price of the replacement asset. However, an examination of the equity funding indicates some potential difficulties – mostly due to inflation. It is assumed for this paper that the company's 'default' financial accounting policy / basis is 'historical cost', irrespective of whether the regulatory revenue is based on a 'nominal' return / historic asset value or a 'real' return / 'inflation indexed' or 'replacement' asset value. However where appropriate the distinction will be made regarding the effect, had the financial accounting policy been based on 'revaluation':
- a) In a nil inflation environment there is no difference between the regulated revenue approach based on a 'nominal' return / historic asset value vs. a 'real' return / 'inflation indexed' or 'replacement' asset value – they are the same thing i.e. 'nominal' and 'real' interest rates are the same, and 'historical cost' and 'indexed' / replacement value are the same. Furthermore, in a nil inflation environment the new asset which is acquired for replacement purposes costs the same as the original asset¹². The accounting process will recover a cash amount through the depreciation mechanism which is equal to the equity-funded portion of the new, replacement asset, thus facilitating the new investment¹³. It would also imply that the equity return that was earned could be paid out to shareholders as dividends without compromising the ability of the company to fund the replacement of the original asset.
 - b) In an inflationary environment and applying the historical cost accounting process, the depreciation mechanism still only recovers the original cost price of the asset. If an asset with a 25 year operational life had cost 100 (or, the equity funded portion was 100¹⁴), at 5% annual inflation rate the replacement thereof will cost 339. However the depreciation mechanism will have recovered and accumulated in cash the original 100¹⁵. It leaves a significant funding shortfall relative to the new acquisition cost. If the equity funding for the previous (original) asset had been 40% (thus 60% debt) and it were possible to obtain the shortfall from additional debt, the debt : equity ratio could have to change to 88 : 12 – clearly not feasible. If the debt : equity ratio is to remain stable it implies that additional equity will have to be obtained to fund the shortfall – in this example another 239 on top of the 100 which had been accumulated through the depreciation mechanism. If the same approach regarding equity returns had been followed as in the nil-inflation example i.e. that the equity return that was earned was paid out to shareholders as dividends, the shareholders would now be faced with a requirement for a significant equity investment.

¹² For the same technology and assuming that no 'real' changes in replacement values have occurred.

¹³ On the basis that a part of the cash which is recovered through the depreciation mechanism will be used to redeem debt principal, thus the remainder is in effect the 'liquidation' of the equity funded part of the asset. See also note 15 below.

¹⁴ It has been explained that inflation should not present a problem regarding the debt-funded portion of the capital investment. Therefore the numerical examples provided focus on the equity funded portion of the total capital required – e.g. the '100' can be seen as say 40% of an asset which cost 250 (assuming a capital structure of 60% debt : 40% equity) or it can be seen as 100% of an asset which cost 100 and was funded solely from equity.

¹⁵ In practice it might be that such cash is used for other purposes. However for the purposes of this paper it is assumed that the cash is preserved for the replacement of the asset.

c) In an inflationary environment and applying the 'revaluation' accounting process, the depreciation mechanism recovers and accumulates more than the original cost price of the asset. Effectively it transfers a portion of income from the equity return to the depreciation mechanism. Although financial accounting and economic regulation might differ in some aspects, the economic and revenue implications of the regulatory approach¹⁶ is that the annual interest rate shortfall is capitalized and from that point forward also depreciated (thus recovered through revenue by virtue of the adjusted depreciation charge), over the remaining life of the asset. Using the same example as above, the depreciation mechanism will recover 201. Although more than would have been recovered on the historical cost approach, it still leaves a funding shortfall of 138. If the equity funding for the previous asset had been 40% (thus 60% debt) and it were possible to obtain the shortfall from additional debt, the debt : equity ratio could have to change to 76 : 24 – clearly not feasible. If the same approach regarding equity returns had been followed as in the nil-inflation example i.e. that the equity return that was earned was paid out to shareholders as dividends, the shareholders would now be faced with a requirement for a significant equity investment, albeit slightly smaller than on the historical cost approach – the exact amount depending on how the 'revaluation' accounting policy was implemented.

50. It is clear that in an inflationary environment the financial accounting depreciation mechanism alone will not accumulate the required equity capital for the replacement asset. It is however known that the discounted net present value of the life cycle revenue stream is equal to the original acquisition cost of the asset, in all of the above examples. This must imply that in an inflationary environment some of the revenue that is accounted for as 'return' should actually from an economic perspective not be deemed to be (distributable) return but should be re-invested in the company (i.e. not extracted in the form of dividends) as a form of 'capital preservation' or 'capital maintenance'.
51. **With the 'historic cost' accounting basis**, the annual historic cost depreciation recovers an amount each year of equal to the original acquisition cost divided by the operational life of the asset. At the start of the life cycle it therefore envisages to recover and accumulate the full acquisition cost, in equal annual amounts. However, after one year of inflation it is already clear that the total accumulated depreciation amount at the end of the cycle will be less than the replacement value, by at least the inflation-driven change in the replacement value which had occurred in that first year – even if after that year, inflation rates reverted back to nil. For example, after year one, if a 5% inflation rate had prevailed for that year, it is already clear that the 100 that will eventually be accumulated through depreciation will be short by the inflation adjustment of 5 which had occurred in that first year. It does not imply that revenues were too low – the solution is of course to deem / designate 5 of the return amount as 'replacement reserve' or similar. It will not be distributable (available for dividend payment).
52. In year two, if a 5% inflation rate had again prevailed for that year, it will be clear that the depreciation amount of 100 plus year one's 'replacement reserve' of 5 = 105, will again (or, still) be less than the replacement value, by at least the inflation-driven change in the replacement value which had occurred in that second year – i.e. 5% of 105 = 5.25. Thus the 'transfer' to the 'replacement reserve' will have to take place again, at a value of 5.25. If this is done each year it means that the original 100 is recovered or accumulated through the depreciation mechanism, and in addition the full annual movement in the

¹⁶ The matter of 'inflation adjusted accounting' is a highly technical accounting subject and subject to changes and amendments. It is not the intention of this paper to focus on that aspect. The examples used attempt more to illustrate the economic regulation approach, whereas the financial accounting approach might differ in some aspects.

replacement value of the asset is accumulated in the 'replacement reserve' through transfers from retained earnings. It also means that at the end of each financial year, the depreciated value of the asset plus the accumulated depreciation plus the 'replacement reserve' will be equal to the new replacement value of the asset at that point (in the context as described by footnote 14).

53. Obviously, for the accumulated depreciation and the 'replacement reserve' to achieve its intention, the cash which is 'preserved' from distribution (e.g. as dividends) through these two mechanisms must be accumulated in a designated fund. The integrity of the fund can be monitored in various ways, however the departure point would be that it must at any time be equal to the balances of the accumulated depreciation plus the 'replacement reserve'. When investment for such replacement actually happens (perhaps commencing a few years prior to the end of the operational life of the original asset) the 'non-debt funded' part of the investment would obviously reduce the fund balance (in the context as described by footnote 14). The 'integrity test' would have to take account of such new investments. One way is that the fund balance must then be equal to the balances of the accumulated depreciation plus the 'replacement reserve' less the value of the works under construction (which is the same as that the fund balance plus works under construction must be equal to the balances of the accumulated depreciation plus the 'replacement reserve'). When the original asset is 'retired' the accumulated depreciation is 'transferred / netted-off' to the cost price of the related asset. At the same time the related 'replacement reserve' must be 'transferred' to the equity account – not a distributable equity account such as 'retained earnings', given that the amount represents equity which had been re-invested in the company in a tangible asset thus would not be available for distribution¹⁷.
54. By the end of the life cycle the amount so accumulated in the 'replacement reserve', assuming 5% inflation rate applied to each year, will be 239. The 100 that had been accumulated through the depreciation mechanism, plus the 239, is exactly the amount needed for the replacement asset namely 339.
55. It also implies that the annual remaining amount of return (after the transfer to the 'replacement reserve') can safely be paid as dividend without compromising the sustainability of the company (assuming no growth in the company). However, the accumulated depreciation and 'replacement reserve' cash funds can be invested until it is needed and will be earning interest. For this analysis and in order to demonstrate the concepts, it was assumed that the interest rate would be the same as the interest rate paid by the company (e.g. as if the company had bought back some bonds or repaid some loans). The potential annual dividend could safely include such interest as well, considering that the 'replacement reserve' has been established to be sufficient i.e. does not require further inflow in the form of interest in order to be sufficient.
56. The outcome of this is that the potential annual dividend is equal to the 'real' rate of return, on the total of the depreciated asset value plus the accumulated depreciation plus the 'replacement reserve'. As explained above, the depreciated value of the asset plus the accumulated depreciation plus the 'replacement reserve' will be equal to the new replacement value of the asset at that point, thus the potential annual dividend is also equal to the 'real' rate of return, on the new replacement value of the asset at that point. This mechanism effectively implies that at most only the 'real' return on the new

¹⁷ Note however that a detailed discussion of the technical financial accounting treatment falls outside the scope of this paper.

replacement value of the asset can be paid as dividend, with the inflation component of the return being re-invested as 'sustaining capital' as a form of 'capital preservation' or 'capital maintenance'.

57. **With regard to the 'revaluation' accounting basis**, there is already some element of 'sustaining capital' built into the depreciation mechanism. However as mentioned above, it will recover and accumulate 201 which still leaves a funding shortfall of 138, using the same approach and data as in that example.
58. With the 'revaluation' accounting basis (and for this example assuming it to reflect the economic regulation approach), the annual depreciation is adjusted to the change in the new replacement value of the asset – e.g. after the asset has been indexed / inflated for the year, the depreciation is calculated as the new replacement value divided by the asset's total operational life. The same result is obtained if the depreciated indexed / replacement asset value is divided by the remaining operational life. In effect the annual depreciation is indexed to the rate of inflation.
59. In this case, the shortfall arises because the 'indexed' depreciation charge reflects the correct depreciation charge for that specific financial year, but does not include an adjustment for the inflation effect on the accumulated depreciation up to that point. By creating a 'replacement reserve' that accumulates the annual inflation adjustment on the accumulated depreciation up to that point (i.e. a type of 'backlog' depreciation adjustment), it ensures that at the end of each financial year, the depreciated indexed value of the asset plus the accumulated depreciation plus the 'replacement reserve' will be equal to the new replacement value of the asset at that point.
60. As in the case of the 'historic cost' accounting basis, for the accumulated depreciation and the 'replacement reserve' to achieve its intention the cash which is 'preserved' from distribution (e.g. as dividends) through these two mechanisms must be accumulated in a designated fund. The monitoring of the integrity of the fund, prior to 'replacement investment' taking place and after it commences, and the accounting transactions upon 'retirement' of the original asset will also apply in a similar way as in the case of the 'historic cost' accounting basis.
61. By the end of the life cycle the amount so accumulated in the 'replacement reserve', assuming 5% inflation rate applied to each year, will be 138. The 201 that had been accumulated through the depreciation mechanism, plus the 138, is exactly the amount needed for the replacement asset namely 339.
62. Similar to the situation on the historic cost accounting basis, the remaining amount of return can safely be paid as dividend without compromising the sustainability of the company (assuming no growth in the company). The potential dividend would include the interest on the accumulated depreciation and 'replacement reserve'. As in the case of using the historic cost accounting basis, the potential annual dividend is equal to the 'real' rate of return, on the total of the depreciated asset value plus the accumulated depreciation plus the 'replacement reserve'. This is the same as the 'real' rate of return, on the new replacement value of the asset at that point – which is identical to the case of the historic cost accounting basis. Thus, the potential annual dividend after the 'replacement reserve' transfer will be equal irrespective of the accounting basis.
63. For either accounting basis, the annual transfer to the 'replacement reserve' is therefore not an additional revenue element i.e. it will not require revenue to increase – it is merely a mechanism to manage equity returns / retained earnings. It does not affect shareholder value or wealth but merely

implies that the shareholder wealth is invested in the company – instead of being distributed in cash and invested or utilized in another way by the shareholder, which would have the implication that either the shareholder will have to make significant equity contributions at the time of replacement of the asset, or additional debt will have to be raised thus the company's capital structure (debt : equity ratio) will significantly weaken (or, there will be insufficient capital to invest in replacing the asset).

64. It was explained above that at the end of each financial year, the depreciated indexed value of the asset plus the accumulated depreciation plus the 'replacement reserve' will be equal to the new replacement value of the asset at that point. Whereas this should be the starting point, in practice there could be other factors that might affect the adequacy of the 'replacement reserve' balance e.g. a known future change to a different technology that might be more or less expensive than the existing technology. Therefore the adequacy of the 'replacement reserve' balance should also be annually evaluated in other ways. One way is to annually estimate the short term portion of the replacement capex on say a ten-year forward view (the lead time will differ depending on the type of asset, the construction lead time for such assets etc.), and to calculate the equity portion of such estimated capital investment. The current balances of the accumulated depreciation and 'replacement reserve' must be such that they, plus the future annual transfers as described, must be able to meet the equity capital requirement for each of the years as estimated in this short term period, whilst the remaining balances must still be adequate for the replacements of assets beyond that period (i.e. must still meet the basic 'test' of the depreciated indexed value of the asset plus the accumulated depreciation plus the 'replacement reserve' being equal to the new replacement value of the asset at that point). In essence it implies that the 'theoretical' 'replacement reserve' balance is tested by taking account of actual replacement capex estimates, when such capex starts occurring in (e.g.) a ten year forward view.
65. If the 'replacement reserve' balance falls below the required level it obviously requires additional transfers to restore it. The further forward this situation is identified, the greater the number of available years over which to restore the balance prior to it actually being required. A short lead time might imply that even the transfer of the total annual equity earnings would not be sufficient, which could result in a number of consequences including a weakening of the balance sheet.
66. The mechanism of transfer to the 'replacement reserve' can be applied in a single-asset environment or a multi-asset fleet environment. In the latter case the fleet of assets could be treated as a single asset i.e. it does not require a 'replacement reserve' for each specific asset.
67. It is often that case that, whilst the regulatory revenue approach is based on a 'real' return / 'inflation indexed' or 'replacement' asset value, the company's financial accounting policy is based on historical cost. In such case it is recommended to also prepare 'notional' financial reports (at least a balance sheet and income statement) on the revaluation basis, including the equity reserves and annual transfers to them as described for that accounting basis, for inclusion in the annual financial report as a note. In fact, in an inflationary environment, given the effect of inflation over the typically long asset lives, it is recommended to always also prepare 'notional' financial reports on the revaluation basis irrespective of the regulatory revenue approach. The decisions regarding dividend payments should take account of both the notional revaluation basis reports, as well as on the historic cost reports.
68. As noted previously, the examples provided focused on the equity funded portion of the total capital required – e.g. the '100' can be seen as say 40% of an asset which cost 250 (assuming a capital structure of 60% debt : 40% equity) or it can be seen as 100% of an asset which cost 100 and was

funded solely from equity. Regarding the debt funded portion, it should be feasible even in an inflationary environment, on condition that the revenue has adjusted in proportion to the higher (inflated) price of the replacement asset. However, as was explained in Chapter 6, in an inflationary environment and using the regulatory revenue approach of 'real' rate of return on 'inflation indexed' or 'replacement value' assets, there would initially be a shortfall between the revenue inflow related to the debt interest, and the actual debt interest cost. It could be mitigated by (a) the use of a moderate gearing ratio; (b) a combination of new assets and older assets in the total fleet; (c) attempting to match the profile of debt principal redemption and interest payments to the regulatory approach; (d) the utilization of tax incentives. In practice it might be a combination of all of these mitigating actions. To the extent that (a) is relied upon, it would imply that a further portion of the return on equity would be 'absorbed' due to the initial shortfall between revenue and actual debt interest cost.

8. Raising the capital for an additional asset that is required in order to expand capacity so as to meet growth in demand

69. It was explained in Chapter 2 that the correct application of the described regulatory revenue approaches would ensure recovery of all fuel costs, operating and maintenance costs, and capital costs (interest and return), and would ensure recovery of the original debt and equity capital invested. By virtue of repayment of the debt principal it created new debt capacity for replacement of the original asset at the end of its operational life, and by virtue of liquidation of the equity capital back to cash it enabled the investment of that equity capital into the new asset to fund the 'non-debt' portion of the required capital. This applied irrespective of whether the regulatory revenue approach was based on a 'nominal' return / historic asset value approach or a 'real' return / indexed or replacement asset value approach, and irrespective of whether the financial accounting basis was 'historical cost' or 'revaluation'.
70. Chapter 7 explained that in an inflationary environment the financial accounting depreciation mechanism alone will not accumulate the required equity capital for the replacement asset, and that the shortfall was much greater on the 'historic cost' accounting basis than on the 'revaluation' basis. The shortfall did not imply that revenues were too low – the solution was to annually retain a portion of the equity returns in a form of 'replacement reserve'. Although the required amount to be retained was higher in the case of the 'historic cost' accounting basis, the outcome was that the annual distributable earnings (potential dividends) were identical on both approaches. Also, in both cases at the end of each financial year the depreciated value of the asset plus the accumulated depreciation plus the 'replacement reserve' is equal to the new replacement value of the asset at that point.
71. The described funding mechanisms ensure adequate funding in order to replace the original asset at the end of its operational life. However these mechanisms clearly do not include further funding for additional assets that might be required to meet any growth in demand that had occurred over the operational life of the original asset.
72. For example, if a compounded annual growth rate of 2.81% is assumed over the 25 year operational life of the original (electricity generating) asset it would exactly double the electricity demand and thus the required capacity – i.e. instead of an amount of 339 being required to replace the original asset (being original cost of 100, inflated at 5% p.a. over 25 years), it would require an additional 339 thus 678 in

total. The debt portion of the required capital could be borrowed on condition that the lenders are satisfied that there would be sufficient additional sales volume to ensure full utilisation of the additional asset, over its operational life, and that the revenues / prices would be 'cost-reflective'. However it is clear that the equity capital accumulated to fund the replacement asset was only sufficient for that purpose and not for anything additional. In terms of the example, if the 100 represented the equity-funded portion of the original asset, then to replace the asset as well as to fund another similar asset due to growth in demand (of 2.81% CAGR) would require an amount of 678. The mechanism through which the 339 for the replacement is obtained has been explained in Chapter 7. The mechanism through which the additional 339 for the 'capacity expansion' (growth) is obtained is described below.

73. As for the funding of the replacement assets, the required additional equity capital does not imply that the revenue is too low. Again the solution requires a further retention of equity returns as a form of non-distributable 'expansion reserve' or similar.
74. If it was feasible to expand the capacity annually at precisely the rate of growth in demand, and it is assumed that the annual capacity expansion would reflect the same technology types and mix as the existing fleet of assets, then it follows that the capital amount that would be required annually would be equal to the annual growth rate, multiplied with the new or current replacement cost of the existing assets (e.g. Replacement Cost New or RCN). As previously explained, the debt-funded portion of this required capital could be borrowed on condition that the lenders are satisfied that there would be sufficient additional sales volume to ensure full utilisation of the additional asset, over its operational life (and of course, cost-reflective revenues). Therefore the annually required amount of equity would be equal to the annual growth rate, multiplied with the new or current cost of the existing assets, multiplied with the percentage of equity capital in the overall capital structure.
75. For example, using the same CAGR of 2.81% as above, if the equity-funded portion of the new replacement cost of the existing assets were 100 at the end of the previous year and the current inflation rate 5%, then the equity capital required for the current year would be 2.95 – being 100 adjusted for one year's inflation of 5% = 105, multiplied by the growth rate of 2.81% = 2.95. If the 2.95 capital investment is actually made and the growth rate continues, then for the following year the equity capital required would be 3.18 – being the 105 plus 2.95 = 107.95, adjusted for one year's inflation of 5% = 113.35, multiplied by the growth rate of 2.81% = 3.18. Similar to the case of the 'replacement reserve', this amount would be re-invested in the company (i.e. not extracted in the form of dividends) as a form of non-distributable 'expansion reserve'. If this is applied each year there would be sufficient equity capital for investments in assets for the purposes of replacement as well as expansion.
76. It could also occur that the demand growth takes place and the transfer to the 'expansion reserve' is made in the first year as per the example above but for some reason the actual capital investment did not take place (e.g. the demand growth was met from a short term temporary supply option, due to e.g. a minimum generator size, or a two-year construction period etc.). It implies that in the second year the capital investment will be made for two years' capacity expansion. In that case the 'expansion reserve' opening balance for the second year must be adjusted for the 5% inflation that had occurred since the transfer was made, given that the investment will take place in the second year at the new or current replacement cost of the existing assets. In this case the transfer to the 'expansion reserve' in

the second year will be 3.33 – being the mentioned 3.18, plus 0.15 (i.e. 5% adjustment on the ‘not-yet-invested’ opening balance of 2.95).

77. If the CAGR continues at 2.81% and the transfer to the ‘expansion reserve’ is made every year as described, there will be sufficient equity capital for the capacity expansion irrespective in which year the capital investment is actually made. For example, if the CAGR continues at 2.81% for 25 years it will double the demand, necessitating not only the investment in replacing the original asset but a another similar investment to cater for the growth in demand. However if the transfers to the ‘expansion reserve’ take place as described for 25 years then the ‘expansion reserve’ balance will be 339 – which, as was explained in Chapter 7, is the replacement cost of an asset which originally had cost 100, after 25 years of 5% annual inflation. There will thus be 339 in the ‘replacement reserve’ and 339 in the ‘expansion reserve’, which is exactly the required equity funding for the investment in the two assets.
78. As in the case of the ‘replacement reserve, for the ‘expansion reserve’ to achieve its intention, the cash which is ‘preserved’ from distribution (e.g. as dividends) through this mechanism must be accumulated in a designated fund. The integrity of the fund can be monitored in various ways, however the departure point would be that it must at any time be equal to the balance of the ‘expansion reserve’. When investment for such expansion actually happens (perhaps commencing a few years prior to the required operational date for the new asset) the ‘non-debt funded’ part of the investment would obviously reduce the fund balance (in the context as described by footnote 14). The ‘integrity test’ would have to take account of such new investments. One way is that the fund balance must then be equal to the balance of the ‘expansion reserve’ less the value of the works under construction (which is the same as that the fund balance plus works under construction must be equal to the balance of the ‘expansion reserve’). When construction or acquisition of the new asset is completed the related ‘expansion reserve’ must be ‘transferred’ to the equity account – not a distributable equity account such as ‘retained earnings’, given that the amount represents equity which had been re-invested in the company in a tangible asset thus would not be available for distribution (however please see footnote 17).
79. Perhaps even more so than the situation with the ‘replacement reserve’, it is not very simple to evaluate the adequacy of the balance in the ‘expansion reserve’. The starting point would be that the ‘expansion reserve’ will be equal to the total percentage of growth since a designated date at which it was deemed that capacity was adequate to meet existing demand as well as a defined future period’s demand growth (e.g. a period equal to the longest construction lead time of all of the potential technology options for the future capacity expansion), multiplied with the new or current cost of the existing assets, multiplied with the percentage of equity capital in the overall capital structure. In practice there could be other factors that might affect the adequacy of the ‘expansion reserve’ balance e.g. a known future change to a different technology that might be more or less expensive than the existing technology. Therefore the adequacy of the ‘expansion reserve’ balance should also be annually evaluated in other ways. One way is to annually estimate the short term portion of the expansion capex on say a ten-year forward view (the lead time will differ depending on the type of asset, the construction lead time for such assets etc.), and to calculate the equity portion of such estimated capital investment. The current balance of the ‘expansion reserve’ must be such that it, plus the future annual transfers as described, must be able to meet the equity capital requirement for each of the years as estimated in this short term period, whilst the remaining balance must still be adequate for the remainder of the required percentage expansion of capacity which might only take place beyond this short term period (i.e. must still meet the basic ‘test’ of the ‘expansion reserve’ being equal

to the total percentage of growth since a designated date, multiplied with the new or current cost of the existing assets, multiplied with the percentage of equity capital in the overall capital structure). In essence it implies that the 'theoretical' 'expansion reserve' balance is tested by taking account of actual expansion capex estimates, when such capex starts occurring in (e.g.) a ten year forward view. Another way of evaluating the adequacy of the balance is to annually estimate the gap between the actually installed capacity (in generating units as well as networks etc.) and the required capacity, on say a ten-year forward view (the lead time will differ depending on the type of asset, the construction lead time for such assets etc.). The annual capital cost will be estimated over this forward period, and the equity portion of such capital investment calculated. The current balance of the 'expansion reserve' must be such that it, plus the annual transfers as described, must enable the 'expansion reserve' to meet the equity capital requirement for each of the years as estimated.

80. If the 'capacity reserve' balance falls below the required level it obviously requires additional transfers to restore it. The further forward this situation is identified, the greater the number of available years over which to restore the balance prior to it actually being required. A short lead time might imply that even the transfer of the total annual equity earnings would not be sufficient, which could result in a number of consequences including a weakening of the balance sheet.
81. The calculation of the transfers to the 'replacement reserve' differs somewhat between the two accounting approaches of 'historic cost' and 'revaluation'. The reason is that the 'revaluation' approach already includes a 'partial replacement reserve' in the form of the depreciation mechanism, which does not apply in the case of the 'historic cost' approach. However, as the depreciation mechanism does not form a part of the 'expansion reserve' calculation there is no difference between the two accounting approaches in the calculation for the transfers to the 'expansion reserve'.
82. It is however often the case that, whilst the regulatory revenue approach is based on a 'real' return / 'inflation indexed' or 'replacement' asset value, the company's financial accounting policy is based on historical cost. In such case it is recommended to also prepare 'notional' financial reports (at least a balance sheet and income statement) on the revaluation basis, including the equity reserves and annual transfers to them as described for that accounting basis, for inclusion in the annual financial report as a note. In fact, in an inflationary environment, given the effect of inflation over the typically long asset lives, it is recommended to always also prepare 'notional' financial reports on the revaluation basis irrespective of the regulatory revenue approach. The decisions regarding dividend payments should take account of both the notional revaluation basis reports, as well as on the historic cost reports.
83. As described in Chapters 7 and 8 it is clear that, in addition to the obvious function of compensating investors for the risk-adjusted opportunity cost of having invested, the equity return is 'used' for a number of issues related to the financial and economic sustainability of the company – (a) as a 'buffer' to meet the shortfall on debt interest, in the case where regulated revenue is based on a 'real' return; (b) to compensate for the effect of inflation on the provision of funding for replacement of assets (especially if regulated revenue and financial accounting is based on historical cost, but also if it is based on revaluation); (c) to accumulate the required equity funding for expansion of capacity. These items individually can constitute significant amounts, and collectively even more so. Therefore it is possible for these mechanisms to function only if there is adequate return on equity in the first place. It does not imply that the return on equity should exceed the calculation of the risk-adjusted cost of equity, which would imply a premium to the price of electricity. However, unless annual demand

growth rates reach a level of perhaps three to four times of that which has actually been experienced over the long term, the normal accepted calculation of the cost of equity would enable these mechanisms to function – irrespective of whether the regulatory revenue approach is based on ‘nominal’ rate of return on depreciated historical cost asset values, or ‘real’ rate of return on ‘inflation indexed’ or ‘replacement value’ assets, and irrespective of whether the accounting basis is ‘historical cost’ or ‘revaluation’.

9. The effect on the funding situation, when the new asset is constructed over a number of years prior to the asset becoming operational

84. If the revenues are ‘cost-reflective’, the equity reserves established and the balances adequate, it resolves to a significant extent any potential difficulties related to funding of new assets whether for the purpose of replacement or for expansion – especially if in addition, the gearing ratio is moderate, there is a good mix of older and newer assets and there are some tax incentives for new capital investments that have the effect of deferring cash tax payments. However all of the examples described assumed that the capex for the new asset would require to be invested in the year that the new operational asset is needed. For example, the balances of the ‘replacement reserve’ plus accumulated depreciation will be equal to the cost of the new asset in the same year that the previous asset reaches the end of its operational life and the new (replacement) asset must become operational. This will be adequate if the investment to acquire the new asset could only be made in the year that the new asset is needed. However even on the various types of ‘turn-key’ and similar contracts it is highly unlikely that the acquisition cost will only flow in the year that the asset is needed – more likely it will require significant up-front payments, deposits, stage or progress payments, etc.
85. Obviously if the asset is self-constructed the capital investment will commence perhaps seven or more years prior to the date that the operational asset is required. The equity capital must be obtained. The debt must be raised, which will imply incurring of the debt interest cost. This will occur prior to the point where the balances of the equity reserves and the accumulated depreciation will be sufficient to meet that equity requirement. It will also be prior to the point where the debt interest will be recovered annually through the ‘return’ component of the ‘cost-reflective’ regulated revenues and where the debt principal will be recovered through the depreciation component of the ‘cost-reflective’ regulated revenues. Clearly a large capital investment for which the cash outflow commences a number of years prior to its operational date could cause some financial difficulty for the company.
86. It is for that reason that many regulators world-wide follow the approach of allowing a return to be earned on the ‘Works under Construction’ (WUC) or ‘Capital Works In Progress’ (CWIP) etc. during the construction process¹⁸. The return enables the debt interest to be paid annually instead of being

¹⁸ Following the United States Energy Policy Act of 2005, the Federal Energy Regulatory Commission issued new Rules in 2006 which incentivized investments. Included was “100 percent of prudently incurred construction work in progress in rate base”.

SOURCE: *“Incentives to Ensure Additional Supply and Transmission”* - Presentation of Denise Parrish, State of Wyoming, USA Joint Licensing/Competition and Tariff/Pricing Committee Meeting, Budva, Montenegro 4-5 February 2008.

capitalised to the debt principal¹⁹ or otherwise financed, and it allows a further opportunity for equity returns to be accumulated to assist with the equity-funded part of the capital. With large capital investments for which the cash outflow commences a number of years prior to its operational date it reduces investment risk and improves access to capital, thus facilitating the investment which otherwise might not have been possible.

87. There are various ways in which this regulatory mechanism could be structured, e.g. the WUC / CWIP could be allowed into the Regulatory Asset Base to annually earn the regulatory return. Another way is to include the annual interest cost (incurred during the construction process) directly into the items which comprise the regulated revenue i.e. to increase the regulated revenue by the annual amount of interest cost incurred during the construction process.
88. A common feature of all of the regulatory mechanisms is that, to the extent that the cost of capital is recovered during the construction process, the 'regulatory value' of the completed asset is reduced. The lower 'regulatory value' results in a lower depreciation charge and a lower return on assets to be recovered through revenues, for every year throughout the operational life of the asset, thus lower revenues / prices.
89. Clearly the recovery of the cost of capital / interest cost through regulated revenue thus through electricity prices would imply a portion of 'pre-funding' i.e. current consumers already paying a part of the cost related to a future asset. This is compensated for by the lower prices during the operational life cycle of the asset. The benefit to the consumer is that this mechanism facilitates the investment in new capacity, to the consumers' benefit, which otherwise might not have happened or would have happened at an increased cost of capital thus increased electricity prices.
90. A further mitigating factor is that this mechanism typically functions during the latter part of the life cycle of the existing assets. As has been explained in Chapters 2, 5 etc. there is an inherent 'front-loading' of the life cycle revenue and price profile in the 'cost-of-service' regulatory model – moderate if the regulatory revenue approach is based on 'real' rate of return on 'inflation indexed' or 'replacement value' assets, potentially severe if the approach is based on 'nominal' rate of return on depreciated historical cost asset values. Thus, the slight increase in electricity prices that would occur due to the recovery of all or part of the cost of capital / interest cost during the construction process typically comes at a time that the electricity prices would be lower than the long term average. In addition this mechanism serves to reduce electricity prices during the operational life of the asset. Thus, by slightly increasing prices at the time that they would be at a low point over the life cycle, and by reducing the prices on the new asset which would initially be at the high point of the life cycle profile, this mechanism serves to smooth prices especially at the time of the inherent 'front-loaded' price increases when new assets are taken into operation.

10. The effect on the credit risk ratings environment if the described approaches are implemented

¹⁹ Note that (a) the capitalisation (or not) of the interest to the debt principal, is a different matter to (b) the capitalisation (or not) of the interest cost incurred during construction to the asset for financial accounting purposes. They are independent of each other and any combination of (a) and (b) is possible.

91. Chapter 5 explained that the Electricity Supply Industry (ESI) have a few characteristics which are common to most infrastructure industries namely highly capital intensive; the assets take long to construct and bring into operation; the assets have very long operational lives; the effect of inflation over the long asset life can create all sorts of funding and pricing problems when it comes to replacement of the assets, or expansion of capacity; the prices for the products/services often are regulated. Credit rating agencies and lenders are well aware that the invested capital is recovered over a very long time, and that much can go wrong over that time. They are also aware that price shocks are difficult to implement, but that the failure to achieve 'cost-reflective' prices imply that the industry or the company is not sustainable. In contrast to what is often perceived, these characteristics make infrastructure investment, including in the ESI, inherently highly risky.
92. Revenue is always²⁰ the source to pay for everything – including the assets (by virtue of repaying the principal of the capital that is raised to fund the assets, and the interest cost on the capital). If revenue is regulated, it implies that the regulatory environment, framework and rules determine the revenue i.e. revenue is completely a function of these factors. It is for that reason that the credit rating assessment methodologies of all the ratings agencies consider the regulatory environment, framework and rules a greater weight in the credit risk assessment than everything else combined. For example the Moody's methodology weights the regulatory environment, framework and rules at 50% of the total assessment²¹. The usual key financial metrics are weighted 40% in the Moody's methodology, however considering that they are all either directly or indirectly functions of (regulated) revenue, it effectively implies that 90% of the total assessment is a function of the regulatory environment, framework and rules.
93. Given the highly capital-intensive nature of the ESI, a weak credit rating is a very severe impediment. The failure to attract capital would effectively imply that the ESI is not sustainable. Therefore it is one of the main objectives of all electricity regulators world-wide, to regulate the industry such that it would attract sufficient and reasonably-priced capital. Failure to attract capital might imply a total regulatory failure.
94. The capital which is required is not only debt – equity capital is a critical component of total capital. The presence of equity capital and equity returns serve as a 'buffer' to ensure that debt principal and interest would be repaid in the event of unforeseen events that reduce sales volume, sales prices, operating costs, plant technical performance etc. A sufficient proportion of equity capital is therefore required to 'unlock' debt capacity.
95. For that reason a regulatory environment, framework and rules which are sound, credible, trusted, predictable, clear and supportive are crucial. In that context, mechanisms that would ensure:
- continued cost-reflective prices,
 - sustainability,
 - price stability,

²⁰ Unless taxpayers pay through higher taxes, in a general 'all consumers' subsidy model. However (other than limited, transparent and targeted subsidies) this would create more negative economic consequences in terms of economic growth, job creation, inflation rates etc.

²¹ SOURCE: Moody's Investors Service – Rating Methodology: Regulated Electric and Gas Utilities, December 2013.
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- the accumulation of adequate equity funding for replacement and expansion of infrastructure,
- earlier recovery (through revenue) of debt interest cost during long construction periods

– would be required and would very significantly improve credit risk assessments and thus access to capital, and at reasonable cost. It is highly unlikely that any of the key credit metrics would be below the acceptable ‘investment grade’ bands, if the above is implemented. The presence or absence of all of the above could make the difference between (a) investment grade, access to capital and thus sustainability, or (b) sub-investment grade, lack of capital, unsustainability and decline.

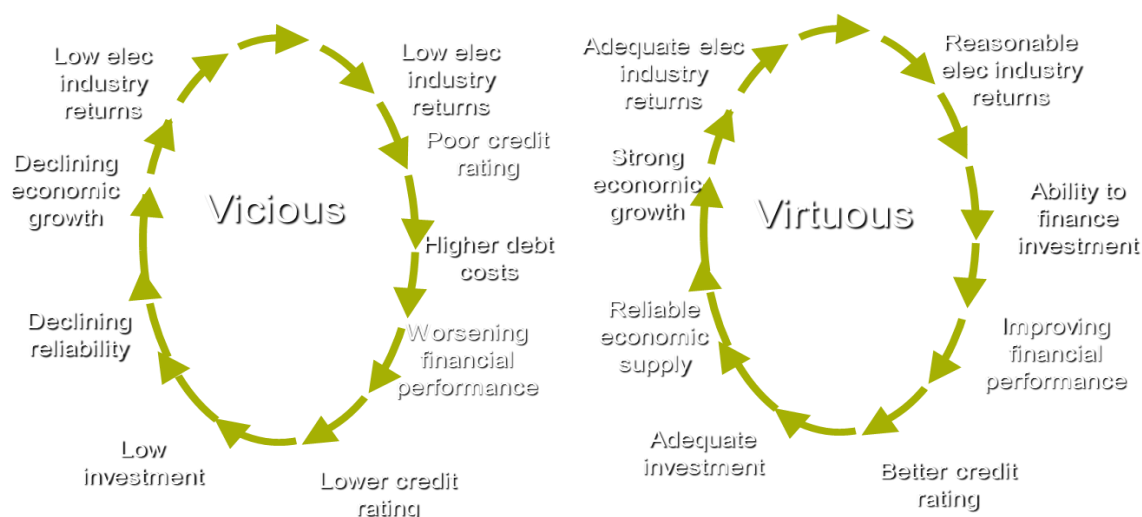
11. CONCLUSIONS

96. This paper examined the matter of ‘cost-reflectivity’, mainly in the context of revenues that are determined through economic regulatory processes. It examined the implications of pricing below cost-reflectivity. It considered further potential problems that might occur mainly in an inflationary environment, even if prices are cost-reflective – such as price instability / price shocks; liquidity difficulties; funding problems regarding replacement of assets and expansion of capacity. It considered the funding implications of a large construction project that takes many years to complete before it becomes operational and starts earning any revenue. It examined the implications and significance of credit ratings and the effect of the above issues thereon.
97. The conclusions can be summarised in the following ten points:
 1. Cost-reflective revenue and prices are critical. There are various options regarding the approach, but they all would average to the same level in the context of a fleet of assets of different ages. In addition they all achieve the same discounted net present value, which is equal to the original acquisition cost of the asset.
 2. Revenues and prices below cost-reflectivity are not sustainable and will lead to the failure of the company, unless another party pays. Private shareholders, suppliers, creditors and lenders will not be willing to do this, therefore the only ‘other party’ that could do it consistently is the taxpayer, through higher tax rates. Unfortunately this is likely to have very negative macro-economic consequences regarding economic growth, job creation, inflation etc. However the worst economic consequences by far will be if neither the electricity consumers nor the taxpayers pay – in which case there will not be sufficient electricity, and consumers will ‘pay’ the economic cost of unserved energy, or will pay the cost of alternative self-generated electricity or other energy sources.
 3. Inflation can cause price shocks – even 2% p.a. inflation rates could cause that, due to the long asset lives of 25 years and more. However there are options to moderate price instability, without affecting sustainability. The option mostly used by regulators is to set regulated revenues / prices on the basis of applying a ‘real’ rate of return on ‘inflation indexed’ or ‘replacement value’ assets.
 4. Setting regulated revenues on the approach of a ‘real’ rate of return on ‘inflation indexed’ or ‘replacement value’ assets can however cause liquidity difficulties specifically with regard to payment of debt interest, in the early years of a new asset. This can be mitigated by the use of a moderate gearing ratio; a combination of new assets and older assets in the total fleet; attempting

to match the profile of debt principal redemption and interest payments to the regulatory approach; the utilization of tax incentives.

5. In an inflationary environment, 'cost-reflective' revenues / prices do not necessarily imply that sufficient equity funding would be accumulated through the depreciation mechanism for replacement of the existing assets. The solution is to annually transfer a portion of the equity returns to a non-distributable 'replacement reserve'. The calculation differs a bit depending on whether the financial accounting policy is based on 'historical cost' or 'revaluation' but the total accumulated equity funding at the end of the operational life of the original asset is the same on both financial accounting approaches, and the potential annual dividends are also the same.
 6. 'Cost-reflective' prices do not necessarily imply that sufficient equity funding would be accumulated from equity returns for expansion of capacity. Again the solution requires a further retention of equity returns as a form of non-distributable 'expansion reserve' or similar. The calculation is the same irrespective of the financial accounting policy.
 7. None of the equity reserve mechanisms are possible if equity returns are too far below adequate ('adequate' being, reflecting the true cost of equity). In addition to the obvious function of compensating investors for the risk-adjusted opportunity cost of having invested, equity returns are also required as a 'buffer' to meet the shortfall on debt interest in the case where regulated revenue is based on a 'real' return; to compensate for the effect of inflation on the provision of funding for replacement of assets; to accumulate the required equity funding for expansion of capacity.
 8. 'Cost-reflective' revenues are set with reference to 'efficient' and 'prudent' costs and asset utilisation. This does not imply 'perfection' – it is rather a test of reasonableness, in the particular context. However if the norm of efficient, prudent and reasonable is not achieved it could imply that some of the costs would not be recovered through revenue. This would of course reduce the equity returns. Given the number of issues for which sound equity returns are required it would be a serious matter for a shareholder to address with the company management.
 9. A large capital investment for which the cash outflow commences a number of years prior to its operational date could cause some financial difficulty for the company. In order to facilitate capital investment on such projects it is common regulatory practice to allow a return to be earned on the 'Works under Construction' (WUC) or 'Capital Works In Progress' (CWIP) during the construction process. This is compensated for in a discounted-present-value-neutral way by deducting the returns earned during the construction period, from the asset value used for regulatory purposes – thus reducing future regulatory depreciation and returns, hence future revenues / prices.
 10. Given the highly capital-intensive nature of the ESI, sound credit ratings are critical. The matters discussed above could contribute significantly to improving credit risk assessments and thus access to capital, and at reasonable cost, especially in combination with a regulatory environment, framework and rules which are sound, credible, trusted, predictable, clear and supportive.
98. These issues therefore pertain to the survival, or not, of a company in the ESI. This diagram perhaps summarises the options well:

Diagram 1: Vicious and virtuous circles²²



99. As such, many of these matters are not really optional – failure to adhere to similar and appropriate mechanisms could likely result in dire consequences, if not in the short term then inevitably in the medium to longer term.

12. BRIEF LITERATURE SURVEY FOR COMMENTS ON RELATED ISSUES

“In economic theory, efficient prices are defined as prices that approach marginal cost, which is the level achieved under – perfectly – competitive conditions. Economic regulation is generally introduced when market failures prevent effective competition and is aimed at mimicking the competitive conditions to steer prices towards efficient levels”.

“if well-implemented, economic regulation should lead to efficient prices...”

SOURCE: Storer, D. and Teljeur, E. (2003) *Administered Prices: Executive Report: A Report for National Treasury*. Page 1

“Continued sub-economic pricing (prices below long-run marginal costs) in the industry ironically run the risk of increasing real costs in the economy (by reducing allocative efficiency). Furthermore, sub-economic energy prices benefit energy and capital intensive growth, and places labour and skills intensive development paths at a disadvantage. Proper economic pricing of power will reverse skewed incentives in the long-term and support South Africa’s primary economic aim, which is to establish labour absorbing development paths.”

“Moving to cost reflective prices will save real costs in the economy...by encouraging efficient use of energy and capacity (including demand side investments) which, if electricity service is priced correctly, will be cheaper in real resource terms, than new supply capacity;”

²² SOURCE: Breslin, Paul, Executive Director ACIL Tasman (April 2004) *The Economic and Social Impact of Electricity Industry Reform*

SOURCE: Steyn, G. (2003) *Administered Prices: Electricity: A Report for National Treasury*. Pages 12, 28, 29

“In the face of the sector’s substantial requirements for new generating capacity, any rational tariff policy will have to increasingly be based on forward looking economic costs — i.e. the reliance on historical book values of generating and other assets which facilitated the low prices of the last two decades will inevitably have to come to an end. Thus, the realignment of prices with underlying long-term costs (that are based on forward looking incremental costs and not just historical book values) is rapidly becoming necessary — both for the financial viability of the sector and for the public interest.”

“It is important to note that in determining the revenue requirements for financial viability, the rate of return obtained by comparison with other utilities/industries must be applied to a rate base which covers the economic replacement cost of all facilities.”

SOURCE: Kessides, I.N., Bogetic, Z. and Maurer, L. (2007) *World Bank Policy Research Working Paper 4197: Current and Forthcoming Issues in the South African Electricity Sector*. Pages 8, 16, 80

“Government should formulate an electricity pricing policy such that NERSA could award overall revenue levels to Eskom that would enable a migration of prices to Long Run Marginal Costs.”, and

“...reluctance to raise prices denies the ESI the ability either to fund investment and maintenance out of profits, or the credit-worthiness to borrow against future profits. In extreme cases the ESI cannot even maintain existing equipment, reliability and availability drop, and power outages become the norm. India is a classic example of this unsatisfactory equilibrium.”

SOURCE: Newbery, D. and Eberhard, A. (2007) *An independent assessment of the performance of the electricity sector in South Africa: Key challenges and recommendations*. Pages 13, 95, 102

“It is recognised internationally that cost reflective tariffs, as reflected by LRMC representing the true economic cost, are the best price signal.”

“The regulator, after consultation with stakeholders, must adopt an asset valuation methodology that accurately reflects the replacement value of those assets...”.

SOURCE: Department of Minerals and Energy (2008) *Electricity Pricing Policy (EPP) of the South African Electricity Supply Industry*. Pages 15, 46

“Policy makers have a strong incentive to regulate prices at a level to compensate the regulated utilities only for their operating costs, not their fixed costs (i.e. sunk investment). This level provides sufficient incentives for a firm to continue operating ex-post their investment, but not sufficient incentive for them to invest further.”

SOURCE: Guasch and Spiller (1999) *Managing the Regulatory Process: Design, Concepts, Issues and the Latin America and Caribbean Story*, World Bank Latin American and Caribbean Viewpoints, p33

"Modelled prices in the regulated scenario come out lower than the competitive scenario primarily because it is assumed that the current regulatory practice of basing the required rate of return on the depreciated historic costs of assets will continue. The consequence of this practice, in a context where there has been considerable over-investment in the past, coupled with the use of a low real rate of return, is regulated prices well below those that are economically sustainable to fund new investment.

The competitive scenario, on the other hand, assumes that modelled prices will rise to the long run marginal cost necessary to fund new base-load plant.

Since there is a high proportion of older (almost fully depreciated) plant in the country, average costs are low while these plants continue to operate. If however, regulated prices were to be based on revalued (replacement or optimised replacement) costs of assets, regulated prices in South Africa would be much higher and the industry would be better placed to fund new investment." Page 5

"Prices will rise substantially in the future as investments in new generation capacity are made. Price rises occur whatever future scenario for the industry is in place.....

Regulated prices are generally based on 'cost-plus' formulations. In South Africa the current method of regulating prices, (based on the depreciated historic costs of plants) results in prices much lower than other methods increasingly being adopted worldwide, (such as the use of replacement cost). These low prices act as a barrier to new entrants and are not sufficient to fund new investment. The regulator should manage price increases in such a way that present regulated prices rise steadily over time to more economically sustainable levels – rather than the economy experiencing shock increases as capacity runs out." Page 10

"There is a general expectation that power tariffs will rise markedly as Eskom's excess capacity is absorbed around 2007." Page 52

"....optimised replacement values, in which the asset base is calculated not on historical costs, nor on replacement costs of existing assets, but on what it would cost to install the assets today with an optimal design. Under this approach, the utility company takes design risk and technology risk because if the utility over-estimates demand growth and builds under-utilised capacity (or networks), consumers will not pay for this mistake. Further, if the real costs of installed assets declines due to technology developments, the utility company similarly takes these risks. The transfer of these risks to the utilities naturally increases their cost of capital and the rate of return that the regulator should use for price setting." Page 54

"A shift to regulation based on revalued assets or optimised replacement assets (a growing trend internationally) would result in quite a different price trajectory for the regulated scenario – generally much higher. Revalued asset approaches are often preferred by regulators as they tend to provide more stable prices by removing the distortions introduced by high inflation rates. Historical cost approaches can give sudden price rises once older assets are replaced by new (more expensive in nominal terms) assets." Page 99

SOURCE: BusinessMap (2001) *The Electricity Supply Industry: Economic and Social Effects of Restructuring*. Pages 5, 10, 52, 54, 99

13. REFERENCES

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