RIIO-2: Beta estimation issues

Ofgem

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FINAL REPORT

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EXECUTIVE SUMMARY

The RIIO price controls set the allowed revenues of electricity and gas networks in Great Britain (GB). As part of those price controls Ofgem will set an allowance for the cost of equity that companies are able to recover.

In its Sector Specific Methodology Decision (SSMD) for the gas and electricity transmission and gas distribution sectors, Ofgem estimated the cost of equity for these network companies at 4.80% and proposed a working assumption of 4.30% for the cost of equity allowance net of expected outperformance.

This estimate of the cost of equity was underpinned by Ofgem's judgement that the asset beta for a GB regulated energy network falls in the range 0.35-0.40. The source for this asset beta range was a set of five listed comparator companies: National Grid, SSE, Severn Trent (ST), United Utilities (UU) and Pennon.

In an ideal world, Ofgem would be able to estimate the asset beta for energy networks in RIIO-2 drawing on a large number of UK listed pure play regulated energy network businesses. Unfortunately, only two UK listed energy companies with network activities (National Grid and SSE) exist and neither is "pure play". As such, it is necessary to consider alternative approaches to estimate the asset beta.

Ofgem commissioned this report from CEPA to examine a range of different approaches and possible sources of evidence that it could in principle draw upon as part of forming its judgements on asset beta in its forthcoming RIIO-2 regulatory determinations. This includes an assessment of:

- the relative risks between GB energy networks and other UK price control regulated industries and companies and how this may impact beta; and
- the sources of evidence that the energy networks and their advisors have highlighted as relevant evidence to Ofgem's forthcoming determinations.

We have not been asked to produce an overall asset beta range and so we do not provide one. We have, however, considered whether the balance of relevant evidence that we consider within the scope of this report is consistent with Ofgem's estimates of the asset beta range.

Given the lack of pure-play energy network comparators in GB, the context for this report is Ofgem's requirement to **identify the asset beta of an investment substitute for an energy network in GB under RIIO-2**. Appropriate comparator selection processes have, as a consequence, been central to our work.

Relative risk assessment

We find that energy networks bear lower risk compared to regulated companies in the UK aviation sector (Heathrow and NERL) as these aviation companies are exposed to within period demand risks where outturn volumes differ from forecasts. While this is limited by risk-sharing arrangements and periodic resets it is clearly a source of greater systematic risk relative to energy networks.

Another candidate that we considered as an investment substitute for GB energy networks in RIIO-2 is GB water networks. There are two listed pure-play listed GB water networks that operate under relatively similar regulatory systems and in the same jurisdiction as GB energy networks (ST and UU) and one listed company that has an interest in a UK water network alongside other group businesses (Pennon). We considered:

- empirical evidence on GB water network asset beta focusing on the traded betas of the two pure-play water companies (ST and UU); and
- why an investor might consider these two water companies a good, or indeed imperfect, investment substitute to a GB energy network, drawing on the findings and conclusions of our UK relative risk assessment.

We find that GB energy and water regulated utilities exhibit many similarities in factors that might be considered to affect systematic risk and, therefore, asset beta. Regulatory protections of value, exposure to within period demand risks, price control risks[2] and firm characteristics are currently broadly similar between sectors.

However, energy and water networks face different sources of dynamic risk, particularly around the determinants of the investment cycle in both sectors: "long-term factors" that might be considered to drive the investment trends and value opportunities for equity holders within these essential regulated industries.

For example, linked to the UK Government's net zero targets, there is considerable uncertainty around the future utilisation and the required scale and scope of investment in GB gas and electricity networks. Future technological change and usage of energy networks, including potentially as integrated vectors, is also increasing in visibility. In contrast, in the water sector, the National Infrastructure Commission (NIC)[3] has highlighted the considerable investment that may be needed to provide resilience to drought risks from climate change.

While these factors are important sector investment dynamics, it is still difficult to conclude that these differences consistently indicate that energy networks are exposed to greater systematic risk than water networks (or vice versa). While the scope for change may be greater in energy networks, some of the risks and opportunities resulting from energy network transitions are likely to be idiosyncratic rather than systematic in nature. Based on current regulatory arrangements heightened uncertainty does not necessarily translate into heightened systematic risk exposure and, therefore, the risk premium that might be demanded by investors.

For these reasons, we consider it appropriate that **Ofgem continues to have regard to GB water networks** – particularly the two 'pure play' networks – in forming its judgement of beta for GB energy networks.

Over the long-term, the empirical evidence of GB water network asset betas are most consistent with a range of around 0.34-0.39[4]. **This is supportive of Ofgem's SSMD range of 0.35-0.40 for GB energy networks.** A slightly lower range might be considered appropriate the more emphasis is placed on the similarities in the water sector regulatory frameworks and the price control building blocks in the two sectors.

However, depending on the weight placed on different components of risk we recognise that GB energy networks may be judged riskier than water networks – or at least that the sources of systematic risk are sufficiently different that water networks are an imperfect investment substitute for a pure play energy network in RIIO-2:

- Investment in energy networks will be driven by factors such as the expected long-term use of gas and electricity networks. The scope for transformative investment is perhaps greatest in the electricity sector, potentially supported by the use of competition for specific high-value projects.
- Equity holders in energy networks are invested in long-lived assets and so their expected returns in the sector may be sensitive to these long-term drivers and the cashflow risks they may create, to the extent they are cyclical and systematic.

As a consequence, we considered another source of evidence that the networks and their advisors have highlighted as relevant to Ofgem's forthcoming regulatory determinations. This is to use European energy networks as a comparator group and investment substitute to a GB energy network in RIIO-2.

Despite variation in regulatory protections and regimes, in particular exposure to demand risk, price control incentives and use of inflation indexation, European energy network comparators may help to inform beta

[2] Where individual building blocks within a price control framework creates a cashflow mismatch between what the regulator allows, and the cost paid by the network.

[3] See NIC (2018): 'National infrastructure Assessment'

[4] Calculated using Ofgem's SSMD working assumption of 0.125 for the debt beta.

estimation for GB energy networks, particularly where greater emphasis is placed on longer term sector dynamics and the cyclicality of investment as the driver of beta.

European energy network comparators

While Ofgem's SSMD range did not place weight on evidence from European energy network comparators, in the course of their analysis and submissions some networks and their advisors have presented evidence from European comparators.

We expanded the initial long list of comparators used by the networks' advisors as their work, in our view, did not present a sufficiently compelling case of the shortlist of companies that were selected. We applied a filtering process to identify the comparators we considered most comparable as an investment substitute to a pure-play GB energy network. We did not undertake a comprehensive relative risk assessment of GB energy vs. European energy networks, however as part of the filtering process we considered the key features of the European companies' regulatory regimes.

Evidence from our preferred sample of comparators indicates an asset beta for European energy networks in the range of 0.32-0.39. Our preferred sample over the most recent 5yr period would suggest an asset beta of 0.36-0.37, slightly above the midpoint of the range. Our estimates are lower than the beta evidence that has been presented by the networks' advisors, primarily because of the filtering process that we have applied to arrive at a preferred set of comparator companies.

Overall, we find that **the evidence from a range of European energy network companies appears broadly consistent, and again supportive of, Ofgem's SSMD asset beta range of 0.35-0.40**. The low end of the range based on our preferred sample sits below Ofgem's range, but this is based on longer-term estimates that may not be representative for two of the comparator companies. The range based on our preferred sample is also similar to our characterisation of the long-term evidence for the GB water comparators.

Beta decomposition

The networks through their advisors have previously raised the issue of beta decomposition where comparators have diverse business interests. Use of beta decomposition analysis was discussed in Indepen's beta study for Ofgem[5] and has been considered in a range of UK regulatory contexts, including by Ofcom[6] when estimating the BT's beta and the Competition Commission (CC) in the context of the 2007 airports inquiry[7].

In cases where businesses are not pure play, but a portfolio business, the company's beta will be the weighted average of the individual business component betas. In theory, we consider this is exactly how investors in a diverse group business would be expected to think about asset beta, i.e. in the context of the systematic risk of the individual business units of the group. As a consequence, decomposition of SSE and National Grid's group beta in particular, could be very relevant evidence for Ofgem's determinations on the cost of equity in RIIO-2.

As discussed in the Indepen report and other literature there are though practical issues that need to be considered if undertaking and interpreting group beta decomposition. The individual business unit betas are unobservable. The appropriate weights in such an analysis should reflect expected future cashflows but in practice must be

[5] Indepen (2018) 'Ofgem – Beta Study – RIIO-2'

[6] Ofcom (2011) WBA Charge Control: Charge control framework for WBA market 1 services.

[7] Competition Commission (2007) Q5 price control: Appendix F – Cost of Capital.

approximated based on recent historic data on revenue, profit or assets.[8] As such the analysis is inherently assumptions-driven and there are practical issues with producing beta decomposition evidence.

We have reviewed the decomposition analysis provided by the networks' advisors and the associated technical issues. We have considered how robust estimates of National Grid's and SSE's GB energy networks asset beta derived from their corporate betas are likely to be, given the assumptions that must be made in order to produce these estimates. We have also used evidence on National Grid and SSE's corporate beta as a check on the plausibility of assuming that GB energy networks systematic risk can be approximated based on GB water and European energy comparators.

Overall, we consider it is challenging to draw robust conclusions from decomposition of National Grid and SSE's beta, although we support the theoretical relevance of the analysis. Given these practical issues, two possible conclusions might be drawn.

One conclusion is that while theoretically justified, the assumptions that are required for the decomposition analysis and the volatility of the results mean that Ofgem would not be justified in placing significant weight, at least directly, on the results compared to the other possible sources of evidence on asset beta that are available. This would echo the conclusions of the Indepen beta study in 2018.

An alternative interpretation is that, taken at face value, the direct decomposition evidence is consistent with energy network betas having risen substantially since 2018, to above 0.4.

However, this increase has not been accompanied by an increase in other comparators, such as GB water or European energy networks. While an asset beta above 0.4 is certainly not an implausible regulatory assumption – it would fall within the CMA's risk spectrum and asset beta range for regulated utilities of 0.3-0.45[9] – accepting this interpretation would also imply (on the basis of the decomposition analysis) that GB energy network betas were as low as 0.2 from 2011-2014 and that the range of assumptions made in the analysis are sufficiently robust. We do not have this level of confidence in our own, or indeed the networks advisors', decomposition analysis to date.

Overall conclusions

Overall, we consider that the analysis and evidence presented in this report is consistent with Ofgem's judgment of an appropriate asset beta range at SSMD (0.35-0.40) and draft determinations (0.34-0.39) for the RIIO-2 gas distribution and gas and electricity transmission price controls.

From different perspectives, we conclude that GB water networks and European energy networks share similar characteristics with GB energy networks – though neither group represents a perfect comparator. Both could plausibly act as relevant comparators to equity holders' systematic risk in GB energy networks. Both represent relevant evidence to Ofgem's forthcoming regulatory determination on asset beta. **Our analysis suggests an asset beta range of 0.34-0.39 would be consistent with the asset beta ranges of both comparator groups**.

While beta decomposition has strong theoretical foundations, and has been used in practice in UK regulatory proceedings, we have discussed a range of practical issues with using the decomposition analysis of National Grid and SSE's group beta, including the volatility of the results and the strength of the assumptions that are required to rely on the resulting estimates of these companies GB energy network asset beta. We consider decomposition analysis relevant evidence, but consider that it at best provides an indication of where Ofgem might consider its point estimate for asset beta should sit within a range relative to the water and European network evidence.

[8] The CC as part of its 2007 airports inquiry suggested the assets of individual business units as the weights for decomposition.

[9] See for example, the Competition Commission determination for Northern Ireland Electricity Limited.

1. INTRODUCTION

The RIIO price controls set the allowed revenues of electricity and gas networks in Great Britain (GB). As part of those price controls Ofgem will set an allowance for the cost of equity that companies are able to recover.

In its Sector Specific Methodology Decision (SSMD)[10] for the gas and electricity transmission and gas distribution sectors, Ofgem estimated the cost of equity for these network companies at 4.80% and proposed a working assumption of 4.30% for the cost of equity allowance net of expected outperformance.

Ofgem's SSMD estimate of the cost of equity for GB regulated energy networks of 4.80% was underpinned by its judgement that the asset beta for a GB regulated energy network falls in the range 0.35-0.40. The source for this asset beta range was a set of five listed comparator companies:

- two, National Grid and SSE, have interests in GB energy networks alongside other group businesses;
- two, Severn Trent (ST) and United Utilities (UU), are near to being 'pure play' GB water networks; and
- one, Pennon, has an interest in a GB water network alongside other group businesses.

Beta evidence from these comparators was combined without applying any specific weightings or adjustments to the raw equity beta estimates to reflect any differences in risk exposure.

In an ideal world, Ofgem would be able to estimate the asset beta for energy networks in RIIO-2 drawing on a large number of UK listed pure play regulated energy network businesses. Unfortunately, only two UK listed energy companies with network activities exist and neither is pure play. As such, it is necessary to consider alternative approaches to estimate the asset beta.

Ofgem has commissioned this report from CEPA to examine a range of different approaches and possible sources of evidence that it could in principle draw upon as part of forming its judgements on asset beta in its forthcoming RIIO-2 determinations. This includes an assessment of:

- the relative risks between GB energy networks and other UK price control regulated industries and companies and how this may impact beta; and
- the sources of evidence that the energy networks and their advisors have highlighted as relevant evidence to Ofgem's forthcoming determinations.

We have not been asked to produce an overall asset beta range and so we do not provide one. We have, however, considered whether the balance of relevant evidence that we consider within the scope of this report is consistent with Ofgem's estimates of the asset beta range.

Ofgem used evidence from GB energy and water comparators to arrive at an SSMD asset beta range of 0.35-0.40. Those same comparators now indicate a range, in Ofgem's judgement, of 0.34-0.39 for the asset beta for its draft determinations on the RIIO-2 gas distribution and gas and electricity transmission price controls.

1.1. ISSUES ADDRESSED IN THIS REPORT

Given the lack of pure-play energy network comparators in GB, the context for this report is Ofgem's requirement to **identify the asset beta of an investment substitute for an energy network in GB under RIIO-2**. Appropriate comparator selection processes have, as a consequence, been central to our work.

[10] Ofgem: 'RIIO-2 Sector Specific Methodology Decision – Finance', May 2019.

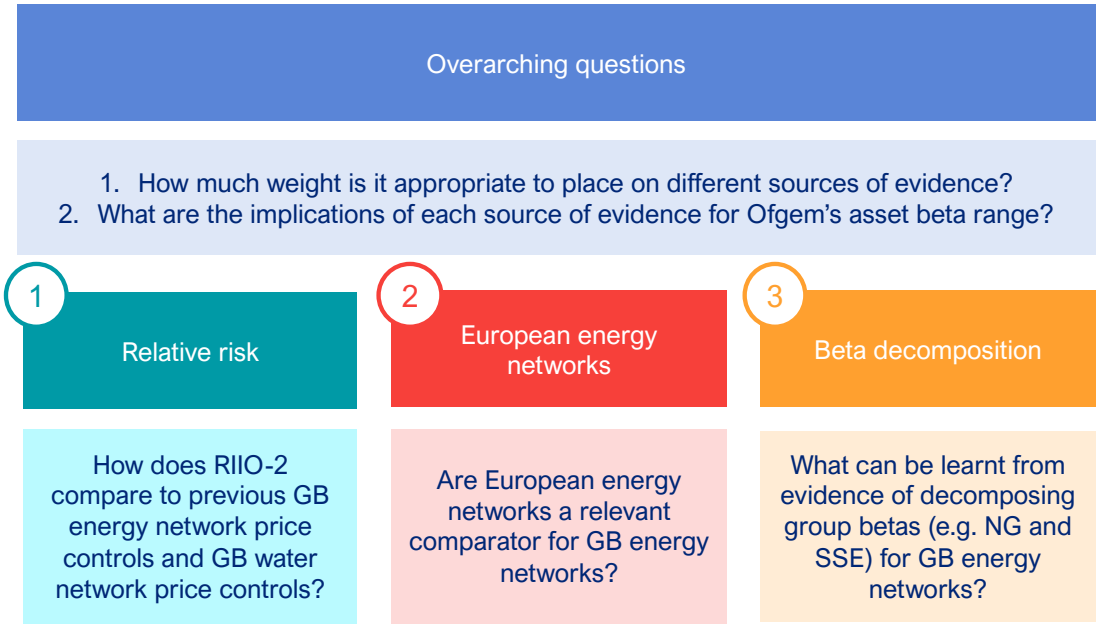
We reviewed how systematic risk exposure for investors in RIIO-2 compares to risk exposure for investors in previous GB energy price controls, risk exposure for investors in current and previous GB water controls, and other relevant UK regulated sectors. This analysis was used to help inform our assessment of the most suitable comparators and investment substitutes to support Ofgem's beta estimates and, where possible, whether those comparators are likely to expose investors to more or less systematic risk than energy networks in RIIO-2.

Supported by the findings of our relative risk analysis, e.g. the key characteristics of the regulatory regime and operating environment in RIIO-2, we have also sought to apply a process throughout our work to filter out comparators that:

- do not have a sufficient proportion of value from relevant activities to improve the robustness of Ofgem's evidence base;
- have materially different regulatory regimes and business operating environments as a pure-play energy network in RIIO-2; and
- suffer from low trading frequency and or produce data that is not considered to be sufficiently robust for Ofgem's decision making process.

As illustrated in Figure 1.1 below guided by Ofgem, our relative risk assessment and evidence submitted by the GB energy network companies and their advisors, we have considered three possible sources of evidence that could be used to inform Ofgem's judgements on asset beta.

Figure 1.1: Identifying relevant comparators and evidence for estimating beta for a GB energy network



Source: CEPA

One candidate that we have considered as an investment substitute for GB energy networks in RIIO-2 is GB water networks. As discussed above, there are two pure-play listed GB water networks who operate under relatively similar regulatory systems and in the same jurisdiction as GB energy networks (ST and UU) and one company that has an interest in a GB water network alongside other group businesses (Pennon). We have considered:

- empirical evidence on GB water network asset beta focusing on the traded betas of the two pure-play water companies (ST and UU); and
- why an investor might consider these two water companies a good, or indeed imperfect, investment substitute to a GB energy network, drawing on the findings and conclusions of our UK relative risk assessment.

In this report, we primarily use the relative risk analysis to inform an assessment of the weight it may be appropriate to place on evidence from GB water networks. Ofgem has carried out its own analysis of the implications of that evidence.

The networks and their advisors have also proposed that European energy networks are relevant comparators for the purpose of estimating GB energy network asset beta in RIIO-2. We reviewed:

- The evidence the networks provided, developed our own summary of the European comparator evidence, and considered the implications for Ofgem's asset beta range.
- The conditions under which European energy networks might be considered a good investment substitute for GB energy networks but also the issues with this evidence base[11].

For the European comparator analysis, we have expanded the initial long-list of comparators used by the networks' advisors (Oxera and Frontier Economics) as neither, in our view, presented a sufficiently compelling case of the shortlist of companies that were selected. We applied a filtering process to identify the comparators that we considered most comparable as an investment substitute to a pure-play GB energy network. We did not undertake a comprehensive relative risk assessment of GB energy vs. European energy networks, however, as part of the filtering process we considered the key features of European companies' regulatory regimes.

The networks through their advisors have previously raised the issue of beta decomposition where comparators have diverse business interests. Use of beta decomposition analysis was discussed in Indepen's beta study for Ofgem[12] and has been considered in a range of UK regulatory contexts, including by Ofcom[13] when estimating the BT's beta and the Competition Commission (CC) in the context of the 2007 airports inquiry[14].

In cases where businesses are not pure play, but a portfolio business, the company's beta will be the weighted average of the individual business component betas. In theory, we consider this is exactly how investors in a diverse group business would be expected to think about asset beta, i.e. in the context of the systematic risk of the individual business units of the group. As a consequence, decomposition of SSE and National Grid's group beta could be very relevant evidence for Ofgem's determinations on the cost of equity in RIIO-2.

As discussed in the Indepen report and other literature there are though practical issues that need to be considered if undertaking and interpreting group beta decomposition. The individual business unit betas are unobservable. The appropriate weights in such an analysis should reflect expected future cashflows but in practice must be approximated based on recent historic data on revenue, profit or assets.[15] As such the analysis is inherently assumptions-driven and there are practical issues with producing beta decomposition evidence.

We have reviewed the decomposition analysis provided by the networks' advisors and the associated technical issues. We have considered how robust estimates of National Grid's and SSE's GB energy networks asset beta derived from their corporate betas are likely to be, given the assumptions that must be made in order to produce these estimates. We have also used evidence on National Grid and SSE's corporate beta as a check on the plausibility of assuming that GB energy networks systematic risk can be approximated based on GB water and European energy comparators.

[11] For example, given the different jurisdictions and regulatory regimes which European energy network companies operate under.

[12] Indepen (2018) 'Ofgem – Beta Study – RIIO-2'

[13] Ofcom (2011) WBA Charge Control: Charge control framework for WBA market 1 services.

[14] Competition Commission (2007) Q5 price control: Appendix F – Cost of Capital.

[15] The CC as part of its 2007 airports inquiry suggested the assets of individual business units as the weights for decomposition.

For this decomposition analysis we have needed to consider US comparators, given one of the business units within the National Grid group operates US energy networks. For the US comparators, we have started from a long list proposed by Indepen and Frontier Economics but applied our own filters given this evidence has been introduced by others. We have also considered if there is a broader sample of relevant comparators that could be relevant to the analysis, using the same filter process we applied to European companies.

Finally, we have maintained the approach taken by participants in the RIIO-2 process of seeking to focus on:

- pure play GB energy networks (of which there are none);
- UK-listed groups with significant representation of GB energy networks;
- other GB regulated networks in adjacent sectors; and
- other regulated energy networks in nearby and similar geographies.

There are, however, a number of other listed companies internationally that hold substantial equity interests in GB energy and water. In addition to the companies considered in this report, three – PPL[16], CKI[17] and Iberdrola[18] – include GB energy networks as a portion of their operating activities and profits. Neither Ofgem nor networks and their advisors have proposed expanding the list of potential comparators further, however, and those additional comparators would present further challenges in interpretation.

1.2. Debt beta

For our empirical work on asset beta, we have needed to apply assumptions on debt beta. As discussed in our report for the UKRN[19] there are good reasons to believe that if using debt betas, then different estimates should be used for de-levering equity betas for different companies and jurisdictions.

In particular, it is theoretically hard to justify debt beta being constant over sector, geography and time. For example, while there is limited information in the public domain, there is some empirical evidence, with theoretical backing, that debt beta increases with gearing or may be linked with equity beta.

For consistency with Ofgem's own estimation of asset beta in its RIIO-2 draft determinations using UK listed comparator companies, we have used debt beta assumptions in this report that are consistent with Ofgem's proposed working assumption of 0.125 for GB regulated networks. In our previous work for Ofgem[20] and other published work on cost of capital we have tended to assume a zero debt beta, in part given the complexities and issues associated with its estimation, as set out in our report to the UKRN.

We note, however, that Ofgem did not specifically consider the applicability of its 0.125 debt beta assumption outside the GB regulatory context. While the debt betas we use in our calculations should be consistent with Ofgem's GB working assumption they need not be identical. For example, if debt beta is assumed to increase with gearing (or in proportion to equity beta), then based on the range of estimates considered in the GB regulatory context and the relative gearing observed in other geographies it is unlikely that a consistent assumption would be higher – and it may be lower.

[16] The owner of Western Power Distribution

[17] CKI has stakes in UK Power Networks, Northumbrian Water, Northern Gas Networks, Wales and West Utilities (WWU) and Southern Water.

[18] Which owns SP Energy Networks.

[19] CEPA (2019): 'Considerations for UK regulators setting the value of debt beta – report for the UKRN'

[20] CEPA (2018): 'Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks'

Gearing and equity beta measurements for the US comparators in this report are lower than those generally observed for GB networks. Though we have not carried out a comprehensive study of US debt betas, a simple adjustment to Ofgem's 0.125 working assumption for GB regulated networks might indicate a lower debt beta of 0.05. We have also calculated our results using a 0.125 debt beta assumption, though our conclusions as set out in subsequent sections of the report are not sensitive to this.

For the purpose of the decomposition work we use a weighted average of our US and GB assumptions for National Grid's corporate debt beta, but also consider the sensitivity of our findings to alternative assumptions.

In the case of our European comparators the differences are less clear-cut. There is, therefore, less justification for applying a debt beta assumption other than the 0.125 that Ofgem has judged appropriate in the GB regulatory context. However, we also calculate our results using a lower 0.05 debt beta assumption in order to illustrate the sensitivity and taking into account the wide range of views on debt beta. As for the US comparators we have not carried out a comprehensive study of European debt betas.

1.3. Report structure

The rest of this report is structured as follows:

- Section 2 presents our assessment of relative risk.
- Section 3 presents our analysis of European energy network comparators.
- Section 4 presents our analysis of beta decomposition.
- Section 5 summarises our conclusions in relation to beta estimation issues.

A series of appendices provide supporting material:

- Appendix A summarises our research on relative risk in comparable GB regulated sectors.
- Appendix B provides our high-level analysis of appropriate debt beta assumptions.
- Appendix C discusses selection of US beta comparators.
- Appendix D summarises the beta evidence on European and US comparators.

2. RELATIVE RISK

In this section we assess the expected riskiness of gas distribution and electricity and gas transmission network operators in RIIO-2 compared to network utilities operating during previous GB energy network price controls, current and previous GB water controls, and UK aviation regulatory determinations. We consider two related issues here. First, to what extent are there clear, well-evidenced sources of difference in systematic risk exposure between the different investments. Second, where we do identify differences, to what extent can those differences be thought of as representative of the overall relative risk exposure between the different investments.

2.1. APPROACH

Ofgem is seeking to estimate the cost of equity using the Capital Asset Pricing Model (CAPM). The CAPM considers systematic and non-systematic (or idiosyncratic) risks separately. The latter can in theory be diversified away by a portfolio investor, while systematic risks cannot be.

The focus, therefore, of our relative risk analysis is the systematic risk relating to the cash flows and asset value of equity investors. An implication of this is that the overall level of uncertainty around a set of future cashflows is not necessarily an accurate guide to the remuneration required.

Relative risk analysis can help to identify the most appropriate comparators to use for beta analysis and ultimately inform the beta range itself.

Beta specifically is a relative rather than absolute measure of risk, analysing the covariance of returns for a company relative to returns from a stock market. In considering the different categories of risk in our analysis, we consider whether the risk itself is likely to be systematic and whether regulated energy networks are likely to be exposed to the systematic component of each risk to a greater degree than other comparators.

We consider three separate categories of systematic risk exposure:

- **Market risk** focuses on longer term factors relating to: the underlying characteristics of demand in the sector; the competitive pressures acting on the regulated company; the overall regulatory framework and its implications for capital maintenance; and future investment drivers and sources of uncertainty such as technological advances and climate change.
- **Price control building block risk** relates to the periodic price controls that determine the revenue regulated companies are able to recover relative to the costs they incur. The key issue here is the extent to which price regulated companies may be exposed to a mismatch between revenue and costs that is related to systematic factors.
- **Firm structure risk** covers characteristics that can magnify or mitigate risks in relation to the two categories noted above, rather than being risks in themselves. For example, the mix of fixed and variable costs and the scale of a firm's tangible assets.

The overall assessment of relative risk will depend on the relative weighting of each category of analysis. The 'Market risk' category generally deals with long-term drivers of value while the 'Price control building block risk' category focuses on shorter-term cash flow issues. Short-term cash flows are likely to be particularly significant to investors' assessment of risk by virtue of being less heavily discounted, however, much of the price control related risk is likely to be performance based and idiosyncratic in nature. We discuss how best to summarise our conclusions in Section 2.4.

We compare RIIO-2 energy networks to three sets of comparators:

- **Category 1** – Energy network companies operating during the RIIO-1 sector price controls, including RIIO-GD1, RIIO-T1 and RIIO-ED1.

- **Category 2** – Energy network companies operating during individual energy network price controls applied prior to RIIO, including DPCR5, TPCR4 and GDPCR.
- **Category 3** – Regulated businesses operating under different frameworks or in different sectors including water (PR19 and PR14) and aviation (RP3 (NERL)[21] and Q6[22]) companies.

A summary of our findings is provided in the subsections which follow, with more detailed supporting analysis provided in Appendix A. We have not summarised our findings that specifically relate to the ESO in this report as we focus on onshore networks with large RAVs.

2.2. Assessment

2.2.1. Market risk

Within this category, we consider longer term factors that impact on the expected cashflows and realised asset value of the business. On these longer-term factors, it is important to be clear on why the factor is systematic, the link between the risk and expected cashflows, and the directional impact in relation to beta.

A number of the risks may be seen to relate ultimately to asset stranding – i.e. factors that may prevent a network business from earning back its investment and earning a normal rate of return on that investment. We distinguish between operational stranding – in which an asset may over time diminish in importance and become unused – and financial stranding – in which investors are unable to recover the value of their investment. The two are, of course, related but the former does not necessarily result in the latter.

We first consider fundamental sources of risk in relation to demand, exposure to competitive pressures, the regulatory framework and the impact of political risk. We then consider more dynamic sources of uncertainty, such as technological change and climate change, that may have implications for systematic risk exposure.

Demand, regulatory framework and political risk

Description

Under sector risk we cover the fundamental characteristics of an industry and the overarching framework firms in that industry operate in. This includes:

- Is underlying demand inelastic?
- Is this business naturally exposed to competition from within or outside the sector?
- Is the business exposed to fluctuations in volume?
- Are there factors that may mitigate the exposure of the business to volume or demand risk? [23]
- What are the features of the regulatory regime (licenses, RAV, appeals framework) and how may this magnify or offset a firm's exposure to fundamental drivers of systematic risk?
- What constraints exist in the legal framework for regulators and the UK Government to create or destroy value for investors?

[21] The air traffic control operator

[22] London Heathrow.

[23] For example, a binding capacity constraint may reduce the impact of demand risk. The excess demand above the capacity constraint acts as a buffer, only once this excess demand is reduced will the regulated business potentially be impacted by the change in demand.

- To what extent is the realisation of value subject to political uncertainty?

Is this risk systematic?

We would expect that sectoral and company specific demand risk will be systematic as the ability and willingness to pay for the use of the infrastructure or essentially utility services in question is often linked to the economic outlook. However, for a largely homogenous product from a natural monopoly of essential network services the non-systematic components of demand risk are likely to be reduced.

Greater demand risk, all else being equal, should lead to a higher beta. For increased political uncertainty, to the extent this is systematic, a higher asset beta is also likely to be observed.

The regulatory and legal framework is not a risk in itself, however this has the potential to mitigate or magnify other risks. The appeals framework, for example, may act as a key source of protection against regulatory risk, where an independent body is in place to review decisions. It may provide protection against:

- stranding of asset values, in particular, prices that are set to prevent the recovery of sunk investment or adherence to fundamental capital maintenance principles; and
- exposure to certain political risks, to the extent that the appeal body's statutory duties are embedded in law (e.g. statutory legislation).

The price control reset process and duration of the control itself may also mitigate or magnify the systematic risk equity holders are exposed to.

For example, compared to other (e.g. more competitive) sectors of the economy, the price resetting process for regulated utilities may bring companies' revenues or prices more regularly into line with the company's efficient costs and levels of expected demand, for a given price level, that are needed to achieve recovery of investment and a normal rate of return. That is, the price resetting process, rather than being a source of risk, may help to reduce the volatility of equity holders returns by dampening or offsetting the impacts of systematic demand risks. [24]

We might expect political uncertainty to include a systematic risk component. Under the premise of the CAPM, this would be reflected in the firm or sector equity beta: political and regulatory risks that cannot be eliminated by a large and diversified portfolio. It has also been suggested that other political and regulatory risk factors may influence equity holders expected returns and valuations of regulated utility businesses. This includes:

- systematic risks that affect multiple companies and where investors cannot eliminate their exposure from holding a diversified portfolio; and
- company-specific (idiosyncratic) risk that may be related to the impact of political or regulatory risk and uncertainty within UK regulated sectors. [25]

[24] This issue was highlighted by First Economics commenting on the impact of the five-year versus eight-year price control periods. They note that "*certain commentators have in the past depicted periodic reviews to be a source of risk, given the uncertainty and disruption that they bring to a business … a price control is ultimately a process that brings allowed revenues back into line with efficient costs. If resets take place more frequently, there is less scope for companies to earn sub-normal or super-normal returns and less risk for companies and their shareholders.*" First Economics (2012): 'The riskiness of the Electricity DNOs under RIIO Relative to Other Regulated Networks'

[25] See Oxera (2019): 'Risky business: political uncertainty and the cost of capital for regulated firms'. The central premise of this report is that there a range of theories for how risk is reflected in asset prices which the authors suggests means that the CAPM is unlikely to provide a full description of how investors determine required returns. "*While this may not matter for the average company, the CAPM will tend to underestimate (overestimate) the rate of return that investors expect for investing in companies with higher (lower) than average exposure to political and regulatory risk"*,

Summary of our relative risk assessment

Our relative risk analysis for this category shows there are differences that can be observed between the different sectors and price control periods we investigated. For example, as summarised in Table 2.1:

- There are some differences in the income elasticity of demand for the different essential services considered and the expected exposure to cyclical factors and falling demand.
- Regulated companies in the UK aviation sector – NERL and Heathrow – in particular, are exposed to greater within-period volume risk.
- The RIIO-1 price controls were eight-year rather than five-year controls, as are proposed for RIIO-2 and the PR19 and PR14 controls listed GB water companies operate under.
- There are differences in the approach to inflation indexation between the sectors and the price controls, including changes in the general inflation measure that is used (switch from RPI vs. CPI or CPIH) or the treatment of real price effects (RPEs) – fixed ex ante allowances vs. indexation.
- Political risks and uncertainty have affected – or may be expected to affect in future – equity holders' risks in different sectors and price controls in different ways.

However, as discussed above, there are also common offsetting factors, which mean that investors exposure to systematic demand, and any political risks that might affect future returns and asset valuations, are not as differentiated as these different factors may on first appearance seem. The sector risks and the regulatory regimes, particularly for energy and water networks, have many closely aligned features, including that:

- Both energy and water sectors – current and previous price controls – have a well-established RAV framework supported by a clear licensing and appeals mechanism.
- Both energy and water networks are subject to revenue cap regulation which mean that operators in both sectors eventually recover their allowed revenues when demand is lower or higher than expected.[26]
- While aviation services are considered to be more sensitive to macro-economic risks[27], water and energy represent an essential product with consensus that demand is inelastic, likely below 1.[28]

Growth opportunities that can be linked to the macroeconomy apply to water and energy utilities, e.g. from new connections and new housing developments. But similar protections also apply through the regulatory framework in both sectors around how the costs of growth are planned for and recovered from customers.

[26] Following a revenue reconciliation process. Different sectors may have different approaches and principles for how the revenue reconciliation and adjustment process to achieve to revenue cap objective applies over time.

[27] For Heathrow, the demand risk exposure is capped though the price control reset process.

[28] For example, Waddams and Clayton (2010): 'Consumer Choice in the Water Sector' reference that a survey of 'meta analyses' suggests a mean figure of 0.3 to 0.4 for the elasticity of water demand to changes in income. However, they note that the current residential demand literature at the time did not provide suitable empirical evidence on price or income elasticities for the UK. Meier et al. (2012) 'Necessity of Luxury Good? Household Energy Spending and Income in Britain 1991-1997' analyse the relationship between household energy spending and income in Britain for the period 1991 – 2007 and find that income elasticities for energy spending are U-shaped and lower than unity although somewhat higher in the longer run.

Text Box 1 – Network planning, investment and growth

The recent National Infrastructure Commission (NIC) report[29] on infrastructure for new housing development explores the interactions between the effective deployment of essential infrastructure (energy, water and wastewater) and new housing development in the UK.

While the paper focuses on the regulatory frameworks for charging across the different sectors, it also highlights the interactions between growth and water and energy network companies' investment plans.

For example, water and wastewater companies' investment plans are set in the context of long-term Water Resources Management Plans which set out set out how water supply will meet demand over at least a 25-year period. Water companies base their forecasts of demand on population and property forecasts which rely on information on housing growth from local plans. The NIC also highlighted an example of the electricity network provider in London proposing as part of its RIIO-ED1 business plan a strategic investment programme to support future connection requests. Gas distribution network operators in their RIIO-GD2 business plans have developed investment plans with new connection growth expectations and forecasts in mind.

In principle, these components of essential network businesses might be considered to have systematic components and, therefore, a source of risk and value for equity investors.

However, the underutilisation risk of growth-related expenditure is typically allocated to new housing developers and customers as opposed to the infrastructure owner or developer of incumbent water and energy networks. The effect on returns may also be *counter* as well as pro cyclical, e.g. if connections are higher (lower) than forecast because of economic conditions, then this may reduce (increase) investor returns, given the effect on the network company's cost base relative to price control expectations.

Of course, specific elements of the regulatory frameworks that apply across energy, water and aviation regulated companies have evolved and changed over time. Energy and water, in particular, have over a series of price control cycles, moved to a total expenditure (totex) based cost incentive mechanism, stronger performance (output-based) incentive regimes and greater use of contractual regulatory features such as uncertainty mechanisms. These factors are discussed under price control building block risks.

However, the core regulatory principles and approach to resetting allowed revenues and prices in response to changes in demand and cost pressures within these sectors, has remained fairly stable over time. This includes Ofgem's proposed regime in RIIO-2. This regulatory stability across sectors has also endured even during periods where political uncertainty may have weighted on asset valuations within the sectors. To the extent the regulatory framework is considered a driver of equity holders exposure to systematic risk when investing in network utilities, we suggest that it is these core common features of UK regulation that matter most, by acting as a offset or dampening effect against the fundamental drivers of systematic risk within different sectors.

What conclusions might be drawn regarding the impact of political and regulatory uncertainty on relative systematic risks between regulated utility sectors and price controls? It has been commented that the water sector has been recently heavily affected by political uncertainty – in particular, discussion of nationalisation. However, there are also factors in the energy sector that might be considered to weigh on the regulatory and political risk that energy networks are also subject to, e.g. related to the UK Government's net zero commitments. While there is political uncertainty that may affect equity holders' systematic risk energy networks in RIIO-2 and beyond, we have not seen evidence that political risk in energy is necessarily above risk in water (or vice versa). Regulatory and political uncertainty has also been a feature in previous energy network price controls and other essential infrastructure sectors, and we consider it difficult to predict its expected impact on the cost of capital.

Table 2.1 below summarises our views.

[29] See NIC (2020): 'Infrastructure to Support Housing' available here

Table 2.1: Summary of relative sector risk analysis

Sector risk factor	Energy networks: RIIO-2	Energy networks: RIIO-1 & previous	Water networks: PR19 and PR14	Heathrow	NERL
Fundamental drivers of systematic risk					
Income elasticity of demand	Low – necessity	Low – necessity	Low – necessity	Moderate – expect greater elasticity	Moderate – expect greater elasticity
Exposure to competition	Very low – natural monopoly	Very low – natural monopoly	Very low – natural monopoly	Low – significant market power	Very low – natural monopoly
Cyclicality of investment	Limited – reflective of asset condition and network requirements Network growth will be driven by new connections, which we expect to be a more systematic driver of investment	Limited – reflective of asset condition and network requirements Network growth will be driven by new connections, which we expect to be a more systematic driver of investment	Limited – reflective of asset condition and network requirements Network growth will be driven by new connections, which we expect to be a more systematic driver of investment	Cyclical, conditional upon capacity constraints – higher demand linked to higher volumes	Likely to sit between energy/water utilities and aviation – mix of asset need and volumes
Political factors	Renationalisation is relevant to financial asset stranding, but currently appears less pronounced than during RIIO-1	Renationalisation impacts more relevant in RIIO-1 relative to previous controls	Renationalisation impacts plausible in PR14, linked to Labour manifesto Potential reduction in risk for PR19	Impact on financial asset stranding less pronounced given competitive position Key political role in future expansion	Impact on financial asset stranding less pronounced given competitive position Brexit impacts on European-wide framework for air traffic
Regulatory framework					
Form of control	Revenue cap	Revenue cap	Revenue cap	Price cap	Hybrid
License	Yes	Yes	Yes	Yes	Yes
Appeals mechanism	Yes – CMA appeal	Yes – CMA appeal	Yes – CMA review	Yes – CMA appeal	Yes – CMA review
Length of control	5 years	8 years[a]	5 years	5 years	5 years

Source: CEPA. Note a: 5 years for price controls prior to RIIO-1.

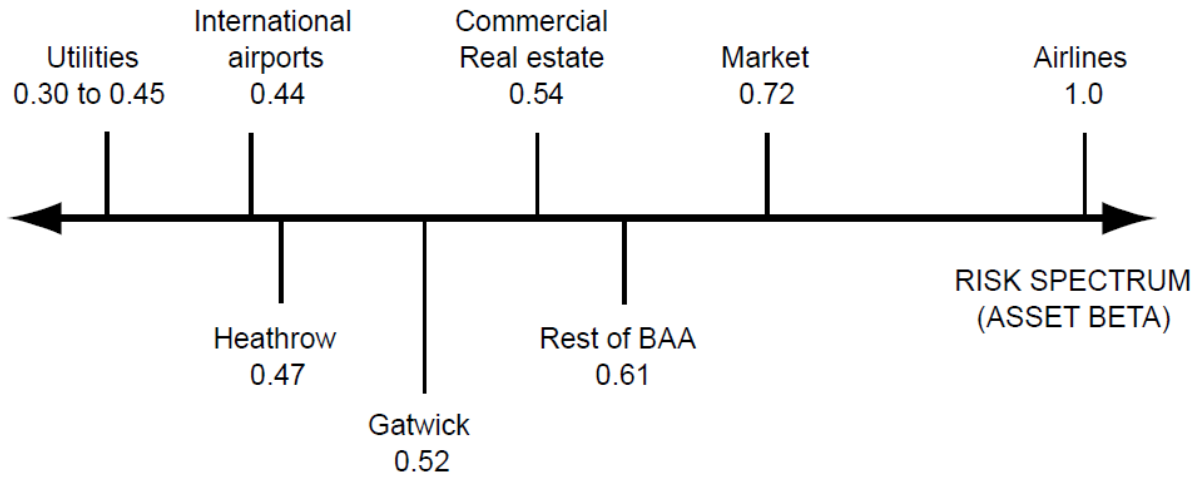
We draw the following conclusions from our analysis:

- We might expect fundamental differences in the sector market risks from the inherent sector economics and demand conditions of network and aviation businesses. For example, long-term differences in income elasticity of demand or exposure to competition within different infrastructure sectors, would be expected to lead to differences in systematic risk.
- Within regulated networks, shared characteristics of low income elasticity of demand, natural monopolies and less cyclical investment are likely to mean differences in market risks are more muted.
- The core regulatory structures[30] that apply in these sectors also act to offset or dampen any differences in sector systematic risk. The high-level core features of the regulatory regimes in GB energy and water networks that provide this offsetting or dampening effect are particularly closely aligned between sectors.
- The exception is perhaps the aviation sector where airports and airport traffic controllers are subject to greater exposure to within period volume risks – and, therefore, a higher degree of systematic risk.

Taken in the round, the above would suggest that regulated utilities such as water and energy networks are relatively less risky than regulated firms in the aviation sector, at least from a market/demand related perspective.

This conclusion on market risk is generally consistent with the risk spectrum the CMA and CC have used for asset beta in previous price control appeals and enquiries, as illustrated in Figure 2.1 below.

Figure 2.1: CMA/CC Risk spectrum (asset beta)



Source: CMA/CC

The CMA/CC has typically positioned regulated utilities, including water[31] and energy networks[32] at the lower end of the asset beta spectrum. Does this necessarily mean that asset beta is the same for all regulated utilities? While the CMA and CC have emphasised market/demand related risks as particularly important drivers of asset beta,[33] the

[30] In particular, the revenue cap framework and price control resetting process.

[31] See Bristol Water referrals.

[32] See NIE referral.

[33] See for example the draft determination for the NERL enquiry where the company's exposure to demand risk appears to have weighed heavily on the CMA's proposed range for asset beta and the 2007 CC Airport inquiry (Appendix F – para 114) which highlighted demand risk, riskiness of airline customers (as a proxy for the effects of income elasticity of demand) and operational leverage as particularly relevant factors to relative exposure of systematic risk.

CMA's range for utilities asset beta is also relatively wide. This might suggest that there is in its view, considerable scope for differences between reasonable comparable industries and sectors. We explore some of the other factors that may be relevant to regulated companies' asset beta in the subsections which follow.

Dynamic risks

Description

Under the category of dynamic risk, we are concerned with future changes to the sector or firms within a sector that could materially affect business valuations. Long-term factors that might be considered to drive investment trends and value opportunities for equity holders within essential regulated industries.

As for the previous section we consider both the fundamental drivers of market risk – patterns of demand, exposure to competition, investment cycles and political uncertainty – and the regulatory framework. In this section we are primarily concerned with an assessment of whether any of these drivers might be expected to be a particular longer-term source of uncertainty for any of the sectors under consideration, a driver of cash flow risk or whether this uncertainty might be expected to be mitigated by the regulatory regime. We are specifically interested in systematic risk: whether developments that create (destroy) value in the wider economy also create (destroy) value for network assets.

We focus on two factors:

- technological change; and
- climate change – both through its potential direct impacts and through its influence on the decarbonisation agenda and relevance of renewable energy.

Given the similarities between GB energy and water networks indicated in the previous section, we focus in particular on whether the long-term picture in these two sectors is also similar.

Is this risk systematic?

The extent to which the risk is systematic may depend on the overall impact on the economy; if it is a distributional effect, then with a diverse equity portfolio, you would expect the risk to have limited systematic impact.

For there to be an increase in beta driven by technological change, we would need to assume that emergence of new technological options simultaneously create (or destroy) value for legacy network assets and across the wider economy. The argument raised to Ofgem appears to be more that technological change is destroying value for legacy network assets, while creating value across the wider economy. This could imply a negative beta risk (i.e. a form of insurance or hedging).

Investors may argue that part of the reason for a long-term correlation with the market is the option value of holding network assets in order to benefit from growth opportunities. However, if consumers pay for this increased market correlation at present and once the growth opportunities arise, there is a risk of consumers paying twice due to speculation around future use of the network. We are not convinced at present that the links between technological change and increased asset betas have been demonstrated.

The impact of climate change on the asset beta should be considered in a similar way. Scenarios where climate change destroys value for legacy assets and the wider economy are plausible. There may, however, also be other cases where the relationship between value in legacy assets and the wider economy could be inverse.

Both issues highlight a more general point, that operational and financial stranding risks should only be captured in the asset beta to the extent they are systematic in nature. Effectively not all fluctuations in demand for essential utility and other infrastructure services will be linked to economic cycles. In particular, we do not consider that stranding risk related to competition from alternative services to be systematic in nature. An investor in a well-diversified portfolio should be able to mitigate the risk of switching, or in fact the sustained downturn in demand within the sector may be a result of the quality of services that are being provided.

Summary of relative risk analysis

Demand for both gas and electricity currently remains relatively stable across various sectors of the UK economy, and network assets are mature. There are many different pathways, however, that could be taken to meeting the UK Government's 2050 target for net zero or adapting to the changes from climate change. These pathways may influence future patterns in demand and lead to new investment cycles:

- Future technological change and usage of the network is relevant and increasing in visibility. Examples include the decarbonisation agenda, decreasing gas consumption and the growth of alternative fuels (LNG, biomethane, hydrogen).
- Distributed generation is also relevant in respect of the operational asset stranding risk of the network.
- The potential for stranding risk is arguably most tangible in the gas sector, with renewable penetration also impacting on electricity networks.

These factors have begun to influence investment requirements and approaches to network price controls across all the energy networks we considered in our analysis. However, although they have been increasing importance in the more recent price controls, including RIIO-2, the fundamental characteristics of the regulatory regime and the use of building blocks in setting price controls have yet to change.

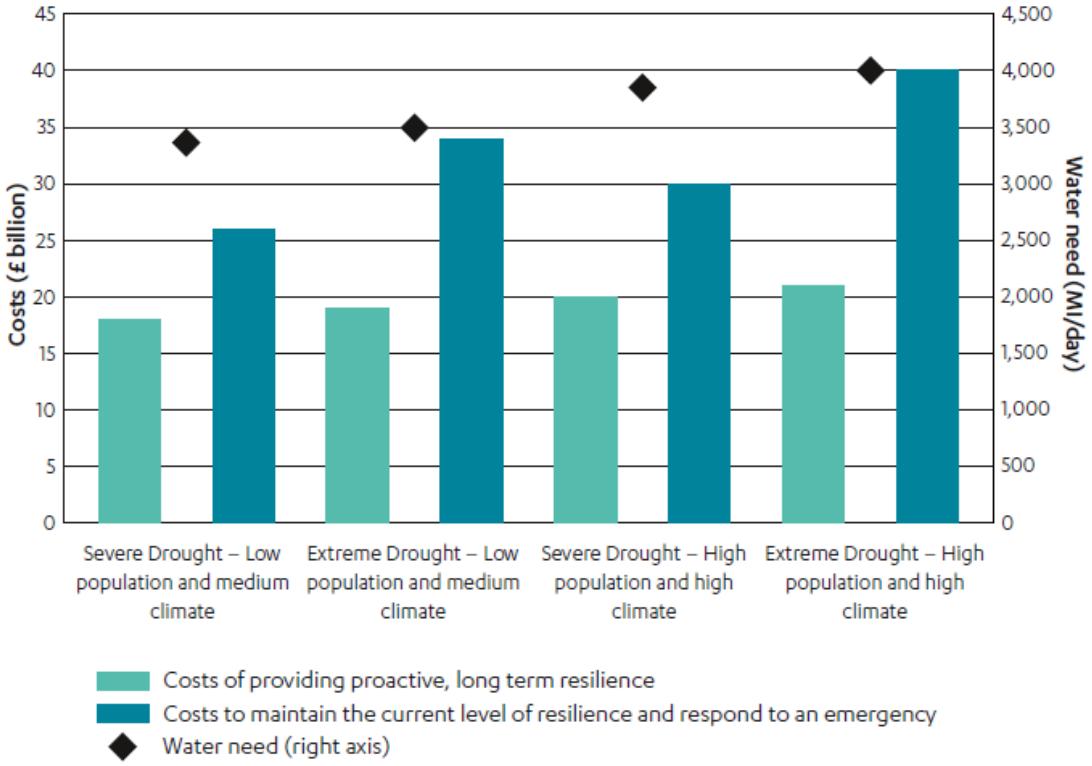
In the water sector:

- Uncertainty over future water resource availability and usage patterns (for example as a result of climate change) may be a source of dynamic demand risk.
- New charging and potentially trading arrangements are being introduced – albeit gradually – and there is discussion of greater future competition across the value chain.
- Companies are also responsible for providing retail services. While these account for a small proportion of overall activities some aspects of retail services, such as exposure to bad debt risk, may serve to heighten exposure to systematic risk.

Technological change and future network use, however, is not generally seen to be as greater a source of uncertainty as in the energy sector.

It is difficult to find consistent data to compare the possible impacts of these long-term dynamic factors and drivers on our regulated sectors in monetary terms, or to draw strong conclusions of the likely effect of these drivers on the expected cost of capital in these sectors. Public bodies such as the CCC and the NIC have set out various scenarios of the possible scale and intensity of investment in energy networks, typically multiples of billions of pounds of expenditure. The NIC's National Infrastructure Assessment – see Figure 2.2 – highlights different cost pathways for the water sector depending on how the sector responds to provide resilience to drought risks. The scale and intensity of these investment programmes create long term opportunities but also risks for equity holders in regulated utilities. On this basis both energy and water networks could be considered on the cusp of a new investment cycle.

Figure 2.2: Costs of providing proactive, long term resilience and relying on emergency response for droughts beyond current resilience levels



Source: NIC[34] Note: Costs are expected present values to 2050 (in 2018 prices)

Credit risk perspective

It is challenging, on the basis of the information above, to reach decisive conclusions regarding relative sources of dynamic risk in the energy and water sectors. In light of the absence of clear quantitative guidance we have also drawn on perspectives from credit rating agencies. While the considerations for debt holders will differ from those of equity investors, much of the debt in the regulated sectors is long-dated (twenty years or more) and so debt holders too are likely to have a long-term perspective. Though less directly relevant to our assessment of equity risk we consider that these perspectives are likely to contribute to our overall understanding.

We have reviewed Moody's recent GB energy and water sector credit ratings for the following sub-factors[35]:

- stability and predictability of the regulatory regime;
- asset ownership model;
- cost and investment recovery;
- revenue risk; and
- scale and complexity of capital programme.

Though Moody's methodology does not explicitly consider long-term dynamic risks we consider those sub-factors informative on the issue. Table 2.2 below summarises recent ratings as well as Moody's overall perspective on the

[34] NIC (2018): 'National Infrastructure Assessment.

[35] Based on: 'Regulated Electric and Gas Networks' Rating Methodology, Moody's, 2017.

GB energy sector. We take Moody's ratings for NGET and NGG to be representative of the electricity and gas sectors respectively. We take Moody's rating for United Utilities to be representative of the water sector.

Table 2.2: Overview of Moody's credit rating sub-factor scores

Sub-factor	GB energy[36]	NGET[37]	NGG[38]	United Utilities[39]
Stability and predictability of the regulatory regime	Aaa	Aaa	Aaa	Aa
Asset ownership model	Aa	Aa	Aa	Aa
Cost and investment recovery	A	A	A	A
Revenue risk	Aa	Aa	Aa	A
Scale and complexity of capital programme		Ba	A	Baa

Source: Moody's Investors Service.

There is some differentiation:

- Capital programme risk is rated particularly highly for NGET. We interpret this as driven primarily by Ofgem's *"proposal for wider application of competition for large discrete onshore transmission projects"*.
- Gas transmission risk is scored lowest, with specific strengths around revenue risk exposure and the capital programme relative to the water sector:
    - Though Moody's doesn't focus on this in relation to United Utilities' rating it has commented on potential revenue recovery and bad debt issues in its 2019 water sector outlook.[40]
    - NGG's capital programme risk is judged lower than in the water sector despite explicit consideration of gas displacement scenarios. Moody's appears to emphasise Ofgem's *"statutory obligation to "secure" that NGG and other gas transportation companies "are able to finance the provision of gas supply services"*." It also notes, however, that *"a continued decline in demand for NGG's core service may create challenges for the business, which are currently difficult to foresee".*

We have also considered Moody's 2017 assessments of the long-term shift to renewables[41] and battery storage[42]. Though some of the specifics regarding these trends will have developed further since then, we consider the overall perspective information.

In relation to decarbonisation and long-term transition: *"changing business models, developing technology and evolving regulation could potentially undermine [networks'] credit quality over time"*. Moody's appears to see this potentially resulting in execution risk on new investment, risks (and potentially opportunities) depending on networks' adaptability and sector fragmentation. This may be considered idiosyncratic risk – though arguably if part

[36] Moody's Investors Service Outlook: 'Regulated electric & gas networks – EMEA', 2018.

[37] Moody's Investors Service Credit Opinion: 'National Grid Electricity Transmission plc', 2020.

[38] Moody's Investors Service Credit Opinion: 'National Grid Gas plc', 2020.

[39] Moody's Investors Service Credit Opinion: 'United Utilities Water Ltd', 2020.

[40] Moody's Investors Service Outlook: 'Regulated Water Utilities – UK', 2020.

[41] See: https://www.moodys.com/research/Moodys-Europes-energy-network-operators-face-long-term-risks-from--PR_368155.

[42] See: https://www.moodys.com/research/Moodys-Battery-storage-trims-British-energy-network-operators-costs-a--PR_372354.

of an economy-wide transition some risks that are thought of as more idiosyncratic such as execution risk might have a systematic component.

Ultimately Moody's emphasises the regulatory response as a key determinant of credit risk. Again, this could be interpreted different ways. The regulatory regime currently mitigates systematic risks – but if economy-wide transitions necessitate changes to the regime that might not continue to hold to the same extent.

Moody's discussion of battery storage helps show how the effect of technological change on systematic risk can be ambiguous:

- There may be some positive correlations between value created by battery storage and value created through networks: *"Widespread battery use in the British electricity grid will be credit positive for transmission network operators by allowing them to integrate renewables at lower cost… National Grid will earn modest incentives for keeping the national transmission grid in balance, and all three transmission owners will benefit in the near-term from delivering grid reinforcement at lower cost."*.
- However: *"batteries reduce the need for investment in the transmission network"* potentially leading to more modest RAV growth opportunities. In addition, *"electricity volumes carried by transmission networks could fall on the back of rising renewables and battery storage"*.

It is not always clear which of these effects might be expected to dominate.

The assessment of network transition as a result of renewables penetration and decarbonisation is treated by Moody's as a Europe-wide issue.[43] To the extent that there is any differentiation it is related to heightened political risk (nationalisation agenda in the UK) or specific intentions regarding network usage (ending use of gas in Netherlands by 2050 – though this was not at the time enacted in legislation). Figure 2.3 below summarises Moody's assessment of the regulatory framework within which energy network transitions would take place.

Figure 2.3: Moody's assessment of European regulatory frameworks

Exhibit 1

European regulatory frameworks are stable and transparent

Moody's Regulated electric and gas networks methodology scores

Regulatory Environment and Asset Ownership Model	Great Britain [1]	Ireland	Netherlands	Italy	Germany	Spain
Stability and Predictability of Regulatory Regime	Aaa	Aa	A-Aa [2]	Aa	A	Baa
Asset Ownership Model	Aa	Aa	Aa	Baa-Aa [3]	Aa [5]	Aaa
Cost and Investment Recovery	A	A	A	A	Baa-A [6]	Baa
Revenue Risk	Aa	Aa	A-Aa [2]	Aa-Aaa [4]	A	A
Expected evolution of the regulatory environment	Stable	Stable	Stable	Stable	Stable	Stable

Notes: [1] Based on GB DNOs, GDNs and onshore transmission networks; [2] Gasunie (A1 stable) and TenneT Holding BV (A3 stable) score A for this subfactor, the latter due to majority of EBITDA and indeed assets, from Germany and framework scored 'A'; [3] Concession-based activities, as for instance gas distribution networks, score at the bottom of the range given uncertainties over the terms of recovery of the residual value at the end of the concession; [4] The regulated revenue of gas distribution networks is entirely shielded from volume risk. A small commodity risk applies to other networks; [5] Based on current rated networks. The asset ownership model in Germany, particularly in relation to the duration of concessions for DSOs, differs by region and therefore this scoring may vary depending on the specific network or region; [6] Transmission system operators score "A" under this subfactor; while DSOs still score "Baa" amid changes to the cost recovery mechanism, which will bed down over the third regulatory period.

Source: Moody's Investors Service

Source: 'Outlook – Regulated electric & gas networks – EMEA', Moody's Investors Service, 2018

To the extent that longer-term, dynamic risks are a factor in relation to GB energy networks Moody's would appear to judge those risks to be mitigated by the regulatory regime to at least as great an extent in GB as in other Western European countries.

[43] Moody's Investors Service Outlook: 'Regulated electric & gas networks – EMEA', 2018.

Overall, while the above analysis is only indirectly relevant as it is from the perspective of debt holders rather than equity investors, it provides some support for our judgement. While it indicates that investors in GB energy networks might be exposed to some specific sources of dynamic risk, it would be difficult to rule out those risks being mitigated by what is perceived as a stable regulatory environment. While future use of competition may heighten risk in the Electricity Transmission sector relative to water, Gas Transmission appears to be perceived as the most stable investment environment.

Summary

Table 2.3 below summarises our assessment within a similar framework that we used to assess risk in the preceding section. We focus on the implications for GB energy networks compared with water networks, given the relatively fine judgements involved here.

Table 2.3: Summary of dynamic risk analysis

Category	Short-term characterisation	Long-term characterisation	Energy vs. water differentiators
Fundamental drivers of systematic risk			
Demand	Stable, inelastic demand	• Potential for reductions in demand (gas) • Potential for changing patterns of demand (gas, electricity and water)	Materiality of change likely to be greater in energy sectors
Competition	Very limited competition	• Scope for increased competition for discrete projects in electricity transmission (CATO or similar) and water (DPC) • Scope for increased trading of water resources and bioresources (water)	Materiality of change likely to be greater in electricity transmission sector
Investment cyclicality	Mature networks	• Potential for network transformation in electricity (and gas – though this is more speculative) • Strengthening network resilience in water	• Magnitude of transformation likely to be greater in electricity transmission sector • Focus on managed decline and decommissioning of gas network may reduce risk in some scenarios
Political risk	Recent threat of nationalisation has receded	Political factors can always exert an influence – but no clear basis to assume a trend	N/A
Regulatory framework			
Legislative basis	Regulators and their duties enshrined in legislation	No reason to anticipate change	N/A
RAV/RCV security	Well-established principle of financial capital maintenance – but no formal legislative or contractual basis	No reason to anticipate change	N/A

Source: CEPA analysis

We draw the following conclusions from the analysis:

- Equity holders in regulated networks are invested in long-lived assets and so expected returns in the sector may be sensitive to these long-term drivers, to the extent they are cyclical, systematic and not mitigated by regulatory arrangements.
- Long-term investment and utilisation of energy networks in different sectors will be driven by a range of factors including composition of energy demand and network transformation to facilitate renewables and distributed generation or to supply heating. Within this:
    - The electricity sector arguably appears most likely to be exposed to longer term dynamic risks. There are a range of potential triggers for transformative investment cycles and scope for greater exposure to competition.
    - The implications of dynamic risks for gas are less clear. While there may be opportunities and risks associated with network transformation (for example to deliver hydrogen) patterns of demand and network utilisation may also result in the long-term decommissioning of the network. The latter might result in relatively low risk exposure for current investors.
- Water networks may be less exposed to these longer-term dynamic risks. Nevertheless there are some examples: Ofwat has taken some steps to introduce competition in some parts of the value chain such as bioresources, and as noted above the water sector can also be expected to be fundamentally affected by the changes and drivers from climate change (particularly responding to drought) and the Government's goal to achieve net zero carbon emissions by 2050.

However, there is little basis to assume that the regulatory regime would not continue to play an important role in offsetting and dampening the effects of dynamic sources of risk. The RAV or RCV has emerged as an important device for regulatory commitment in the gas, electricity, water and transport sectors.[44] Asset stranding is, as a consequence, unlikely under the GB regulatory framework, although we acknowledge the RAV or RCV is not enshrined in legislation as in some jurisdictions.

2.2.2. Price control building block risk

Within this category we are interested in whether individual building blocks within a price control framework creates a cashflow mismatch between what the regulator allows, and the cost paid by the network. The cashflow mismatches feed through into profit volatility and different business valuations. We are interested in considering the extent of risk in light of the mechanisms in place.

The most significant risk factor with respect to overall profits is likely to be total expenditure ('totex'), but other building blocks e.g. incentives, finance, pensions and tax may be relevant. Where possible we look to present metrics relative to the RAV, rather than revenues. We consider the RAV is generally a better proxy for the value of the firm and accounts for firm structure characteristics.

Total expenditure

Description

There are several factors in relation to the risks existing for total expenditure. The factors should be considered together, as there are key interdependencies e.g. if there is no risk tied to each unit of total expenditure, the scale of this expenditure does not influence risk.

The factors considered include:

[44] The CMA in a number of regulatory referrals as emphasised the importance of regulatory certainty in supporting the perception of the UK as a stable regulatory environment. See for example, the Phoenix Natural Gas referral.

- complexity and uncertainty of the investment programme[45];
- scale of the investment programme (relative to RAV[46]);
- treatment of cost risks tied to general economy-wide and firm-specific inflation (e.g. RPEs);
- ability to recover costs tied to development and planning;
- costs that are treated as pass-through;
- the existence of uncertainty mechanisms and re-openers;
- number of comparators in the industry;
- incentive regime (ex-ante vs ex-post), with applicable incentive strength on cost deviations; and
- linkage of expenditure to defined outputs or deliverables.

The first three factors are the key drivers of the level of outturn expenditure.

The other factors discussed are more relevant to the treatment of outturn costs and the basis for cost allowances. As such, all factors can in principle impact on the level of profitability and, as consequences, equity holders expected returns.

Is this risk systematic?

Total expenditure will have both systematic and non-systematic components. The directional impact on beta from total expenditures mismatches is not clear cut. While positive economic growth should lead to increased investment, improved efficiencies and productivities, it can also lead to increased wage pressures, material cost increases and less labour market spare capacity.

Overall, we would expect there to be a positive beta relative to scale of total expenditure, especially where cost inflationary impacts are accounted for within the regulatory framework.

A number of the factors noted above would be mitigations that would reduce the extent to which total expenditure cashflow mismatches are tied to the performance of the economy. In the absence of the mitigations and regulatory protections set out, the asset beta would be higher.

Summary of relative risk analysis

We provide a detailed comparison of total expenditure risk between sectors and price controls. The totex to RAV ratio is a particularly relevant measure for the totex risk category.

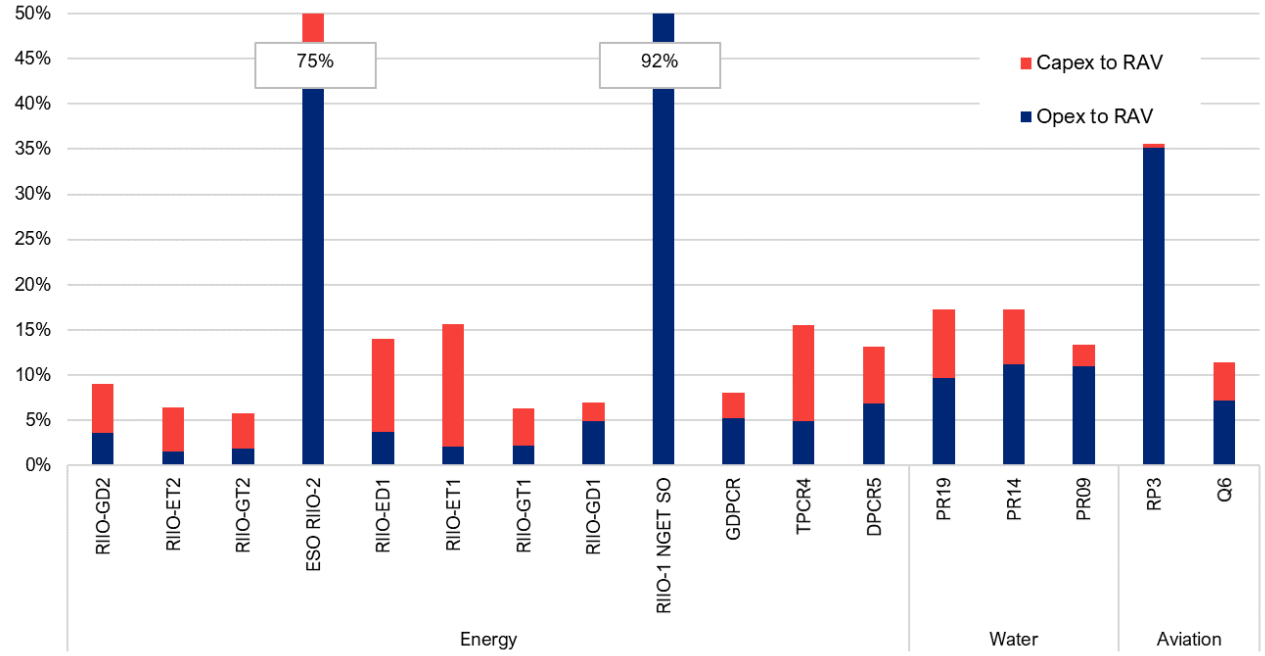
Where a company faces exposure to performance on totex, an extra pound of totex under the same regulatory arrangements creates a risk in the near term. The more totex a company must carry out relative to the scale of its existing operations, the greater will be its exposure to performance, management and coordination risk – though arguably much of this risk will be idiosyncratic in nature. In the longer term, the additional totex creates a larger asset base, therefore impacting on other metrics that we consider, such as exposure to asset stranding.

[45] This is relevant for both the ability to set an accurate cost allowance, together with the potential distribution for outturn costs.

[46] We take RAV as an imperfect proxy for the firm valuation given its availability on a consistent basis. The scale relative to RAV of totex can indicate the extent of the firm value that can be impacted by totex in the short-term, although the RAV and totex are interlinked.

In Figure 2.4 below we compare totex to RAV ratios for the price controls we have considered through our relative risk analysis, also illustrating the respective opex and capex components.

Figure 2.4: Totex to RAV across regulated sectors



Source: Regulatory determinations. RIIO2 based on company submissions.

What can be drawn from the analysis in Figure 2.1 as regards perceptions of relative risk? The comparison shows that the 'asset light' companies of the ESO (in RIIO-2), NGET SO (in RIIO-1) and NATS (in RP3) have significantly higher totex to RAV ratios than the other networks being considered.

The analysis might also suggest that at a totex level electricity networks are generally more exposed to cost shocks than gas networks. To the extent to which the differences in investment intensity between the energy network sectors, and price controls, are considered to have a systematic component, it might be concluded that electricity networks are fundamentally subject to the highest systematic risk.

Recognising that the composition of expenditure may also affect risk, we have broken down the totex to RAV ratios into capex and opex components. The higher totex to RAV ratios reflect the large capex programmes that both electricity network sectors are currently (and in future are expecting to) deliver. Gas and electricity distribution businesses typically have higher opex to RAV ratios as a consequence of the more opex focused nature of their energy network businesses. Water companies on average also appear to have higher totex to RAV ratios than most GB energy networks, and in particular, have a much higher opex component of totex relative to RAV.

Another factor that may be informative on total expenditure risk is the sharing factor that applies for over- and under-spends relative to an ex-ante allowance. From our comparator set, both the RP3 and Q6 price controls use ex-post cost assessment. RIIO-2 for the ESO operates under a different framework, with no explicit incentive rate around outturn costs. For the other sectors, water and energy network utilities with a large regulatory asset base, all now typically operate under a Totex Incentive Mechanism (TIM).

Table 2.4 below summarises incentive strength across regulated sectors and price controls. The proposed incentive strength for RIIO-2 is lower than RIIO-1 price controls and is lower than PR19. Based on this metric alone, the RIIO-2 price control might be perceived to be at the low end of the totex risk spectrum.

Table 2.4: Incentive strength across comparators (totex, unless otherwise stated)

RIIO2	RIIO-GD1	RIIO-T1	RIIO-ED1	GDPCR	TPCR4	DPCR5	PR19	PR14	PR09
33-50%[47]	62-64%	45-50%	53-70%	33-36% capex, 100% opex	25% capex, 100% opex	49-55%	43% underspend, 59% overspend[48]	44-59%	14-45% capex, 100% opex

Source: CEPA analysis

Overall, we have drawn the following conclusions from the analysis:

- Relative to the RIIO-1 price controls, the RIIO-2 price controls are expected to involve lower totex-to-RAV ratios and lower totex incentive strength. Electricity networks have higher totex to RAV ratios, driven by higher capex to RAV. In general, the energy network businesses that involve more opex, e.g. electricity and gas distribution, have higher opex to RAV ratios.
- A key reason for cashflow differences in totex in RIIO-1 was linked to allowances for Real Price Effects (RPEs). For RIIO-2, Ofgem has chosen to index RPEs. We understand that there will be a greater role for uncertainty mechanisms and pass-through costs, and stronger linkages to outputs. Overall, we would therefore expect RIIO-2 to face lower systematic risk on total expenditure than RIIO-1.
- Relative to the water sector, the RIIO-2 price controls also have slightly lower totex-to-RAV ratios and lower totex sharing factors. Both sectors use benchmarking to set cost allowances. This would indicate that RIIO-2 would be lower risk for this category than water. We are however cautious of the risk of the different type of investment to be conducted; if investment in water is more linked to maintenance activities with more certain cost allowances and a reduced distribution of plausible outcomes relative to energy, this would run counter to the relationship posited above[49].

Financing

Description

The cost of capital reflects expected financing costs over the price control. This requires forecasting of movement in market rates over the price control. Indexation of the cost of debt and/ or cost of equity can provide protections around movements in rates. We include return adjustment mechanisms (RAMs) and floors/ ceilings to revenues in our discussion of finance, where the impact of these is to reduce profit volatility.

Is this risk systematic?

We would expect there to potentially be systematic components to financing risk, although we are primarily concerned here with cashflow mismatches. If we consider the cost of debt, scenarios can be considered where company risk is positively and negatively correlated with market risk. Higher growth may be associated with higher central bank rates, leading to higher corporate costs of debt as the risk-free rate is higher and potentially there is greater competition for uses of capital. This market growth could contribute to lower profits. However, low growth scenarios could also cause a higher corporate cost of debt as spreads potentially widen in light of recessions.

[47] Based on information from Ofgem on expected incentive strength at the time of writing.

[48] Represents the average incentive strength in the industry.

[49] Assessment from technical experts could be informative on this topic.

We would expect that protections to constrain the difference between actual and outturn costs of capital will reduce the absolute size of beta risk associated with financing.

Summary of our relative risk analysis

We consider that indexation is one way in which regulators can reduce risk faced by regulated networks. Table 2.5 below summarises the sectors in which indexation has been used, as well as those sectors where the financing allowances are set for a single company. We consider that where there is a single company, the weight placed on the actual cost of debt may be greater, reducing part of the financing risk for the network.

Table 2.5: Financing risk factors by comparator

	Indexation – cost of equity	Indexation – cost of debt	Single company focus
RIIO2	Yes	Yes	No
RIIO2 ESO	Yes	Yes	No
RIIO-1 (all)	No	Yes – including bespoke mechanism	No
GDPCR	No	No	No
TPCR4	No	No	No
DPCR5	No	No	No
PR19	No	Yes	No
PR14	No	No	No
PR09	No	No	No
Q6	No	No	Yes
RP3	No	No	Yes

Source: CEPA analysis

The introduction of cost of equity indexation for RIIO2 provides further regulatory protections against financing risk. PR19 has introduced cost of debt indexation for the first time in the sector.

Pensions

Description

On pensions, regulators have allowed partial or full recovery of deficit costs. The two features impacting on risk with respect to pensions include the valuation of the deficit and whether recovery of the deficit is fully or partially underwritten by consumers. This impacts on profit volatility.

Is this risk systematic?

The basis for pension deficits from defined benefit schemes can arise from performance of investments in the wider economy, so the risk could be considered systematic. Larger deficits (negative profits) will likely arise where the performance of the economy is poor, so it is a positive beta risk.

Protections in place will have the impact of reducing beta risk.

Summary of our relative risk findings

We noted that one of the key determinants of price control building block risk for pensions relates to the recovery of pension deficits. We set out in Table 2.6 below our understanding of the treatment of established pension deficit recovery costs.

Table 2.6: Treatment of pension deficit costs by comparator

Sector	Treatment of pension deficit costs
RIIO2	Full
RIIO2 ESO	Full
RIIO-1 (all)	Full
GDPCR	Full
TPCR4	Full
DPCR5	Full
PR19	Partial – 50%
PR14	Partial – 50%
PR09	Partial – 50%
Q6	Full
RP3	Full

Source: CEPA analysis

All sectors provide protections against pension deficits. Relative to unregulated sectors, this may be a key protection where the deficit is significant. Ofwat allows only partial recovery, while other sectors allow full recovery.

We understand that Ofgem's approach involves a true-up mechanism for actual deficit costs, which Ofwat has not allowed. Ofgem reviewed their treatment of pension costs in detail a review concluding in 2017[50].

Other

Description

The 'other' category groups together different items, including incentives and tax.

Rewards and penalties from incentives will have an impact on profits of a regulated firm. The strength of those incentives and the plausible outcomes around those incentives will impact on the risk stemming from the non-cost efficiency incentives.

Tax payments for the notional company will be relevant to profit volatility. We need to consider whether this is reflective of possible options around company structures and the tax implications of doing so.

Is this risk systematic?

For incentives, there are likely to be systematic components. We would expect that growth in the wider economy could help support broader investment and productivity gains to improve performance through incentives. There will also be non-systematic components to performance.

For tax, it is difficult to arrive at a strong systematic relationship between performance and the wider economy. While poorer economic performance could lead to higher corporate tax rates, the imposition of this could be

[50] Ofgem (2017) Decision on Ofgem's policy for funding Pension Scheme Established Deficits, April 2017.

subject to a time lag. As with other cost recovery risks, the rest process under price controls, may also mitigate or dampen the degree of exposure regulated infrastructure and essential utility providers face in relation to tax.

Mitigations to reduce the extent of cashflow mismatches will decrease beta risk.

Summary of our relative risk findings

We present in Table 2.7 below a summary of the ex-ante assumptions around possible scenarios for cost performance and incentives. There are two different types of assessment we consider: indicative incentive ranges refer to estimates of the range of plausible outcomes while capped incentive ranges refer to strict limits. These are presented separately. We note that a degree of judgement is required in defining an appropriate indicative range; we have been guided by the assumptions used by Ofgem to calibrate and represent the applicable ranges.

Table 2.7: Comparative incentive exposure as a % of RAV – ex ante assumptions

Sector	Assumed incentive exposure	RAV assumption	Incentive exposure as % of RAV (per annum)
Indicative incentive range			
RIIO2 - networks	We assume +/- 2% RoRE, using 60% notional gearing[51].	Not required.	+/- 0.8%
RIIO-GD1	Estimate of +/- 3.5% RoRE, with 65% notional gearing	Not required.	+/- 1.2%
RIIO-T1	Estimate of +/- 3% RoRE, with 57.5% notional gearing	Not required.	+/- 1.3%
RIIO-ED1	Estimate of +/- 4% RoRE, with 65% notional gearing	Not required.	+/- 1.4%
DPCR5	Estimate of +/- 4% RoRE, with 65% notional gearing	Not required.	+/- 1.4%
PR19	Estimate of +/- 3.5% RoRE, with 60% notional gearing	Not required.	+/- 1.4%
PR14	Estimate of +2.5% to -4.0% RoRE, with 62.5% notional gearing	Not required.	+0.9% to -1.5%
Capped incentive range			
RIIO2 - ESO	We understand that there are potential annual rewards of £15m, compared to a maximum £6m penalty.	£303m[52].	+5.0% to -2.0%
NERL RP3	Calculations of potential rewards and penalties across capacity, 3Di target and capex delivery incentive of +£4.8m to -£17.7m per annum[53].	c.£1,200m[54]	+0.4% to -1.5%

Source: CEPA analysis

[51] We have assumed 60% notional gearing for all networks in this example. Using 55% gearing would increase the RoRE range to +/- 0.9%.

[52] Provided by Ofgem.

[53] Based on CMA provisional findings for NERL in RP3.

[54] Based on CAA RP3 decision, average RAV.

The analysis indicates that RIIO2 represents more limited risk across the cost and performance incentives than previous price controls in the energy sector. The level of exposure is also lower than for the water sector in PR14 and PR19.

The ESO in RIIO2 faces higher exposure as a proportion of RAV than other networks based on the upper and lower limits of its incentive range. The structure of the ESO's regime is different, however, with incentive rewards and penalties linked to assessments in three distinct areas and subject to a strict cap. For regimes that incorporate a cost sharing approach, in principle the range of outcomes is unbounded and the range shown in Table 2.7 is intended to be indicative of the range of plausible outcomes. In practice therefore we consider the likely range of outcomes under the ESO's regime to be more similar to the onshore networks than a simple comparison of the upper and lower limits might suggest.

2.2.3. Firm structure risk

As discussed previously the firm structure risk category relates to inherent features of a firm that magnify other risks discussed in the two categories above. As such, we do not discuss whether these items are systematic or not below. We consider two firm structure characteristics:

- the mix of fixed and variable costs – which we refer to as operational gearing; and
- the scale of tangible assets and the RAB compared to operating cash flows – which we refer to as asset intensity.

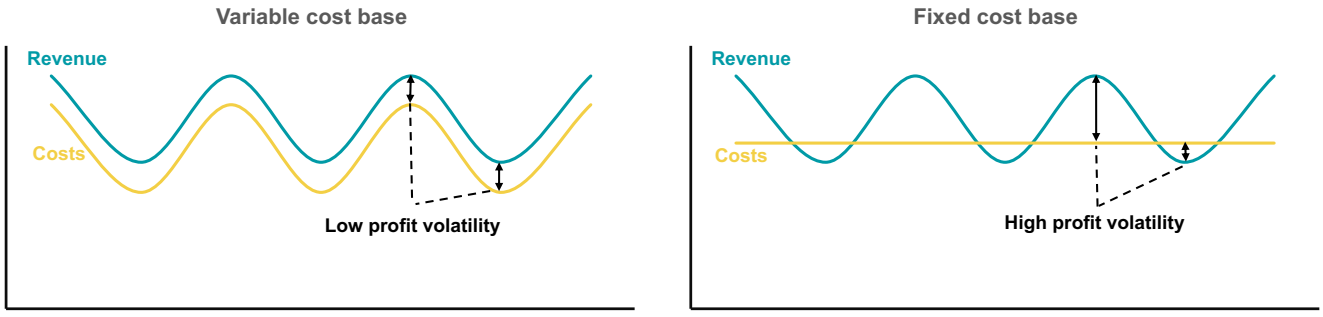
The subsections below consider each of these characteristics in turn.

Operational gearing

Description

The interaction between revenues and costs determines a company's profitability. Where a company is exposed to demand risk its revenue will be a function of the price it is able to charge and the volume supplied. Costs may, in general, be thought of as being fixed – i.e. they do not change as volume changes – or variable – i.e. they change as volume changes. Figure 2.5 below illustrates how fixed and variable costs will have different implications for the volatility of profits. With fully variable costs there is little variation in profit with respect to fluctuations in volume (and revenue). With fully fixed costs the same fluctuation in volume (and revenue) can have significant implications for profits.

Figure 2.5: Illustration of the impact of operational gearing



For a company operating in a competitive market operational gearing is likely to be an important determinant of systematic risk exposure. In regulated sectors, however, the implications are more nuanced. Where a pure price cap (or price cap with volume sharing) is used operational gearing will influence exposure to demand risk as in the case of an unregulated firm. The relevance of operational gearing may, however, be limited or even eliminated by the regulatory regime. Where a revenue cap is used, insulating the regulated company from demand risk, operational gearing is no longer strictly relevant. Where application of a price cap is moderated through some form

of adjustment based on outturn costs (for example ex post cost assessment or use of volume drivers), again operational gearing and indeed demand risk in general will tend to be less relevant.

Summary of our relative risk analysis

We do not consider operational gearing to be relevant to a consideration of systematic risk exposure in regulated energy or water networks. Both sectors operate under a revenue cap with no material exposure to demand risk that a large fixed cost base might otherwise magnify.

Operational gearing may in principle be a more relevant consideration in the aviation sector. Both the Q6 and RP3 price controls are price caps in which the regulated companies are partly exposed to volume risk. However, three factors limit the applicability of operational gearing analysis. First, both the Q6 and RP3 regulatory regimes incorporate significant protections against demand risk. Volume forecasts are periodically reset and are subject to sharing factors. Second, we are not aware of robust data on the balance of fixed and variable costs in the two sectors. Finally, both sectors have incorporated ex post cost assessment into the regulatory framework, which would be expected to dampen revenue volatility relative to a scenario in which a pure price cap were in operation.

Overall, we do not consider it appropriate to adjust our relative risk assessment for operational gearing independent of our assessment in relation to demand risk exposure. Both the Q6 and RP3 frameworks incorporate a degree of demand risk – but it has not been possible to differentiate the extent of this demand risk on the basis of operational gearing, i.e. the mixture of variable and fixed costs.

Asset intensity

Description

Any business will have to manage some degree of fluctuation in revenues, costs and asset values. In a regulated setting, other things being equal the return earned on the RAB (strictly speaking the equity component of this return) acts as the buffer available to the regulated company to absorb such fluctuations. The scale of the baseline allowed return relative to the scale of such fluctuations may exacerbate or dampen systematic risk exposure. Where fluctuations are large in magnitude relative to baseline allowed returns systematic risk may be more acute (and vice versa). We refer to this aspect of firm characteristics as asset intensity.

For example, focusing on the return element only, if we assume a given cost of capital of 5% and a RAB of £100, there is an annual allowed return of £5.

- In Scenario 1, assume the allowed return represents 1% of total revenues (i.e. £500 revenue). If there is a cost shock equal to 1% of total revenues (£5), this wipes out the entirety of the allowed return i.e. the achieved WACC goes to 0% from 5%.
- In Scenario 2, assume the allowed return represents 50% of total revenues (i.e. £10 revenue). If there is a cost shock equal to 1% of total revenues (£0.10), the achieved return is 4.9% (i.e. £4.90/100).

'Asset light' firms are therefore often thought of as being relatively more exposed to systematic risk. This issue was discussed, for example, in the Competition Commission (2010) Bristol Water decision[55]. The CC used depreciation and return to represent operating cashflow, relative to total revenues (including opex and tax). Where the operational cashflow is lower, there is greater exposure to short-term fluctuations in profit in percentage terms.

An adjustment to our relative risk analysis to reflect asset intensity is not necessarily required. Where sources of risk are comparable as a percentage of RAB asset intensity may not be a relevant consideration. For example, in

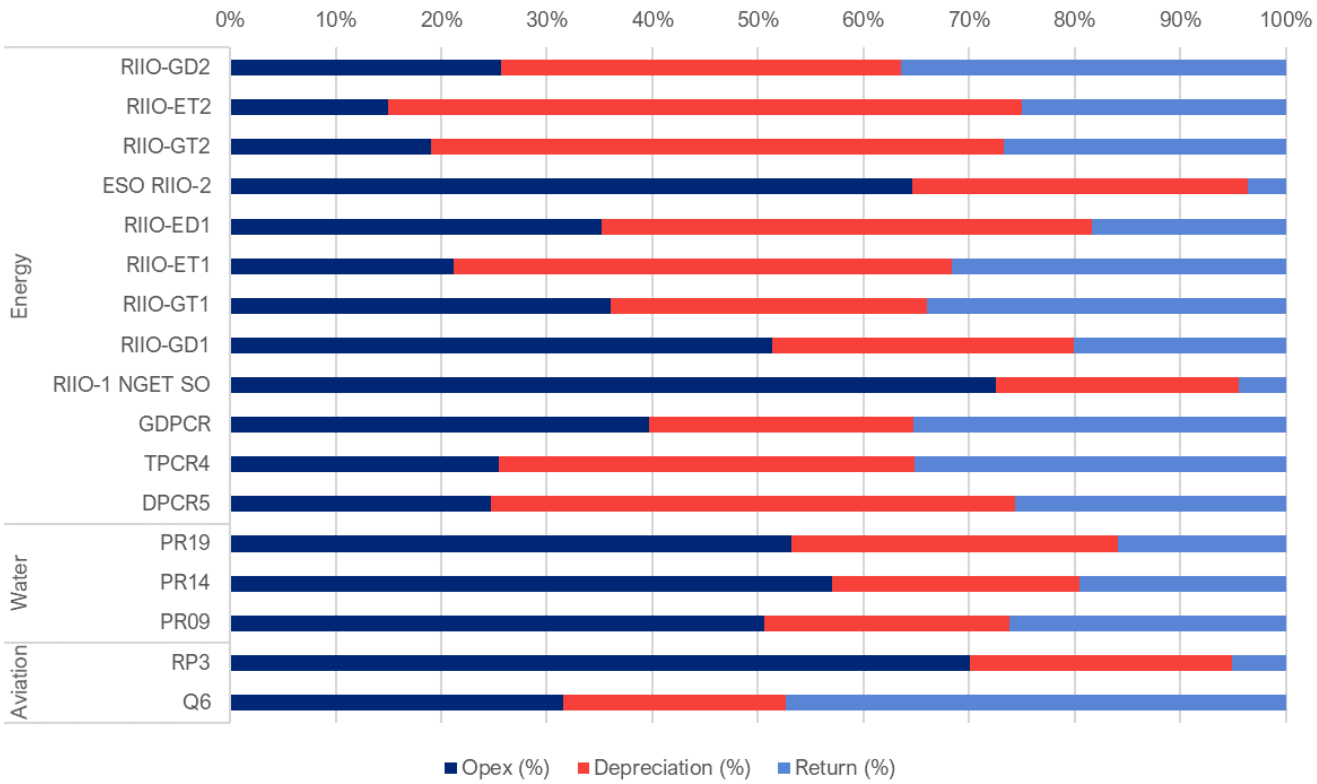
[55] https://assets.publishing.service.gov.uk/media/55194c7240f0b614040003d2/558_appendices.pdf, p204.

the two scenarios above the differential impact on profit arose as a result of considering a cost shock of a given percentage of *revenue*. The significance of this was far greater for the asset light company. A cost shock of a given percentage of *RAV*, however, would affect both firms equivalently.

Summary of our relative risk analysis

As presented in Figure 2.6 below, the share of operational cashflows impact is most pronounced for asset light comparators (RP3 and the ESO). In the water sector, we have observed a similar share of depreciation and return combined over recent price controls. We find RIIO-2 controls to have a less magnifying impact than PR19.

Figure 2.6: Share of operational cashflows by comparator



Source: CEPA analysis of regulatory determinations, company documents and Ofgem data

2.2.4. Summary of assessment

We present our assessment of relative risk of network utilities operating under different price controls in Table 2.8 below, based on the evidence presented within this section. Where our assessment says 'lower' ('higher') this means that we consider the comparator to be lower (higher) risk than RIIO-2.

The overall judgement reached is in some cases sensitive to the weighting of different categories of risk. This is particularly true in the case of the comparison between energy and water (abstracting away from any changes in regimes over time):

- Within the 'Market risk' category the overarching regulatory framework is very similar between the two sectors, and the current structure of demand, exposure to competition, investment cyclicality and political risk is arguably also similar.
- Looking further into the future at more dynamic sources of long-term risk, conclusions are more judgement-based. Patterns of network demand and investment intensity are arguably greater sources of uncertainty in the energy sector than in the water sector. This uncertainty may continue to be mitigated under a stable regulatory framework and aspects of it (particularly execution risk on new investment) may

be more idiosyncratic than systematic in nature. There are also future sources of uncertainty that may be greater in the water sector, such as the influence of climate change on water resource pressure and the opening up of contestable parts of the value chain.

- Price control building block risk appears, if anything, slightly higher in water than in energy. Many aspects of building block risk, however, are arguably related to delivery and execution and might be expected to be more idiosyncratic than systematic in nature.

The similarities in the regulatory regimes and current market structures are currently important determinants of risk exposure. There is little evidence indicating that the regimes would be expected to diverge and so it is plausible that investors would judge GB energy and water networks to be reasonably close investment substitutes. Over the long-term, however, the picture is not clear-cut: GB water networks may be judged similar to energy networks (on the basis that future uncertainty may be mitigated by the regulatory framework) or less risky (on the basis that future uncertainties are more significant in the energy sector.

Our overall rating for RIIO-T1 accommodates a range of judgements. In its RIIO-T1 determination Ofgem adopted a slightly higher asset beta estimates for some transmission companies reflecting the scale and complexity of the capital investment programme. While we do not consider this additional risk to be an inherent feature of transmission networks it does appear to have been a feature at the time of the RIIO-T1 price control.

Table 2.8: Comparison of RIIO-2 risk relative to other comparators

Risk versus RIIO2	Market risk	Price control building blocks	Firm structure	Overall
Set 1 comparators				
RIIO GD1	Similar	Similar/Higher	Similar	Similar
RIIO T1	Similar	Similar/Higher	Similar	Similar/Higher
RIIO ED1	Similar	Similar/Higher	Similar	Similar
Set 2 comparators				
GDPCR	Similar	Similar/Higher	Similar	Similar
TPCR4	Similar	Similar/Higher	Similar	Similar
DPCR5	Similar	Similar/Higher	Similar	Similar
Set 3 comparators				
ESO	Similar	Slightly higher	Higher	Higher
PR19	Similar/Lower	Similar/Higher	Similar	Similar
PR14	Similar/Lower	Similar/Higher	Similar	Similar
PR09	Similar/Lower	Similar/Higher	Similar	Similar
Q6	Higher	Similar/Lower	Similar	Higher
RP3	Higher	Slightly higher	Higher	Higher

2.3. SELECTED QUANTITATIVE EVIDENCE

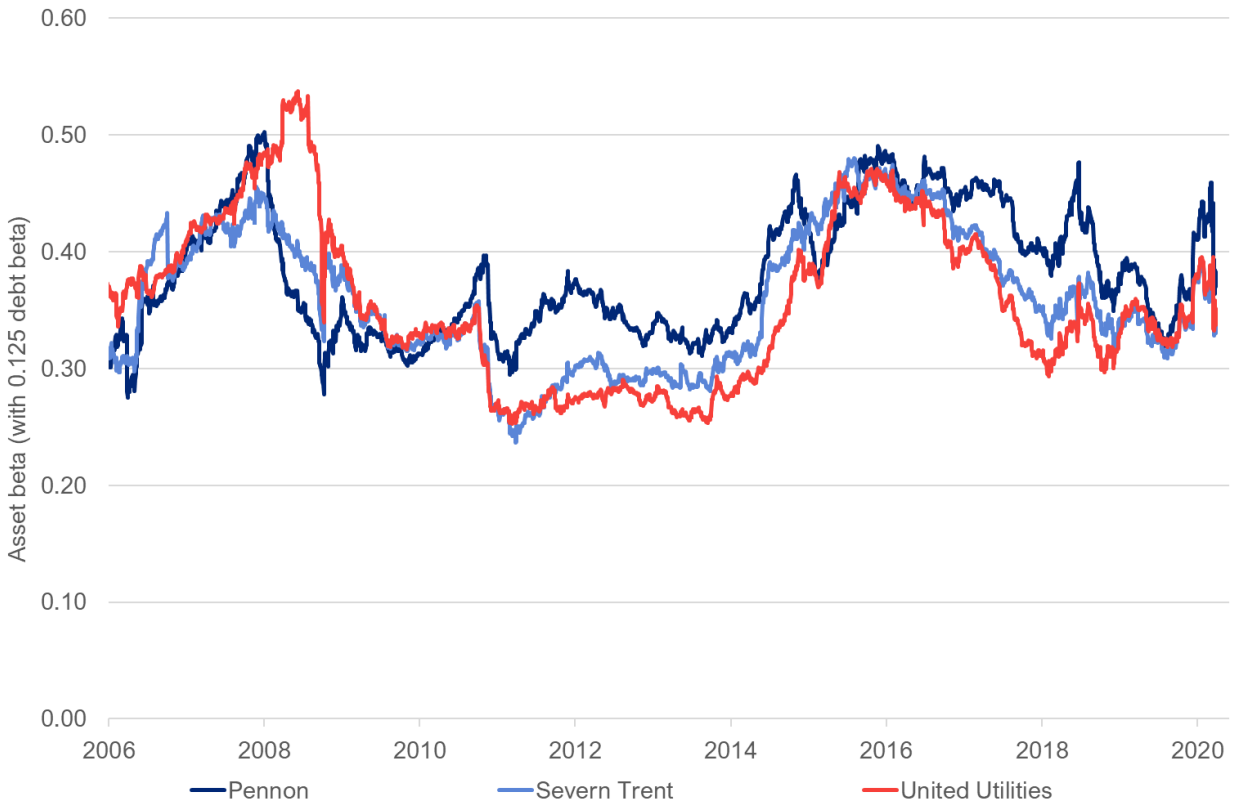
We have undertaken the analysis in Section 2.2 in order to inform Ofgem's treatment of comparator evidence in reaching its estimates of GB energy network betas. We have not been asked to provide our own detailed assessment of comparator evidence. However, in this section we briefly characterise the evidence for GB water sector comparators in order to aid the subsequent discussion and interpretation.

We present asset beta measurements for the three current listed GB water companies in Figure 2.7 below. This is based on one beta estimation approach (OLS) and specification, but we note that Ofgem is considering a range of

different specifications as part of its work for draft determinations, building on the findings and conclusions of the Indepen beta study.[56]

Over a fifteen year time horizon, there are (brief) periods where individual asset beta measurements are as low as 0.25 and as high as 0.50, when calculated relative to the FTSE All-Share Index[57]. Due to the relative importance of non-GB regulated business activities the beta measurements for Severn Trent and United Utilities are more likely to be representative of the regulated sector as a whole than the measurements for Pennon.

Figure 2.7: UK listed water companies – daily two year asset betas, with a 0.125 debt beta



Source: Bloomberg

We present in Table 2.9 below the averages for the three water companies, as well as for only the two pure play listed companies.

Table 2.9: UK listed water company asset betas

	SVT & UU	SVT, UU and PNN
5-year average	0.385	0.397
10-year average	0.345	0.359

Source: Bloomberg

We consider that a range of around 0.34-0.39 is representative of the comparator betas over time, with beta measurements outside this range tending to be followed by mean-reversion. In reaching this high-level

[56] Indepen (2018): 'Beta study – RIIO-2'

[57] We note that calculations using the FTSE All-Share Index as opposed to the FTSE100 index increase the asset beta by 0.01-0.02 over a ten-year horizon.

characterisation of the evidence we place slightly more weight on the estimates excluding Pennon given its higher proportion of non-GB regulated business activities.

2.4. Discussion

Based on applying our analytical framework we find:

- **Energy networks bear lower risk compared to regulated companies in the UK aviation sector** (Heathrow and NERL) as aviation companies are exposed to within period demand risks where outturn volumes differ from forecasts. While this is limited by risk-sharing arrangements and periodic resets it is clearly a source of greater systematic risk relative to energy networks.
- **Water and energy networks in contrast exhibit many similarities.** Regulatory protections of value, price control building blocks and firm characteristics are all broadly similar, as is the current industry structure in terms of maturity and elasticity of demand, prevalence of competition and position in the investment cycle.
- **Energy and water networks will face different sources of dynamic uncertainty**, particularly around future patterns of network utilisation and demand and the determinants of the investment cycle in both sectors. On balance it is difficult to conclude that these differences consistently indicate that energy networks are exposed to greater systematic risk than water networks (or vice versa). While the scope for change may be greater in energy networks, based on current regulatory arrangements greater uncertainty does not necessarily translate into greater systematic risk exposure. Within the energy sector there may be differences, with electricity networks in our view most likely to be exposed to greater dynamic risk.
- In light of the similarities, we consider that a suitable starting hypothesis is that **GB water networks would be considered by many investors to be a reasonable investment substitute for GB regulated energy networks** and hence informative as to the latter's asset beta. Within this, however, there are aspects of risk exposure that are difficult to conclude on decisively and they cannot be considered perfect substitutes.

As a result of these findings we consider it appropriate that Ofgem continues to have regard to GB water networks – particularly the two 'pure play' networks – in forming its judgement of beta. We do not attempt to summarise this evidence in full in this paper. Over the long-term water network asset betas (calculated using Ofgem's SSMD working assumption of 0.125 for the debt beta) are most consistent with a range of around 0.34-0.39, albeit based on one form of beta estimation approach. We therefore consider our relative risk analysis supportive of Ofgem's SSMD range of 0.35-0.40 or a slightly lower range the more emphasis is placed on the similarities in the water sector regulatory frameworks and price control building blocks.

However, depending on the weight placed on different components of risk we recognise that energy networks may be judged riskier than water networks (though the converse may also be also true in relation to some sources of uncertainty such as climate change and resulting water resource pressure). Investment in energy networks will be driven by factors such as the expected long-term use of gas and electricity networks (e.g. in supply of heating or power generation). Equity holders in energy networks are invested in long-lived assets and so their expected returns in the sector may be sensitive to these long-term drivers and the cashflow risks they may create, to the extent they are cyclical and systematic.

As a consequence, **European energy networks as a comparator group and investment substitute to a GB energy network may more closely reflect these sector-specific risks that GB energy networks are exposed to**. Despite variation in regulatory protections and regimes (in particular exposure to demand risk, price control incentives and use of inflation indexation) European energy networks may help to inform beta estimation for GB energy networks. We therefore undertake an analysis of European energy network betas in Section 3.

We also use the findings of this analysis to inform our analysis in Section 4 of beta for the two listed companies that have interests in GB energy networks (National Grid and SSE) alongside other group businesses.

3. EUROPEAN ENERGY NETWORK COMPARATORS

While Ofgem's SSMD range did not place weight on evidence from European energy network comparators, in the course of their analysis and submissions some networks and their advisors have presented evidence from European comparators. In the absence of any UK listed pure play energy network such evidence may offer a reasonable proxy for market and sector risk. In this section we therefore consider the potential robustness and implications of evidence from European energy network comparators.

We expect European comparator evidence will tend to be most informative the more weight that is placed on sector-specific issues, and will tend to be less informative the more weight that is placed on the regulatory framework and price control building blocks. The purpose of this section is to assess whether Ofgem's overall conclusion on beta is likely to be particularly sensitive to this weighting of the evidence and whether the evidence from European comparators appears consistent with the SSMD asset beta range of 0.35-0.40.

3.1. EVIDENCE PRESENTED TO OFGEM

We focus on two reports in relation to European energy comparators. The first is from Oxera, directly utilising European comparator evidence to inform an estimate of the asset beta[58]. The second report is from Frontier Economics in relation to beta decomposition[59]. The topic of beta decomposition is covered in the next section; however, we consider that there is read-across from the European comparators chosen for that analysis.

The Oxera report uses four European comparators[60], calculated relative to the Eurostoxx TMI index. A debt beta of 0.05 is used, with analysis up to the end of August 2019. The analysis is based on daily asset betas, with reference to the most recent 2yr and 5yr betas.

Oxera state that the European beta evidence suggests a slightly wider asset beta range than the GB evidence[61]. Oxera quote a range of 0.25-0.46 for the European evidence, relative to 0.28-0.40 for the GB evidence. Both figures use a 0.05 debt beta.

Frontier's analysis uses two of the four Oxera chosen comparators (Enagas and Snam), together with five other comparators (Endesa, Enel, Hera, REN and Transelectrica). The selection of comparators is said to be informed by a 50% operating income threshold. As with Oxera, a daily asset beta is calculated, with a 0.10 debt beta. Beta estimates for the European comparators are calculated relative to local indices. The Frontier analysis is used for beta decomposition analysis rather than as standalone evidence, and we discuss the main conclusions of this report in Section 4.

The two submissions do not reflect a consistent view of the relevance of comparators. This weakens the evidence base and poses a challenge to interpretation, although the choice of comparators is naturally subjective. We have therefore sought to take a systematic approach to identify the most relevant and robust comparator evidence. The following section summarises our approach.

[58] Oxera (2019) Cost of equity for RIIO-2 – Q4 2019 update.

[59] Frontier Economics (2020) Beta decomposition. A report for National Grid and SSE.

[60] Enagas, Red Electrica, Snam and Terna Rete.

[61] The UK evidence appears to refer to the two UK-listed energy networks and two UK-listed pure play water companies. In deriving a preferred asset beta range later in the report, Oxera do not include the UK-listed water companies.

3.2. OUR APPROACH

There are two key stages to obtaining reliable and robust evidence for informing Ofgem's asset beta estimate. The first stage involves the selection of suitable comparators, while the second stage is calculating beta under a preferred specification.

For the identification of suitable comparators, we have developed a longlist of potential comparators to be assessed against four criteria:

- **Regulated share of value:** the percentage of value (defined with reference to profits, assets or revenue) accounted for by 'pure play' regulated energy network assets;
- **Regime similarity:** the high-level comparability of the regulatory regime to the UK (though we have not carried out a detailed relative risk analysis of each country's regimes);
- **Liquidity:** the trading liquidity of each comparator, in order to filter out those that may not have robust pricing data; and
- **Data robustness**: the reliability and robustness of the resulting beta estimates, including their volatility over time and sensitivity to modelling choices such as the reference index.

As discussed in the introduction, we have tested the sensitivity of our ranges to different debt beta assumptions, including 0.05 (as used by Oxera) and 0.125 as adopted by Ofgem for GB regulated networks. We summarise evidence from two-year windows of high frequency data, with a preference for estimates summarised over the long-term. We present estimates based on local indices and broad-based pan-European indices.

3.2.1. Longlist of potential comparators

Our longlist contains twelve potential comparators. This list includes the nine companies included in the reports discussed above from Oxera and Frontier Economics[62]. We then reviewed analyst reports, consultancy studies and independent research with a view to identifying additional European listed companies with material network businesses. We identified three further comparators: Elia, Fluxys and A2A.

The twelve comparators are included below, with a brief description of the regulated European assets owned by these companies.

- Elia: Belgian and German electricity transmission.
- Fluxys: Belgian gas transmission.
- Red Electrica: Spanish electricity transmission.
- Enagas: Spanish gas transmission
- Endesa: Spanish electricity distribution.
- REN: Portuguese electricity transmission.
- Terna Rete: Italian electricity transmission.
- Snam: Italian gas transmission.
- Enel: Italian electricity distribution.

[62] This includes the Frontier shortlist of European comparators. Our review did not find companies in the Frontier longlist that we considered should be included as pure play comparators.

- HERA: Italian electricity and gas distribution.
- A2A: Italian electricity and gas distribution.
- Transelectrica: Romanian electricity transmission.

Other studies have considered other comparators. For example, NERA[63] has previously considered Naturgy and Acea. However, these two have very low proportions of regulated activities and so we consider them unlikely to improve the overall robustness of Ofgem's asset beta judgement.

For our assessment against the four factors discussed above we use a traffic lights scoring system, with green equating to the comparator that is most appropriate.

3.2.2. Factors affecting our comparator selection

Regulated energy network share of value

With the number of GB 'pure play' comparators being limited, European comparators have been proposed as potentially useful additions to the evidence base on beta. The European comparators should be 'pure play' regulated companies to the extent possible, otherwise the beta estimates will be biased through any unregulated activities. For reference, National Grid and SSE's GB regulated energy businesses have accounted for around half of their adjusted profit over the past five years. Arguably any comparators with a lower share of regulated energy networks would be unlikely to materially improve the overall robustness of the analysis and so we seek to focus on businesses that are at least 50% regulated energy networks by value.

We use segmented financial accounts data to assess the regulated energy network share of overall company value. Different measures are available, including shares of revenue, assets and profits. The granularity of the segmented data can vary by company, requiring more interpretation and leading to slightly more uncertainty.

We do not specify a singular measure for estimating the regulated share of value – though we expect operating profits adjusted to strip out the effect of one-off factors most likely to be an accurate guide. If the unregulated part of the business is similar in the extent to which it is asset intensive, then assets may be a reasonable proxy to consider. Revenues are less likely to be relevant given that some activities create lower margins. An example of this would be retail activities, where there would likely be a low margin as a proportion of revenues. However, in some cases segmented revenue data is more easily available.

In Table 3.1 below we set out our assessment of the regulated share of value. A green ranking corresponds to a company whose activities are predominantly regulated energy networks. An amber rating involves a firm where regulated activities correspond to over half of the company value, but where the unregulated business is sufficiently high that it is likely to impact materially on the beta. A red rating is where the regulated segment represents less than half of the value of the company. The Sum of the Parts valuation is sourced from a report by Barclays[64].

[63] NERA (2019): 'Cost of capital for SPT in RIIO-2 – Report for Scottish Power Transmission plc'

[64] Barclays (2020) European Utilities – Covid-19: double upgrade Centrica, Engie to OW. 14 April 2020.

Table 3.1: Assessment of the regulated share of value, based on latest available data

Company	Rating	Revenues	Profits	Assets/other
Elia		>99%	>99% EBIDTA, op income	>85%
Red Electrica		90%	>85% EBIDTA, EBIT	85% (SoTP, based on transmission RAB + outperformance)
Terna Rete		90%	95% EBITDA	>85% (SoTP, based on transmission RAB + outperformance
REN		>95%	90% EBITDA, >95% net income	>99%
Enagas		>80%	85% operating income, 48% net income	40%, 62% (SoTP, based on transport and storage)
Snam		79%	>75% operating income	>75%, 80% (SoTP, based on transmission RAB + outperformance)
Enel		27%	47% EBITDA, adjusted EBITDA, 77% operating income[65]	41% (SoTP, based on Italian and Spanish networks)
Endesa		14%	55% EBITDA	47%, >55% (SoTP, based on Networks Spain)
HERA[66]		Up to 61%	48% EBITDA	48%
A2A		12%	36% EBITDA, 28% operating income	n/a
Fluxys		68%	50% operating income	n/a
Transelectrica		39%	n/a	n/a

Source: Bloomberg, Barclays.

We have also had regard to the non-regulated network components of each business. In the case of all of the four companies with marginal ratings there are business units that might be expected to materially distort beta measurements obtained for the purpose of benchmarking regulated energy networks. For example, Enel and Endesa are better characterised as power generators and traders and as such their risk profile is unlikely to correspond closely to that of a regulated energy network.

Regulatory regime comparability

The comparators on our longlist all have regulatory energy network assets. As discussed as part of our relative risk analysis, the regulatory regime can influence the systematic risk faced by a regulated firm, e.g. by offsetting or dampening the effects of fundamental drivers of systematic risk faced by energy networks.

We have not conducted a detailed relative risk assessment of each of the individual price controls our longlist of comparators currently or has historically operated under. We have though looked at key features of the regulatory regimes and used this to make our assessment, as shown below. We present overleaf a high-level summary of different regimes. This is based on analysis by Moody's credit rating agency and from the Council of European

[65] This is materially higher than <50% in preceding years.

[66] This is for integrated electricity and gas, of which the distribution networks are only one component.

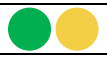
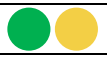
Energy Regulators (CEER)[67]. While some points of detail regarding the regulatory framework do differ, the main features are often very similar. Energy networks are regulated under a RAB model with periodic resets to price control assumptions. As for GB regulated networks these features are likely to dampen or mitigate many of the sources of systematic risk that investors in the energy sector might otherwise be exposed to.

In general, we view the comparators in Table 3.2 to be similar to GB networks. Where there are differences – for example in the application of price caps or hybrid regimes rather than a revenue cap or the absence of inflation linkages – we view the resulting differences as being unlikely to completely obscure the relevance of the comparison. Comparability appears strongest, at a high level, for Elia and Fluxys. Most points of difference relative to GB appear to be sources of slightly greater risk (e.g. introduction of a small amount of demand or volume risk or lack of inflation linkage). Our assessment appears to be broadly in line with findings from the networks' advisors. For example, in its report for SPTL NERA concluded that "based on our relative risk analysis we consider that the Italian and Spanish networks face broadly similar risks to SPT".

Though not specifically related to the regulatory regime we note that Transelectrica may face a different degree of risk than other comparators judged on the basis of its own credit rating and the sovereign rating of Romania, its country of operation. Moody's currently rates Transelectrica Ba1, the highest sub-investment grade rating. Romania's sovereign rating – which is likely to be a relevant if indirect consideration for a regulated network serving a broad customer base – is Baa3, the lowest investment grade rating. Although we have not captured these points in our assessment in Table 3.2, they are likely to be relevant considerations for our overall assessment.

[67] CEER (2020) Report on Regulatory Frameworks for European Energy Networks 2019.

Table 3.2: Assessment of European regulatory regimes – first set

	Belgium ET	Germany ET	Spain ET	Spain GT	Italy ET	Italy GT	Portugal ET	Portugal GT
	Elia	**Elia**	**Red Electrica**	**Enagas**	**Terna Rete**	**Snam**	**REN**	**REN**
RAB model?	Yes	Yes	Yes	Yes	Yes – revalued historical cost	Yes	Yes	Yes
Type	Revenue cap	Revenue cap	Revenue cap (no volume risk)	Hybrid (volume risk only for growth component)	Price cap (only 10% revenue at risk)	Price cap (only 1% revenue at risk)	Hybrid revenue/ price cap	Hybrid revenue/ price cap
Control length	4yrs	5yrs	6yrs	6.5yrs	8yrs	3yrs	3yrs	4yrs
Recognition of investment	Ex-ante, with ex-post true-up	Ex-post, up to Investment Measure limit	Ex-post audited value plus sharing adjustment	Ex-post audited value plus sharing adjustment	Ex-post once complete	Ex-post	Immediate recognition (ex-ante allowances)	Immediate recognition (ex-ante allowances)
Efficiency assumptions	50% sharing factor for gains on manageable costs No x-factor	Controllable costs subject to efficiency factor	Implicit 50% sharing based on unit costs Efficiency to be defined	Implicit 50% sharing based on unit costs Efficiency to be defined	End of period profit share 1.3% X factor on controllable opex	End of period profit share 1.0% X factor on controllable opex	1.5% X factor on operating costs	2.5% X factor on operating costs
Inflation	CPI on controllable costs	RAB linked to specific assets Revenues tied to CPI	No linkage	No linkage	CPI on RAB & allowed opex	CPI on RAB & allowed opex	Opex indexed to GDP deflator	Opex indexed to GDP deflator
Assessment								

Source: CEPA analysis of Moody's and CEER.

Table 3.3: Assessment of European regulatory regimes – second set

	Belgium GT	Italy GD	Italy ED	Spain ED	Romania ET
	Fluxys	**A2A, Hera**	**A2A, Hera, Enel**	**Endesa**	**Transelectrica**
RAB model?	Yes	Yes	Yes	Yes	Yes
Type	Revenue cap	Price cap	Price cap	Revenue cap	Revenue cap
Control length	4yrs	6yrs (2x3yrs)	8yrs (2x4yrs)	6yrs	5yrs
Recognition of investment	Ex-ante with ex-post true up	Ex-post recognition	Ex-post recognition	Ex-ante with partial ex-post true up	Ex-post recognition
Efficiency assumptions	50% sharing factor. No x factor.	1.7% x factor applies.	1.9% x factor. Profit sharing applies.	Implicit 50% sharing factor	2.0% x factor. Assess efficiency ex-post.
Inflation	CPI controllable costs	RAB indexed to inflation Opex updated by CPI	RAB indexed to inflation Opex updated by CPI	No CPI linkage, nominal return	RAB indexed to inflation
Assessment					

Source: CEPA analysis of Moody's and CEER.

Trading liquidity

Beta is a relative measure relating to movements in the price of a stock relative to movements in a stock index. To assess this reliably, there needs to be sufficient liquidity in the underlying stock. In the absence of this liquidity, the beta will not be representative.

We use the bid-ask spread as a proxy for liquidity. Regulators and advisors often refer to a threshold of 1% – see for example NERA's 2016 advice to Ofcom, in which NERA applies a threshold of 1% and reports use of a similar threshold on the part of the German energy regulator[68] – with bid-ask spreads above this potentially indicating a lack of trading frequency or liquidity sufficient to interfere with accurate beta estimation. We seek to avoid using companies with a bid-ask spread above 1% though as for our assessments in other categories we also seek to accommodate comparators in the analysis where possible and do not apply a strict cut-off at the 1% threshold.

Table 3.4: Assessment of liquidity

Company	Bid-ask spread, 5yr average	Bid-ask spread, 10yr average	Assessment
Elia	0.23%	0.23%	
Red Electrica	0.05%	0.55%	
Terna Rete	0.11%	0.23%	
REN	0.21%	0.33%	
Enagas	0.06%	0.38%	
Snam	0.10%	0.27%	
Enel	0.06%	0.20%	
Endesa	0.06%	0.57%	
HERA	0.18%	0.51%	
A2A	0.13%	0.35%	
Fluxys	1.30%	1.12%	
Transelectrica	Insufficient data	Insufficient data	

Source: Bloomberg, CEPA analysis

The difference in bid-ask spreads between the 5yr and 10yr figures are impacted by wider spreads from May 2012 for 12-18 months. This stemmed from the reaction in financial markets to the Eurozone crisis during this period, with concerns around sovereign default. The impact of the global financial crisis was pronounced for countries where our comparators are based (e.g. Portugal, Italy and Spain). We consider this issue in our overall assessment of comparators and our results.

Data robustness and reliability

Under this criterion, we consider three different tests of data robustness and reliability:

- Are estimates excessively noisy or volatile?
- Are estimates excessively sensitive to the choice of reference index?
- Are beta estimates based on reasonable gearing figures?

[68] NERA, 'Update of the Equity Beta and Asset Beta for BT Group and Comparators', March 2016.

Each of the tests requires some degree of judgement in interpreting the results of the analysis:

- For the first test, we consider the difference between the maximum and minimum values over a ten year time horizon. The five UK listed network businesses have ranges of 0.20-0.37 between their maximum and minimum values over a ten-year horizon.
- For the second test, we compare results from the local index relative to the beta calculated against the Eurostoxx reference index. This is calculated over both 5yr and 10yr horizons, using the absolute difference in asset betas. Large differences in results between the indices would make us cautious of the results.
- For the third test, we consider whether the stock has transient or more structural period of negative gearing. As we utilise net debt for our gearing method, it is plausible to have negative gearing. However, in selecting the appropriate adjustment for financial leverage, it creates complications.

The results from these tests are presented in Table 3.5 below.

Table 3.5: Results from data robustness and reliability testing

Company	Test 1	Test 2		Test 3	Assessment
	Max-Min (local)	5yr diff – Euro v local	10yr diff – Euro v local	Negative gearing?	
Elia	0.33	0.03	0.02	No	
Red Electrica	0.24	0.00	0.01	No	
Terna Rete	0.32	0.07	0.06	No	
REN	0.15	0.03	0.03	No	
Enagas	0.23	0.01	0.02	No	
Snam	0.41	0.07	0.06	No	
Enel	0.32	0.08	0.08	No	
Endesa	0.45	0.00	0.00	No	
HERA	0.33	0.05	0.05	No	
A2A	0.34	0.06	0.05	No	
Fluxys	0.19	0.00	0.00	No	
Transelectrica	0.61	0.51	0.40	Yes - structural	

Source: Bloomberg. Note: 'Euro' refers to the Eurostoxx index.

We assess four companies as 'Green' under this metric. For these companies, as with most comparators in the sample, we do not need to concern ourselves with negative gearing. The four companies have variation over time that is towards the low end of UK listed comparators and there is a relatively low sensitivity to the choice of reference index.

There are five further companies with a green/amber rating. While there is moderate variation over time, the sensitivity to the reference index is relatively high. Two companies in particular – Terna Rete and Snam – exhibit relatively consistent trends over time such that more recent beta estimates are generally higher than historic estimates. We reflect on this in our interpretation of the evidence.

We have not sought to judge robustness with reference to the level of our beta estimates. Fluxys is clearly very low, but it is not clear that is driven by a lack of robustness. Transelectrica has a very high beta against a local index, with accompanying issues around volatility over time. As a result, it is challenging to be confident in an estimate of Transelectrica's beta.

3.2.3. Summary – shortlist of comparators

We present the results using our traffic lights scoring approach in Table 3.6 overleaf. We combine the scores against individual criteria into an overall score. There are six companies with an overall green score. These companies form our preferred sample. The companies concerned produce robust empirical estimates based on largely pure play regulated assets and similar regulatory regimes.

Five other comparators generate an amber rating overall. Four of these have low shares of regulated energy network activities, while another, Fluxys, appears to suffer from a low trading frequency that may risk affecting its beta estimates, though the resulting data is not obviously lacking in robustness.

While we recognise that beta estimates are sensitive to sample selection and therefore it can be helpful to be relatively accommodating, overall we do not view the four comparators with the lowest proportion of regulated energy network activities as being likely to improve the robustness or informativeness of our sample. The non-regulated business units of these companies risk distorting the results to the extent that they become uninformative.

We exclude Transelectrica from our samples on the basis of the volatility of its data.

In addition to their objective drawbacks as comparators, both Fluxys and Transelectrica produce beta estimates that are outliers relative to the other comparators. Though we sought not to judge suitability for inclusion on the basis of the level of the resulting beta estimates this would further strengthen the case for excluding Transelectrica. The case of Fluxys is more complex and we recognise that there are arguments for including it.

On balance we consider it unlikely that the six companies with amber and red ratings would improve our interpretation. We therefore exclude all six from our sample, though we present results for the full set of twelve comparators in order to illustrate the overall sensitivity.

Table 3.6: Overall assessment of comparator suitability

Company	Regulated share	Comparability	Liquidity	Data robustness	Overall	Included in Oxera sample?	Included in Frontier sample?
Elia							
Red Electrica						Yes	
Terna Rete						Yes	
REN							Yes
Enagas						Yes	Yes
Snam						Yes	Yes
Enel							Yes
Endesa							Yes
HERA							Yes
A2A							
Fluxys							
Transelectrica							Yes

Source: CEPA analysis.

3.3. RESULTS

In this section we present the asset betas calculated for the companies in our sample, relative to the companies identified by both Frontier Economics and Oxera. We focus on our results from our preferred sample of six companies, and show results using the full set of twelve companies considered to further illustrate sensitivity to sample selection.

We present our results adopting the 0.125 debt beta used by Ofgem in the SSMD in Table 3.7 below. The results for both CEPA samples and the Oxera sample produce slightly lower results using local indices relative to the Eurostoxx index, while the Frontier and full sample produce slightly higher results using local indices. This is primarily a function of Frontier's inclusion of Transelectrica, which has exceptionally high beta estimates relative to its local index.

Table 3.7: Asset beta estimates, with a 0.125 debt beta

Sample	5yr vs local	10yr vs local	5yr vs Eurostoxx	10yr vs Eurostoxx
CEPA preferred (n=6)	0.36	0.32	0.37	0.34
Frontier (n=7)	0.46	0.43	0.41	0.40
Oxera (n=4)	0.40	0.36	0.44	0.40
Full (n=12)	0.40	0.37	0.39	0.36

Source: Bloomberg

Our results using a 0.05 debt beta are shown in Table 3.8. The impact is a slightly lower asset beta for all samples, linked to the lower debt beta assumption.

Table 3.8: Asset beta estimates, with a 0.05 debt beta

Sample	5yr vs local	10yr vs local	5yr vs Eurostoxx	10yr vs Eurostoxx
CEPA preferred (n=6)	0.32	0.28	0.34	0.30
Frontier (n=7)	0.43	0.40	0.39	0.37
Oxera (n=4)	0.37	0.33	0.40	0.37
Full (n=12)	0.37	0.34	0.36	0.33

Source: Bloomberg

As noted in the introduction to this report, the assumption of 0.125 for the debt beta is consistent with Ofgem's working assumption in its SSMD. Evidence on relative gearing and equity betas suggests that it is plausible that the applicable European energy network debt beta would be lower than that assumed for GB regulated networks. We show estimates using a 0.05 debt beta to illustrate the range of sensitivities, though further work on European debt beta estimation would be required in order to judge the appropriate positioning within this range.

3.4. Discussion

In this section we have considered evidence on European energy network beta. Based on this approach, we selected a narrow sample of six preferred European comparators that we considered the best investment substitutes for a GB energy network.

Evidence from these comparators indicates an asset beta for European energy networks in the range of 0.32-0.39. Our preferred sample over the most recent 5yr period would suggest an asset beta of 0.36-0.37, slightly above the midpoint of the range. Though we generally prefer longer horizon estimates, use of the most recent five-year period would guard against lower historical data for some comparators (particularly Terna Rete and Snam) and higher bid-ask spreads in the longer 10yr time horizon.

The range presented above is lower than would be derived used Frontier's chosen sample. Our calculations indicate an asset beta of 0.40-0.46 using Frontier's sample. The inclusion of Transelectrica, a Romanian network with low trading liquidity and volatile beta estimates that we do not consider informative in this context, is a key driver of this difference in ranges. Frontier's sample also includes several companies that have only minority energy network operations and might better be characterised as energy generators and traders.

Our range is also lower than that proposed by Oxera. The set of four comparators selected by Oxera would indicate an asset beta range of 0.36-0.44. While we agree with the relevance of those four companies, we consider that two others – Elia and REN – are equally valid comparators on the basis of their share of regulated energy network activities, comparability of the regulatory regime and data robustness. This accounts for our lower proposed range.

We note that while it includes several companies that we do not consider robust comparators for benchmarking European energy network risk, the full set of twelve comparators under consideration would indicate an asset beta range of 0.36-0.40.

Overall, the evidence from a range of European energy companies appears broadly consistent with Ofgem's SSMD asset beta range of 0.35-0.40. The low end of the range based on our preferred sample sits below Ofgem's range, but this is based on longer-term estimates that may not be representative for two of the comparator companies. The range based on our preferred sample is also similar to our characterisation of the long-term evidence for the GB water comparators.

Finally, we note that the evidence presented in the previous subsection shows that European asset beta estimates are sensitive to the debt beta assumptions chosen. As discussed in the introduction, we have not undertaken a detailed study of debt beta for the European comparators considered but in theory would expect it to vary between sectors, geography and time. From examining corporate data on the companies in our sample (e.g. gearing levels relative to GB regulated networks) it is unclear what the appropriate debt beta assumption should be when seeking to estimate European comparators asset beta compared to the assumption Ofgem has used for GB regulated networks. This issue may warrant further analysis and study.

4. BETA DECOMPOSITION

The two UK listed companies with interests in GB regulated energy networks, National Grid and SSE, each have significant other business interests, meaning they cannot necessarily be assumed to be representative of 'pure play' GB energy network systematic risk exposure. In this context we would expect investors to think of the systematic risk exposure of the group as a weighted average of the systematic risk exposure of its constituent parts.

Ofgem's RIIO-2 sector specific methodology decision drew on a report for Ofgem by Indepen, which highlighted this issue. Two papers were produced in response on behalf of the networks that have been highlighted to us by Ofgem:

- NERA (2019) Review of Indepen report recommendations on beta estimation. Prepared for National Grid.
- Frontier Economics (2020) Beta decomposition. A report for National Grid and SSE.

The Indepen report suggested that decomposed beta estimates might in principle help to refine regulatory determinations, with Ofcom's decomposition of BT's beta cited as an example in regulatory practice. However, the Indepen report also highlighted the strong assumptions required in order to carry out a decomposition analysis and found the analysis to lack robustness as a result.

NERA's response to the Indepen report supported the use of beta decomposition techniques in principle though it did not include a quantitative assessment of its application to National Grid. The Frontier Economics report introduced practical estimates of the inference that could be drawn from National Grid's corporate asset beta, based on assumptions for the remainder of its business units.

This section considers further whether applying techniques to decompose the corporate group betas of these two companies is likely to improve the evidence base available to Ofgem.

4.1. METHODOLOGICAL ISSUES

As noted, we do not disagree with the theoretical relevance of beta decomposition. All three reports referred to in the introduction to this section also highlighted practical challenges in producing and interpreting decomposed beta estimates. We summarise the key methodological issues in this section.

4.1.1. 'Dependent variable' selection

Where a corporate group has multiple business units, in principle any one of those business units can be inferred through a beta decomposition exercise. By definition none of the individual business unit betas is observable. The business unit whose beta is being inferred can be thought of as the 'dependent variable'; the 'explanatory variables' are then comparator-based beta estimates for the other business units and the weightings of each business unit (discussed further in Section 4.1.4 below).

The following formula (in which beta estimates for each business unit 1-n and the Group are designated *ß* and the respective weightings are designated *W*) summarises the relationship:

$$\beta_1 = \frac{\beta_{Group} - \beta_2 * W_2 + \cdots + \beta_n * W_n}{W_1}$$

In principle, any one of the business units can be designated the 'dependent variable'. In the case of National Grid, for example, it is potentially just as valid to consider what beta can be inferred for its US operations based on comparators for its GB operations as it is to consider the beta that can be inferred for its GB operations based on comparators for its US operations.

The equation above has no error term or residual. The decomposition analysis effectively decomposes an observed corporate group beta into an explained portion – based on betas for comparator businesses weighted by some measure of business unit revenue, profit or assets – and an unexplained portion. The 'dependent variable' beta is assumed to take whatever value necessary to account for this unexplained portion.

In practice there will be a range of sources of uncertainty and volatility in all components of the above equation:

- beta estimates for the corporate group and selected comparators will typically be 'noisy';
- comparators for each business unit will be imperfect; and
- the weights used are unlikely to perfectly capture investors' expectations of future cashflows.

A beta decomposition based on the equation above will reflect all such uncertainty and volatility in the 'dependent variable' business unit beta.

Where a business unit has no available comparators, it may be natural to assume that this approach may produce the best available estimate. Where comparators are available for all business units, however, the equation set out above implies a strong judgement that the comparators for the business units labelled *2-n* are significantly more informative than those for business unit *1*.

We bear these issues in mind in producing and interpreting the analysis of National Grid and SSE's betas. We also consider an approach in which comparator evidence for all business units is weighted and then compared to the corporate group beta. While this cannot directly inform a beta estimate for any business unit, it can help to show whether the combination of comparators produces plausible results over the long-term. We discuss this approach further in Section 4.4.

4.1.2. Comparator selection

In order to implement the beta decomposition equation above it is necessary to select appropriate comparators for the business units *2-n*. This selection inevitably entails a degree of judgement. We have applied a structured and objective approach to selecting comparators, informed by those used by advisors to Ofgem and the networks. We outlined our approach to selecting European comparators in Section 3.2; our approach to selecting US comparators for the purpose of decomposing National Grid's beta is summarised in Appendix B.

4.1.3. Debt beta

In the introduction to this report we noted that, for consistency with Ofgem's own estimation of asset beta in its RIIO-2 draft determinations using UK listed comparator companies, we have used debt beta assumptions in this report that are consistent with Ofgem's proposed working assumption of 0.125 for GB regulated networks. We have considered the implications of this in particular in relation to the use of US comparator evidence.

In our review of debt beta for the UKRN we referred to a range of different sources of evidence for calculating debt beta assumptions. We also noted that some sources of evidence indicated potential links between debt beta and gearing or equity beta. We have used these potential links to inform a lower debt beta estimate that remains consistent with Ofgem's working assumption for GB networks.

The evidence we have seen indicates that a ten percentage point change in gearing might be expected to result in a 0.06 change in debt beta (at least over some range). With levels of gearing for our US comparators being around 10-15 percentage points lower, on average, than the pure play GB networks, this suggests a debt beta up to 0.09 lower. Equity betas for our US comparators are also lower; if debt betas vary in proportion to equity betas then this too could account for a lower debt beta assumption.

We have not undertaken a full analysis of US corporate or energy network debt betas. However, we consider that the above sensitivities are sufficient to motivate consideration of a lower debt beta assumption of 0.05 for US comparators. We calculate National Grid's corporate group debt and asset betas consistent with this assumption, maintaining an assumption of 0.125 for its GB network business. The results in this section are presented on this basis, but our conclusions are not sensitive to alternative debt beta assumptions for the US comparators.

4.1.4. Business unit weights

In principle decomposition weights should be based on forward looking expectations of cashflows for each business unit. In practice, however, these are unobservable and must be estimated. Proxies based on revenue, operating income and assets are often used.

Table 4.1 below shows segmented information from Bloomberg over different horizons to highlight the proportion of the business represented by the GB regulated entity. There is considerable variation in the inferences that can be drawn. Setting aside data on revenue, which is least likely to be informative given potential differences in profit margins across diverse activities, the share of GB regulated activity for SSE over the past 10 years could be characterised as low as 32% based on assets or 70% based on operating income.

Table 4.1: Segmentation data for National Grid (NG) and SSE

GB regulated share, by metric	NG			SSE		
	Spot FY19	5yr ave	10yr ave	Spot FY19	5yr ave	10yr ave
Revenue	28%	36%	37%	15%	6%	5%
Operating income	36%	51%	56%	49%	69%	70%
Adjusted operating income	38%	50%	55%	74%	53%	47%
Assets	31%	42%	56%	34%	34%	32%

Source: Bloomberg

We focus in our analysis on adjusted operating income as the best available guide of the expected long-term contribution of each business unit. Whichever metric is chosen, it is clear that neither National Grid nor SSE is a pure play comparator. The advantage of considering beta decomposition techniques is that it may allow more informative conclusions to be drawn that reflect the relative importance of the two corporate groups' GB regulated businesses. The main challenge though is that the data available from which to draw these inferences is so volatile.

4.2. Frontier Economics evidence

The Frontier Economics report referred to in the introduction to this section applied beta decomposition analysis to the two UK listed energy networks: National Grid and SSE. Frontier argued that decomposing the betas for National Grid and SSE would produce more robust estimates of GB energy network asset betas than available comparators such as GB water networks. Frontier presented two approaches: a 'direct decomposition' approach and a 'full information' beta approach.

4.2.1. 'Direct decomposition' method

Under the direct decomposition approach, Frontier solve for the GB energy network beta by using the Group betas as the starting point. Comparators are used to proxy the non-GB regulated parts of the Group, using weights based on segmental operating income data from Bloomberg[69].

For National Grid, Frontier identify seven pure-play regulated utilities in the US to proxy National Grid's US operations. For both National Grid and SSE, Frontier uses Centrica only to proxy the unregulated activities.

The approach focuses on both 5yr and 10yr horizons, using daily betas assessed against the FTSE All-Share index for UK listed companies and local indices for other countries. The beta is calculated using the 'excess' return of

[69] Frontier note that their use of total assets for segmentation creates less robust results.

stocks, rather than the total returns of the stocks. There is an assumed debt beta of 0.10 (sensitivity tested using a debt beta of 0.05).

Table 4.2 below reproduces the results from Frontier's direct decomposition approach. On the basis of this analysis, Frontier suggests that Ofgem's use of a simple average of five firms may be underestimating the pure play GB regulated energy beta.

Table 4.2: Results from Frontier's direct decomposition method

	5yr time horizon	10yr time horizon
GB regulated energy beta – National Grid	0.43	0.30
GB regulated energy beta – SSE	0.50	0.44

Source: CEPA reproduction of Frontier results

Two aspects of the direct decomposition results are challenging from an interpretation perspective:

- Over the 10yr time horizon, the GB regulated energy network asset beta is 0.30 for National Grid, but 0.44 for SSE. The SSE asset beta is more than 40% higher than the National Grid asset beta, despite the two companies operating in the same regulatory operating environment.
- Comparing 5yr and 10yr horizons for National Grid shows betas of 0.43 and 0.30 respectively. This approach implies that the period 5-10yrs ago had a low beta of less than 0.2 for the GB regulated energy networks business.

We return to issues of interpretation in Section 4.5.

4.2.2. 'Full information' method

The full information beta approach adopts a regression-based methodology to estimate the pure play betas for each activity separately, based on regressing asset beta estimates for a sample of companies against their segmentation weightings. The principles of the approach are similar to the direct decomposition method and the same time horizons and segmentation weights are used. The dependent variable for the regression is each company's group asset beta, with the weights for each comparator group being the explanatory variables.

Table 4.3 below reproduces the results from Frontier's direct decomposition approach. Although we understand that the results are coefficients from a regression no standard errors were provided. On the basis of this analysis, Frontier again suggests that Ofgem's use of a simple average of five firms may be underestimating the pure play GB regulated energy beta.

Table 4.3: Results from Frontier's full information method

	5yr time horizon	10yr time horizon
GB/European regulated energy networks	0.45	0.39
US regulated energy networks	0.30	0.33
Non-regulated energy utilities	0.50	0.53

Source: CEPA reproduction of Frontier results

Frontier chose to include both GB and European regulated energy networks in a combined sample. While this has the effect of increasing the sample size (which otherwise would include only two companies with GB regulated energy network activities), as shown in Section 3.2.3 we do not agree with Frontier's chosen comparators.

Two businesses – Enel and Endesa – are included in the sample despite significant generation and trading activities that are more central to their business than regulated energy networks. A further example, Transelectrica, is included despite significant issues regarding the robustness and relevance of its beta estimates. Given the particularly high betas reported by Frontier for these three companies (especially Transelectrica, for which Frontier reports an asset beta of 0.73 over a five year period) it is likely that the results for the combined GB/European

regulated energy networks group are significantly inflated by their inclusion. Frontier did not show results separating out the coefficients on GB and European regulated energy networks.

4.3. OUR DECOMPOSITION ANALYSIS

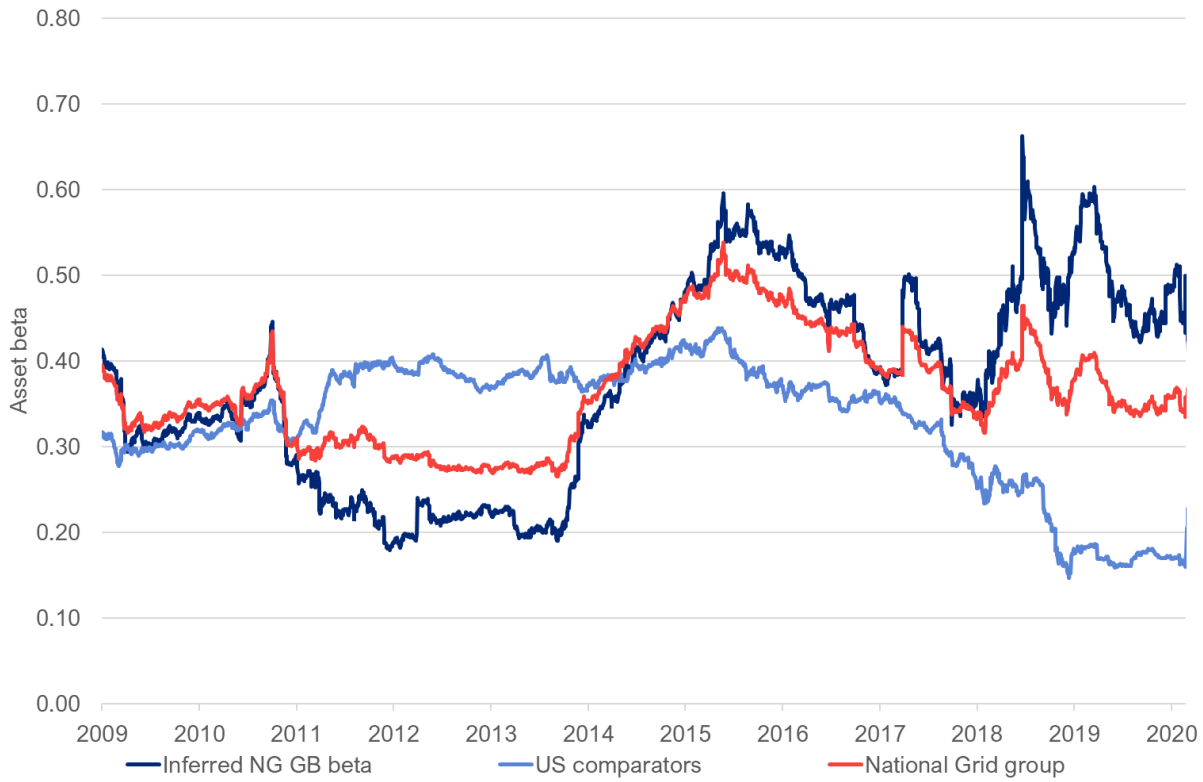
We have carried out our own direct beta decomposition analysis. We have not adopted any major differences in approach to that applied by Frontier Economics. However, given that we reach a different view on comparator selection, use adjusted operating income and apply different debt beta assumptions, our results differ slightly.

We have also considered two alternative variants of the analysis. In principle, any business unit can be made the target of a beta decomposition analysis. We also present an indicative analysis of PPL's GB beta as an alternative variant to the analysis of National Grid.

4.3.1. Estimating National Grid's GB beta

We have sought to treat National Grid's GB regulated business as the dependent variable in the decomposition analysis. This uses the National Grid group beta and US comparators, then infers a GB regulated asset beta based on the relevant shares in the business. Figure 4.1 shows the results with the National Grid corporate group beta and the US comparators shown for context.

Figure 4.1: National Grid decomposition analysis – treating GB as the dependent variable[70]

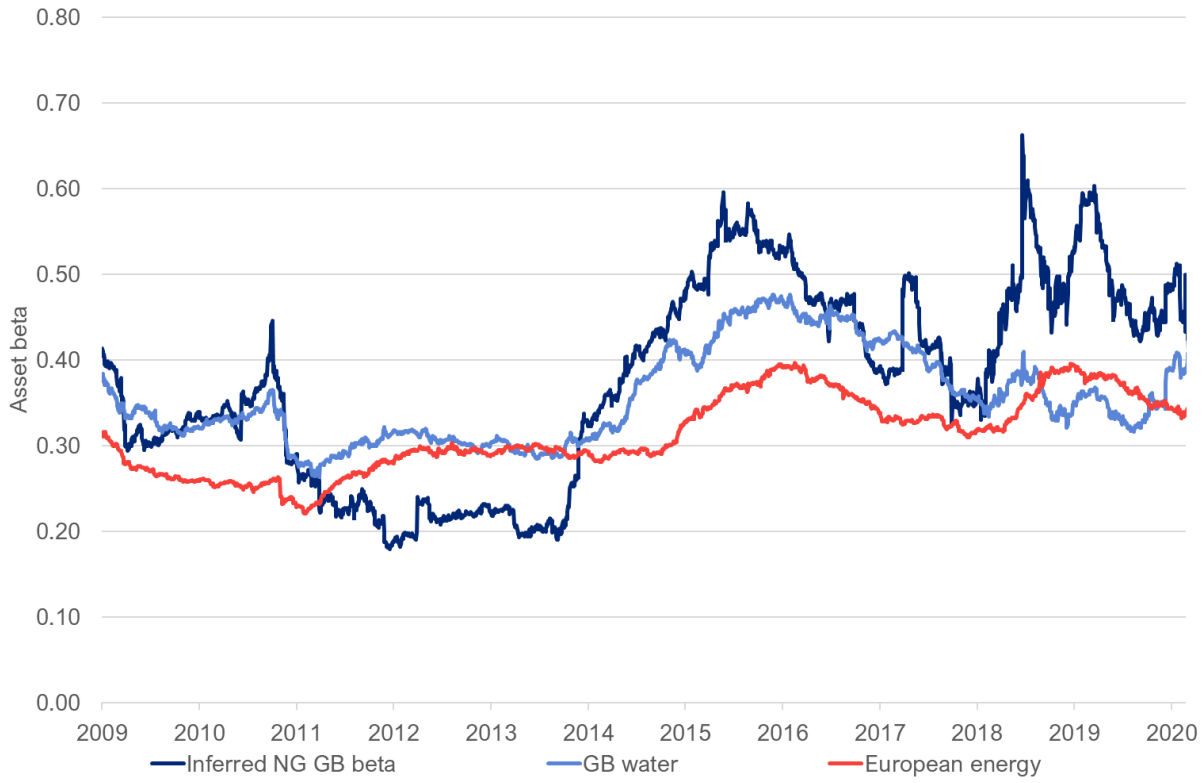


Source: Bloomberg, CEPA analysis.

We compare the inferred GB regulated beta with our GB water and preferred European energy comparators in Figure 4.2 below to provide further context around the results from this decomposition analysis.

[70] The analysis shown for National Grid includes a 0.05 debt beta for US comparators together with a weighted debt beta for National Grid group, reflecting the shares of US comparators and GB regulated energy networks.

Figure 4.2: National Grid decomposition analysis – comparing inferred National Grid GB to other comparators



Source: Bloomberg, CEPA analysis.

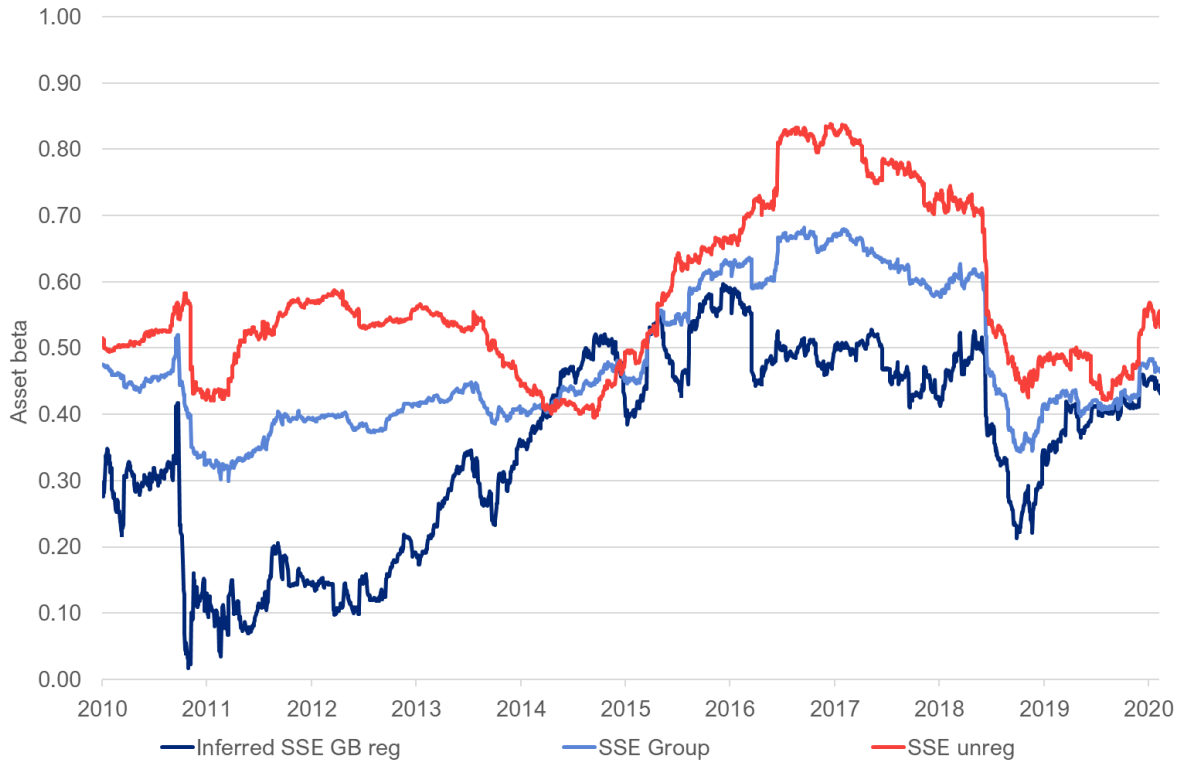
We draw the following conclusions from this comparison:

- Decomposed results are more volatile than either GB water or European energy comparators, spending time both materially below and materially above these other 'investment substitute' comparators.
- On balance over the long-term, our analysis suggests there is no clear evidence that the inferred GB energy network beta is systematically higher than GB water – however there are more pronounced differences based on short-term evidence.
- While the results over certain periods look plausible e.g. 2014-17, there are other periods where the results appear difficult to reconcile:
    - In 2011-14, GB water betas and European betas rose by 0.1, while National Grid's inferred GB beta fell by 0.1.
    - From 2018-20 the inferred National Grid GB asset beta has risen by 0.1-0.25 without any similar trend for GB water networks or European energy networks.

4.3.2. Estimating SSE's GB beta

We have undertaken similar analysis for SSE, with the GB regulated energy beta used as the dependent variable and Centrica used as the comparator for the unregulated business. We have used a 0.125 debt beta for all betas shown for SSE. Figure 4.3 shows the results with the SSE corporate group beta and unregulated comparator shown for context.

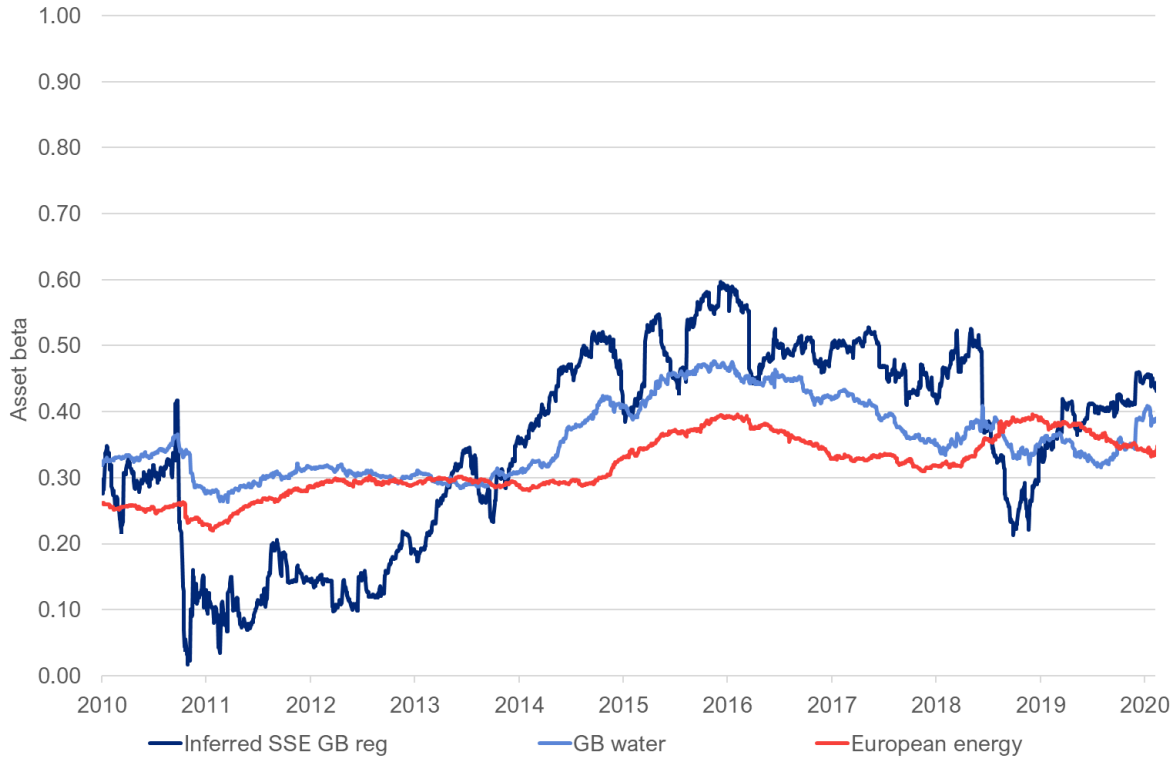
Figure 4.3: SSE decomposition – inferred GB asset beta



Source: Bloomberg, CEPA analysis.

The inferred GB regulated business is close to zero in the early 2010s, before rising to close to 0.60 only five years later. As shown in Figure 4.4 below, the inferred GB regulated beta for SSE is volatile and frequently appears to adopt different trends to both GB regulated water networks and European energy networks.

Figure 4.4: SSE decomposition – comparing inferred GB energy beta with other comparators



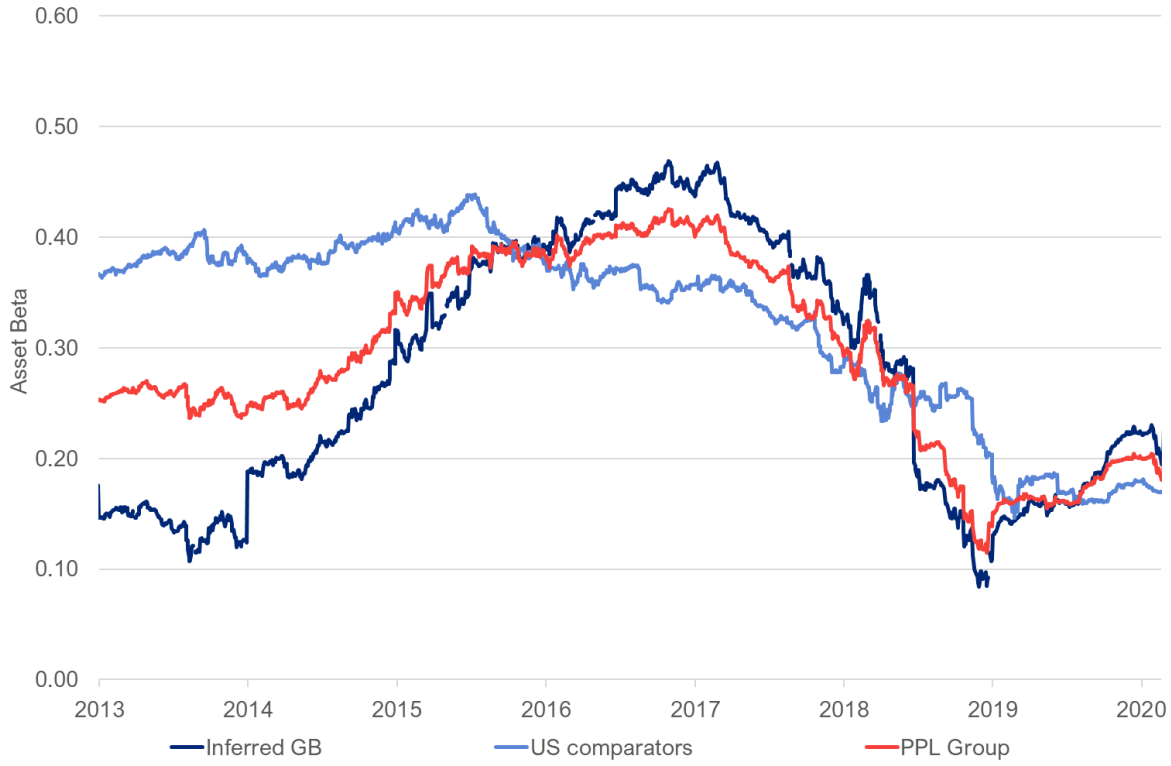
Source: Bloomberg CEPA analysis.

4.3.3. Estimating PPL's GB beta

PPL is a US-listed company, with regulated US and GB energy assets[71]. While the PPL beta is generally not used in GB regulatory determinations as a result of a traditional focus on UK-listed comparator companies, the share of GB regulated networks in pre-tax income, net income and adjusted net income continue to be above 50%. The share for the GB regulated business is comparable to or even higher than those observed for National Grid and SSE. We consider PPL to be a useful additional data point to consider, although the results should be considered illustrative and as a prompt for further discussion, particularly given its US listing.

Our analysis for PPL follows the same approach as with National Grid group to arrive at an inferred GB regulated energy asset beta. We use the same comparator set as with National Grid for PPL's US operations, focusing on the period from 2013, after when PPL had divested its supply operations. Figure 4.5 shows our results.

Figure 4.5: PPL decomposition – inferred GB asset beta[72]



Source: Bloomberg, CEPA analysis.

We find that the inferred GB beta is significantly different to what we have found for National Grid and for SSE. The inferred GB regulated energy business is materially lower than our GB water network comparisons, particularly in the most recent two-year period.

4.3.4. Summary

In the subsections above, we have carried out our own sensitivity analysis of the inferences that might be drawn from direct beta decomposition analysis of National Grid and SSE's group betas. For consistency purposes, we have not adopted any major differences in approach to that applied by Frontier Economics.

[71] PPL owns Western Power Distribution (WPD).

[72] As with our analysis for National Grid, we use a 0.05 debt beta for US comparators and a weighted asset beta for PPL group, using a regulated GB energy networks debt beta of 0.125.

Overall, across the three sets of comparators we do not get consistent stories when trying to solve for a dependent variable – i.e. the asset beta of the GB energy network regulated business. We consider it is challenging to draw robust implications from this analysis, although as discussed above we support the theoretical relevance of beta decomposition in setting an allowed rate of return in RIIO-2.

Given these practical issues, two possible conclusions might be drawn. While theoretically justified, the assumptions required in decomposition analysis and the volatility of the results, mean that Ofgem would not be justified in placing significant weight on the results in its determinations for RIIO-2 despite the further work undertaken by the networks and their advisors. This would echo the conclusions of the Indepen beta study in 2018 that suggests further work is needed to allow decomposition analysis to inform regulatory determination.

An alternative interpretation is that, taken at face value, the direct decomposition evidence is consistent with energy network betas having risen substantially since 2018, to above 0.4. However, this increase has not been accompanied by increase in other comparators, such as GB water or European energy networks. Accepting this interpretation would also imply that GB energy network betas were as low as 0.2 from 2011-2014.

This recent trend is not universally indicated. The increase in GB energy network betas results only from decomposition of National Grid's corporate group beta. The decomposition of SSE's beta implies that GB energy network betas fell in 2018 before recovering, and our illustrative decomposition of PPL's beta implies that GB energy network betas fell in 2018 and remain at very low levels.

We return to these points of interpretation in the discussion of our conclusions in section 4.5.

4.4. RECONSTRUCTING CORPORATE BETAS

In order to make the best use of the available data on National Grid and SSE's beta we have also considered an alternative approach in which corporate group betas are used as the basis for hypothesis testing – rather than as the basis for a mechanistic derivation of a specific business unit beta. Though the resulting conclusions are less directly applicable – we do not obtain a direct estimate of the GB regulated energy network asset beta – they may better capture the effect of measurement error and volatility. We summarise our approach in the following section.

4.4.1. Approach

In this section we set out an approach to hypothesis testing through reconstructing National Grid and SSE's corporate betas, building on the approaches discussed above. We adopt the same fundamental grounding as the other analyses discussed above in that we use weights for different parts of the business and use comparator companies to assess risk for those different business segments.

Overview

As well as potentially informing a direct estimate of the asset beta for GB regulated energy networks, the beta decomposition analysis addresses two interrelated questions:

- Are group betas for National Grid and SSE good proxies for GB regulated energy networks?
- Are GB water networks or European energy networks a good proxy for GB regulated energy networks?

Our approach involves creating 'reconstructed' corporate group betas using weights and comparators. This contrasts to a direct decomposition analysis in that we do not solve for any particular business unit beta. This means that the reconstructed corporate group beta is not constrained to be equal to the measured corporate group beta; where there is a difference between the two this approach makes no judgement (and offers no guidance) as to which (if any) comparators or weightings might be mis-specified.

We also present results of our analysis on a time series basis to better identify periods when there are deviations between our constructed betas and actual company betas.

Other assumptions contained within our analytical framework are as follows:

- We conduct analysis on asset betas to control for differences in leverage.
- We present two-year rolling daily beta estimates, using OLS regressions.
- We use the FTSE All-Share Index as a relative index for UK stocks, and local indices for European and US stocks.
- Our US comparator asset betas are de-levered using an asset beta of 0.05; our conclusions are not sensitive to this assumption.

We focus on National Grid and SSE, though we note that Pennon also has a material proportion of the business (prior to the sale of Viridor) with unregulated assets. Beta decomposition is possible for Pennon; the asset beta for Pennon has been 0.03 and 0.04 higher than the average Severn Trent and United Utilities betas over the previous five and ten years respectively.

Comparator selection

For National Grid, we use the following comparators:

- GB regulated energy networks business – proxied either by the three listed GB water networks or our European energy networks sample (see Section 3).
- US comparators – proxied by a sample of five US listed energy companies (discussion of comparator selection is contained within Appendix B, following similar tests for our European comparators).
- National Grid Ventures and other businesses – we use a fixed asset beta of 0.75 as a proxy for these activities, to broadly reflect market risk[73]. National Grid Ventures contains a variety of businesses that we do not think can be accurately proxied, including interconnectors (operational and in construction), metering, LNG, large scale US renewables, property and venture capital funding.

For SSE, we use the following comparators:

- GB regulated energy networks business – proxied either by the three listed GB water networks or our European energy networks sample (see Section 3).
- Other businesses – we use Centrica as the proxy for SSE's other activities (as per the approach taken by Frontier). The unregulated business primarily included energy retail supply over our time horizon, therefore we consider Centrica to be a reasonable proxy for the sample period[74].

Weights

We consider that profit metrics are likely to represent a better basis for applying weights to the different business segments compared to revenues or assets. This is consistent with the Frontier approach. However, there can be one-off factors that mean this is less representative of underlying trends and forward-looking value. We use adjusted operating income as the basis for weightings.

[73] We estimate non-financial gearing on the FTSE100 index of 28.8%. With a 0.125 debt beta and a 1.0 equity beta to reflect the market, we obtain a 0.75 asset beta. With a low proportion of profits from this part of the National Grid business, this assumption is unlikely to lead to large scale variations in the constructed asset beta.

[74] With SSE's sale of its retail arm to OVO energy, in future Centrica is less likely to be a relevant proxy for SSE's unregulated activities.

4.4.2. Results

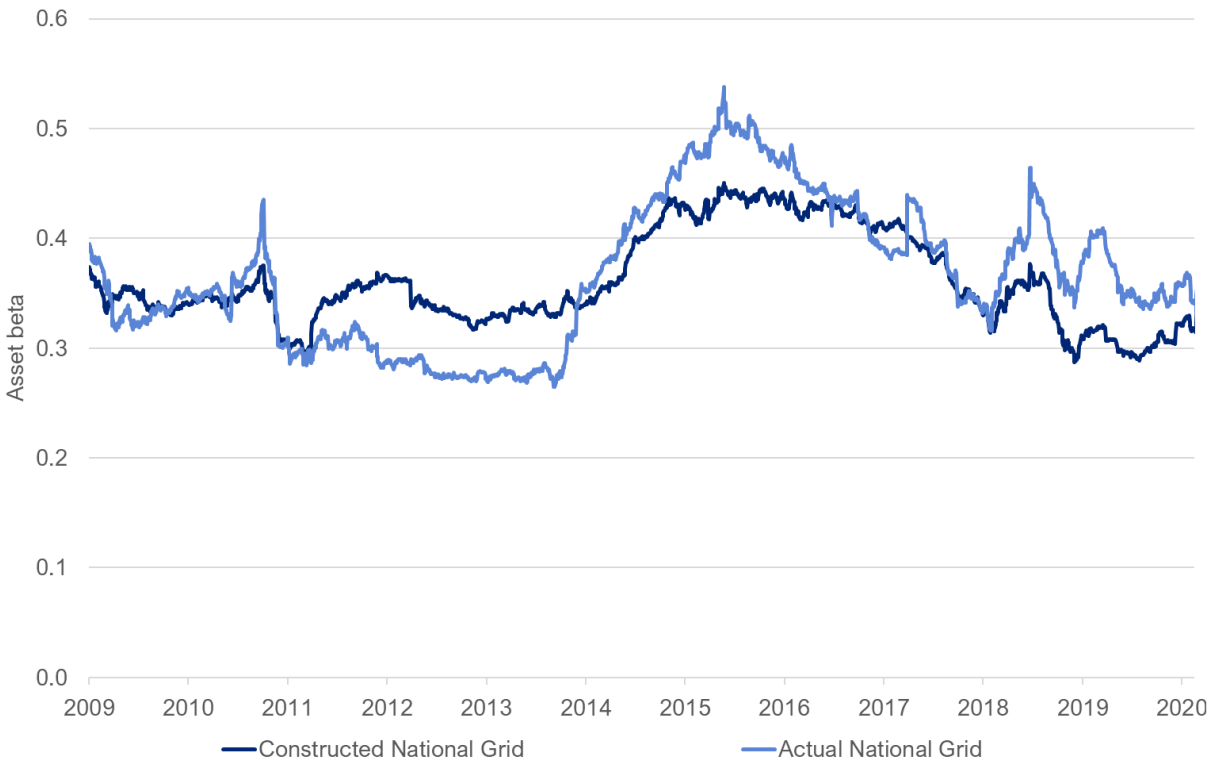
Our results are shown separately for National Grid and SSE. We show results using both GB listed water companies and European energy networks as alternative proxies for the GB regulated energy networks businesses.[75] The results include charts showing how our constructed asset betas, using the choices discussed above, compare to the actual asset betas of both National Grid and SSE. Where the two series are close to one another over a sustained period of time, this may suggest that the combination of comparators and weights shown is a reasonable approximation of the corporate group.

We consider beta estimates over both 5yr and 10yr horizons. Our preference is to focus on the longer-term horizon, as we consider that short-term 'noise' is more likely in our 5yr average. However, we reference the shorter time horizon to consider the possibility of a structural change in risk for the business.

National Grid

Figures 4.6 and 4.7 below show our reconstructed National Grid corporate group beta using GB water networks and European energy networks respectively as proxies for GB energy networks. We use our preferred sample of European energy network comparators.

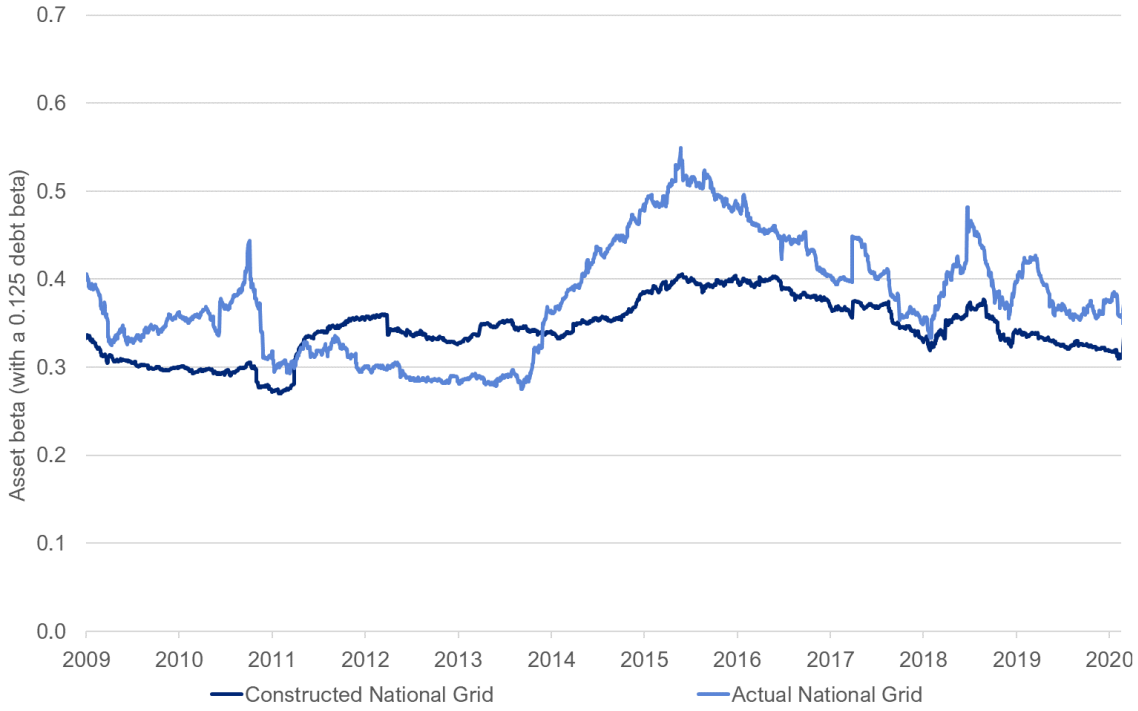
Figure 4.6: National Grid beta reconstruction (using GB water networks)



Source: Bloomberg, CEPA analysis

[75] Further information on the asset betas of our comparator groups can be found in Appendix C.

Figure 4.7: National Grid beta reconstruction (using European energy networks)



Source: Bloomberg, CEPA analysis

Table 4.4 summarises the results over 5- and 10-year time horizons. Over a 10-year horizon the constructed beta using GB water comparators is very close to (0.01 below) the National Grid corporate group average beta. The constructed beta using European energy comparators is lower, particularly over the shorter-term, reflecting the 2014-17 period.

Table 4.4: National Grid beta reconstruction – summary

Asset beta	5yr average	10yr average
Actual National Grid Group	0.41	0.37
Constructed National Grid Group (GB water comparators)	0.37	0.36
Constructed National Grid Group (European energy comparators)	0.35	0.34

Source: CEPA analysis

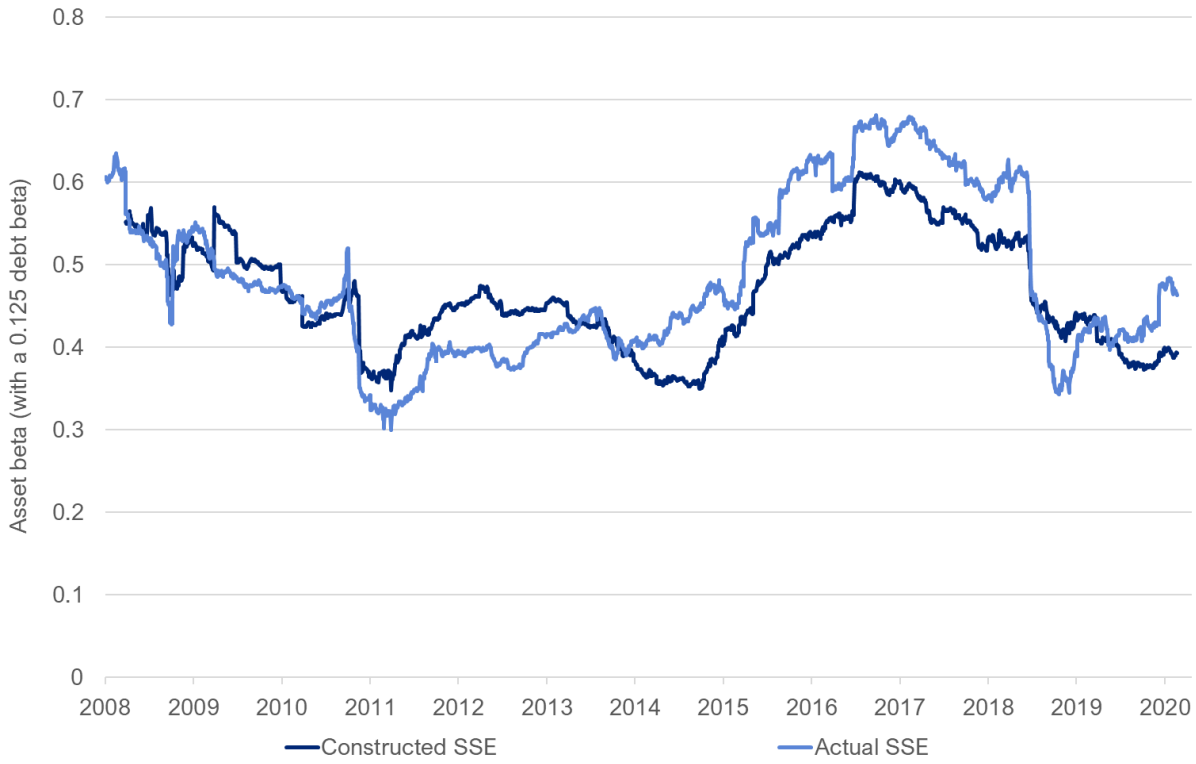
SSE

Figures 4.8 and 4.9 below show our reconstructed SSE corporate group beta using GB water networks and European energy networks respectively as proxies for GB energy networks. We use our preferred sample of European energy network comparators.

Figure 4.8: SSE beta reconstruction (using GB water networks)

Source: Bloomberg, CEPA analysis

Figure 4.9: SSE beta reconstruction (using European energy networks)



Source: Bloomberg, CEPA analysis

Table 4.5 summarises the results over 5- and 10-year time horizons. Over a 10-year horizon the constructed beta using GB water comparators is equal to the SSE corporate group average beta, with the constructed beta using European energy comparators being slightly (0.02) lower. As with National Grid, constructed beta averages over the shorter time horizon are below those observed.

Table 4.5: SSE beta reconstruction – summary

Asset beta	5yr average	10yr average
Actual SSE Group	0.55	0.48
Constructed SSE Group (GB water comparators)	0.52	0.48
Constructed SSE Group (European energy comparators)	0.50	0.46

Source: CEPA analysis

The correspondence over time between the constructed and actual SSE beta time series appears relatively strong based on either GB water or European energy comparators.

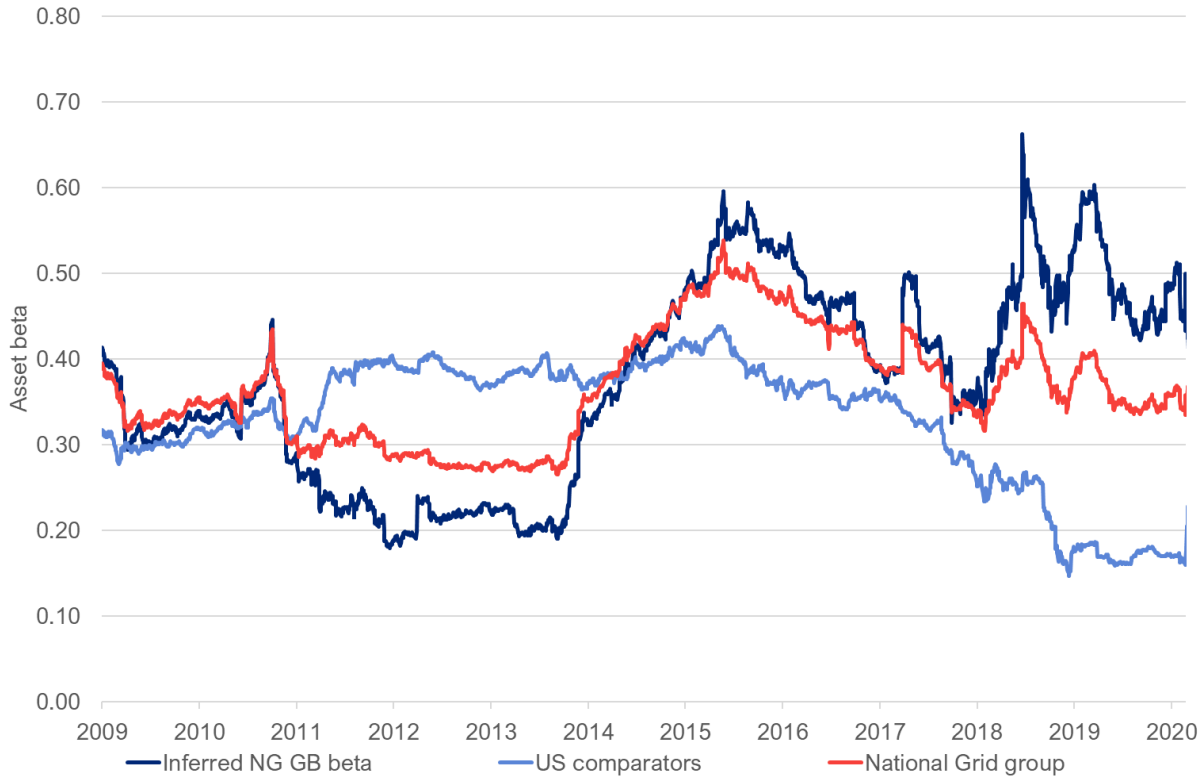
4.5. Discussion

We consider that the principles of beta decomposition analysis are consistent with how investors would think about the asset beta of a portfolio business. The primary question we have sought to address in this section is the weight that can be attached to such analysis and its implications.

There are practical challenges inherent in carrying out beta decomposition analysis. The results are affected by estimation choices such as the choice of business unit comparators and weightings. The direct decomposition results will tend to produce volatile beta estimates, as any noise, volatility or measurement error in comparator beta measurements and weightings will directly impact the resulting estimates.

As discussed above, direct decompositions of National Grid and SSE's asset beta may appear to show GB energy network beta estimates above those observed for either GB water networks or European energy networks, and potentially above Ofgem's proposed asset beta range for RIIO-2. Figure 4.10 (based on our own decomposition analysis) shows the relationship between National Grid's corporate group beta, the average of the US comparator betas and the implied National Grid GB energy networks beta.

Figure 4.10: Presentation of asset betas by groups within decomposition analysis



Source: Bloomberg, CEPA analysis.

A number of features of the estimates stand out:

- The implied GB energy networks beta is highly volatile, particularly over the past two years, with frequent increases of more than 0.1 over short periods.
- Extreme implied betas for the GB energy networks business unit are not unusual. For a sustained period around 2011-14 the implied GB energy networks beta was around 0.2.
- Beta estimates for the US comparators dropped significantly in late 2018, from around 0.3 to around 0.2. Though the National Grid corporate group beta appeared to vary with the US comparator betas prior to that point, the late 2018 drop was not reflected in any sustained change in the National Grid corporate group beta. One implication of this was a significant increase in the implied GB energy networks beta.

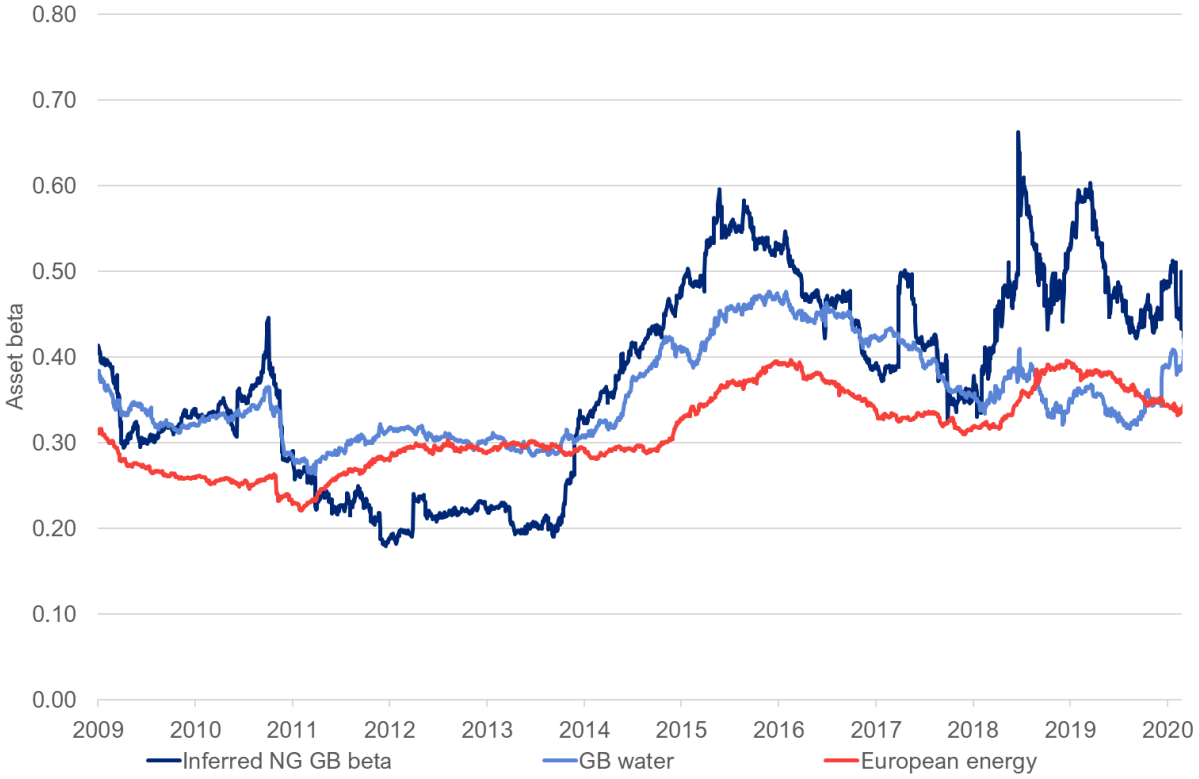
These features appear to be reflected in Frontier's decomposition-based estimates of National Grid's GB energy networks business unit beta. Over the shorter-term (a five-year horizon) Frontier estimates an asset beta of 0.43; over the longer-term (a ten-year horizon) the corresponding figure is 0.30. It is hard to reconcile such volatile evidence into a consistent estimate.

Implications can vary between different companies as well as over time. Frontier's evidence based on SSE's corporate group beta indicates a GB energy networks asset beta of around 0.50 in the short-term and 0.44 over the longer-term. Our own evidence from SSE's beta appears more consistent with a lower estimate both in the short-term and over the longer-term – though our estimates are highly volatile and, ranging from close to zero to above 0.5 for short periods. We have carried out a similar illustrative analysis of PPL's corporate group beta, which indicates a much lower GB energy networks asset beta of 0.28-0.31.

These wide variations in results and implications in our view indicate that a low weight should be ascribed to this evidence, even though beta decomposition has strong theoretical underpinnings.

We have also considered how the implied GB energy network betas based on direct decomposition analysis relate to other potential comparators such as GB water networks and European energy networks. Figure 4.11 below summarises this evidence based on National Grid's corporate group beta. The sharp increases in the implied beta of National Grid's GB energy networks business in 2018 do not correspond with any material changes to either GB water network or European energy network asset betas.

Figure 4.11: Presentation of asset betas for National Grid within decomposition analysis



Source: Bloomberg, CEPA analysis.

This poses a challenge to interpretation. GB water networks are regulated under a similar framework and are based in the same country. European energy networks operate in the same sector, as well as generally being regulated under comparable frameworks and being based in the same region. It is not clear what source of risk could be consistent with these trends. We are more inclined to interpret recent volatility in the decomposition-based estimate of National Grid's GB energy networks business as a consequence of measurement error and volatility in the inputs to the analysis.

Our analysis in Section 4.4 calculated reconstructed beta estimates for National Grid and SSE, using GB water networks and European energy networks as proxies for the GB energy networks business units. Over the long-term the results were plausible, with the reconstructed beta estimates being close to the observed corporate group betas. Where the reconstructed betas sit below the observed corporate group betas, there are four potential explanations (here in the case of National Grid):

1. National Grid's GB regulated energy business may be slightly higher risk than the GB water or European energy comparators.
2. The weights used may not be reflective of the expected share of future cashflows.
3. National Grid's US business may be slightly higher risk than the US energy comparators.
4. National Grid Ventures and other businesses may be slightly higher risk than our proxy for the market.

In order to justify a direct beta decomposition estimate of GB regulated energy betas one would have to place all weight on the first explanation. This entails a strong judgement that the comparators used to proxy National Grid's

US business are materially more informative than those that could be used to proxy its GB business. Based on the evidence available to us we consider that it is difficult to place weight on one particular driver only.

We are therefore cautious about the amount of weight it is appropriate to place on decomposition analysis – particularly where it is summarised over relatively short time horizons. Group level betas can be below their long-term trend value for periods of several years and so we find it unlikely that robust conclusions could be drawn over periods as short as, say, five years.

Over the longer term:

- Frontier Economics' decomposition-based estimates of GB energy network betas ranged from 0.30 (based on National Grid's corporate beta) to 0.44 (based on SSE's corporate beta). This does not appear inconsistent with Ofgem's proposed range or with the range of estimates generated by GB water and European energy network comparators. It is, however, wider than those ranges and aligned with the range the CMA has previously set out for utilities at 0.30-0.45.
- Our reconstructed corporate group betas using GB water networks and European energy networks as proxies appear to correspond reasonably closely to actual measured National Grid and SSE betas.

Bearing in mind the difficulty of drawing robust conclusions from beta decomposition analysis and the alternative interpretations of the results, we do not conclude that these results are inconsistent with Ofgem's proposed asset beta range, nor with the use of GB water networks or European energy networks as proxies for GB energy network betas.

5. CONCLUSIONS

In the absence of pure-play energy network comparators in GB, we considered a range of investment substitutes for a GB energy network under RIIO-2 as sources of potentially relevant evidence for asset beta.

From different perspectives, we conclude that GB water networks and European energy networks share similar characteristics with GB energy networks – though neither group represents a perfect comparator. Both could plausibly act as relevant comparators to equity holders' systematic risk in GB energy networks. Both represent relevant evidence to Ofgem's forthcoming regulatory determination on asset beta. Our analysis suggests an asset beta range of 0.34-0.39 would be consistent with the asset beta ranges of both comparator groups.

While beta decomposition has strong theoretical foundations, and has been used in practice in UK regulatory proceedings, we have discussed a range of practical issues with using the decomposition analysis of National Grid and SSE's group beta, including the volatility of the results and the strength of the assumptions that are required to rely on the resulting estimates of these companies GB energy network asset beta. We consider decomposition analysis relevant evidence, but consider that it at best provides an indication of where Ofgem might consider its point estimate for asset beta should sit within a range relative to the water and European network evidence.

Overall, we consider that the analysis and evidence presented in this report is consistent with Ofgem's judgement of an appropriate asset beta range at SSMD (0.35-0.40) and draft determinations (0.34-0.39) for the RIIO-2 gas distribution and gas and electricity transmission price controls.

Appendix A RELATIVE RISK ASSESSMENT

In this Appendix we include a detailed review of risk across a range of sectors. Our assessment in Chapter 2 is based upon the evidence presented below. The evidence base includes tables providing a description of the drivers of risk in a sector, with charts providing quantitative information across our comparator sectors.

Our risk assessment covers risks faced during a price control, rather than simply the ex-ante expectations of risk at the time of the setting of the price control. Where comparison is to the asset beta set by a regulator ahead of a price control, a distinction may be required to ensure comparability.

The risk assessment analysis we undertake covers the following comparators:

Set 1 comparators

- RIIO2 price control for all networks excluding ESO (not separated by sector)
- RIIO2 for ESO
- RIIO GD1
- RIIO T1
- RIIO ED1

Set 2 comparators

- GDPCR
- TPCR4
- DPCR5

Set 3 comparators

- PR19
- PR14
- PR09
- Q6 for Heathrow only
- RP3

We now present our comparative assessment and comparative data.

A.1. DESCRIPTIONS OF RISK BY PRICE CONTROL

We provide a description of risk by price control in this section. Our comparative assessment of risk is contained within the main body of this report.

Table A.1: Set 1 Risk Assessment: Descriptions

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
Market Risk					
Demand, regulatory framework and political risk	RAB framework with clear licensing. Licences are associated with obligations. Licences have no set expiration, they continue until Ofgem provides a minimum notice period, unless it is revoked. Revenue cap regulation is applied. Switch to CPI/H indexation. Despite significant capex on long-life assets, financial asset stranding risk is low due to regulation in place. Average asset life currently assumed as 45 years across the sectors, although Ofgem have asked the companies to consider asset lives as part of their business plan submissions. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume.	Regulatory regime will provide regulatory protections around assets, which tend to be shorter asset life assets. Revenue cap regulation is applied. Investment tends to involve a greater proportion of opex than other asset intensive regulated sectors, hence a smaller asset base to recover. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume. With shorter asset lives, investment can be responsive to changing needs and less risk for an existing investment.	First price control to be conducted under Ofgem's RIIO model. RAB framework with clear licensing. Licences are associated with obligations/conditions. Revenue cap regulation is applied. RPI inflation indexation with additional adjustment to reflect difference between forecast and actual RPI. Despite significant capex on long-life assets, financial asset stranding risk is low due to regulation in place. Average asset life 56 years for existing assets, and 45 years for new assets. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume.	First price control to be conducted under Ofgem's RIIO model. Electricity Transmission licences have no set expiration, it continues until Ofgem provides at least 25 years notice, unless it is revoked. RAB framework with clear licensing. Licences are associated with obligations/conditions. Revenue cap regulation is applied. RPI inflation indexation with additional adjustment to reflect difference between forecast and actual RPI. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life 20 years for existing assets, and 45 years for new assets. Move for NGET to 45-year asset life, depreciated on a straight line	First price control to be conducted under Ofgem's RIIO model. RAB framework with clear licensing. Licences are associated with obligations/conditions. Revenue cap regulation is applied. RPI inflation indexation with additional adjustment to reflect difference between forecast and actual RPI. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life of 45 years. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume. Labour Party manifesto included nationalisation of utilities.

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
			Labour Party manifesto included nationalisation of utilities.	basis, for new assets. Moves it in line with NGGT, SPTL and SHETL. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume. Labour Party manifesto included nationalisation of utilities.	
Dynamic risk	Future technological change and usage of the network is relevant and increasing in visibility. Examples include the decarbonisation agenda, decreasing gas consumption and the growth of alternative fuels (LNG, biomethane, hydrogen). Distributed generation is also relevant in respect of the operational asset stranding risk of the network. Potential role for increasing competition in the different sectors, more likely in transmission than distribution. Gas network is associated with greater discussion of stranding, with renewable penetration also impacting on electricity networks.	The system operator is likely to retain a role even with any changes to the underlying network. Rapidly changing energy system could result in uncertainty of investment, although short asset lives provide some protection.	Future technological change and usage of the network is relevant and increasing in visibility. Examples include the decarbonisation agenda, decreasing gas consumption and the growth of alternative fuels (LNG, biomethane, hydrogen). Distributed generation is also relevant in respect of the operational asset stranding risk of the network. Future competition seen as less feasible in distribution. Gas network is associated with greater discussion of stranding, with renewable penetration also impacting on electricity networks.	Future technological change and usage of the network is relevant and increasing in visibility. Examples include the decarbonisation agenda, decreasing gas consumption and the growth of alternative fuels (LNG, biomethane, hydrogen). Distributed generation is also relevant in respect of the operational asset stranding risk of the network. Discussion of greater competition e.g. CATO regime and different models e.g. Competition Proxy. Gas network is associated with greater discussion of stranding, with renewable penetration also impacting on electricity networks.	Future technological change and usage of the network is relevant and increasing in visibility. Examples include the decarbonisation agenda and technological change in electricity distribution. Distributed generation is also relevant in respect of the operational asset stranding risk of the network. Future competition seen as less feasible in distribution. Electricity distribution less associated with discussions of stranding.
Price control building block risks					

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
Total expenditure	Ex-ante regime applies with blended incentive strength linked to certainty of cost. Cost allowances set using benchmark data across multiple firms over many years; more relevant for distribution than transmission. Introduced RPE indexation. Greater use of uncertainty mechanisms and pass-through. Stronger link to outputs and deliverables. Company proposals suggest a level of costs broadly in line with RIIO1 costs. More investment to extend or develop the network may exist than routine maintenance activities (especially in transmission). System interaction may also create greater complexity. Relatively low totex-to-RAV ratio, (see Appendix A.2).	ESO is funded through a totex approach with fast and slow money. No totex incentive mechanism and therefore efficiently incurred costs will be passed through. Fast money will be passed through the year it is incurred. Slow money will be added to the RAV and will receive a return for the WACC. Cost allowances set based on scrutiny of the business plan. There is a cost trigger process to aid monitoring. The incentive framework also includes a standalone cost efficiency check on Black Start costs. High totex-to-RAV ratio (see Appendix A.2).	Ex-ante incentive regime. Totex incentives linked to IQI mechanism. Outputs based framework is key element of RIIO framework – allowances linked to defined outputs companies need to deliver. Cost allowances set using benchmark data across the GDNs over many years (both historical and forecast). Notional RPEs set, but not indexed. Greater scale and complexity in investment than water, but not as much as transmission. Annual adjustment for pass through costs. Reopener mechanisms for number of cost areas. Low totex-to-RAV ratio (see Appendix A.2).	Ex-ante incentive regime. Totex incentives linked to IQI mechanism. Outputs based framework is key element of RIIO framework – allowances linked to defined outputs companies need to deliver. Cost allowances set using project level assessments. Uncertainty mechanisms used for cost areas where ex ante allowance not considered most efficiency approach – mainly load related capex. Reopener mechanism in place. Notional RPEs set, but not indexed. Transmission investment has greater scale and complexity than Distribution sectors and water. Revenues/allowances can be adjusted downwards if output levels funded for are not delivered. Medium totex-to-RAV ratio (see Appendix A.2).	Ex-ante incentive regime. Totex incentives linked to IQI mechanism. Outputs based framework is key element of RIIO framework – allowances linked to defined outputs companies need to deliver. Cost allowances set using benchmark data across the GDNs over many years (both historical and forecast) – use bottom-up and top-down totex models and disaggregated activity-level modelling. Ex-ante allowance for RPEs, not indexed. Greater scale and complexity in investment than water, but not as much as transmission. Price control settlement includes uncertainty mechanisms for areas of cost that Ofgem deemed not appropriate to set ex ante allowances. Low totex-to-RAV ratio (see Appendix A.2).
Financing	Indexation for both debt and equity. Use of return adjustment mechanisms considered.	There is an option for Ofgem to include additional funding to account for any risks which cannot be appropriately remunerated through the WACC.	Indexation for the cost of debt (iBoxx 10-year simple trailing average index). Fixed allowance for cost of equity.	Finance elements for RIIO-T1 not consistent across Transmission sector. Fixed allowance for cost of equity.	Indexation for the cost of debt (10-20 years index trailing average for slow-track companies)

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
	No longer proposing to use a cashflow floor.	Bespoke financing arrangements for reflect ESO debt financing.	No return adjustment mechanisms.	Indexation for the cost of debt. Bespoke financing arrangements for transmission companies to reflect timing impacts. No return adjustment mechanisms.	Fixed allowance for cost of equity. No return adjustment mechanisms.
Pensions	Pass-through of Pension Scheme Established Deficits. Subject to triennial revaluation.	Allowances for Pension Scheme Established Deficits will be revisited at three-year cycles.	Deficit recovery - Pass-through of Pension Scheme Established Deficits. Subject to triennial reasonableness reviews. True up of PPF levies and pension scheme administration costs – Introduced a £1m threshold. If annual combined outturn costs exceed the aggregate combined allowances plus £1m threshold, Ofgem will true up excess on an NPV neutral basis. True up adjustments are treated as fast money.	Pass-through of Pension Scheme Established Deficits. Subject to triennial revaluation. True up of PPF levies and pension scheme administration costs – Introduced a £1m threshold. If annual combined outturn costs exceed the aggregate combined allowances plus £1m threshold, Ofgem will true up excess on an NPV neutral basis. True up adjustments are treated as fast money. Decrease in TO regulatory fraction[76] from 56.8% to 52.7% for NGGT.	Pass-through of Pension Scheme Established Deficits: DNO's pre-privatisation defined benefit pension scheme deficits are funded through revenues. Subject to triennial reasonableness reviews. Costs of ongoing pensions, including scheme administration and Pension Protection Fund (PPF) levy costs, are now provided for in the overall totex assessment (no longer set specific allowances).
Other	Incentives exist across the price control, with more muted rates relative to RIIO-1. Current working assumption for the sharing factor with consumers, for over/under	From April 2018 the ESO receives a reward or penalty to be determined based a holistic ex-post evaluation of ESO performance, based on a recommendation by an independent panel of experts and stakeholders. Maximum level set	A relatively high-powered incentive regime applies across a package of expected outputs. The GDN sharing factors with consumers, for over/under performance, ranges from 62% to 64%.	A relatively high-powered incentive regime applies across a package of expected outputs. Move from separate opex and capex incentive rates in TPCR4 to totex.	A relatively high-powered incentive regime applies across a package of expected outputs. DNOs rewarded or penalised for performance through adjustment to allowed revenues.

[76] Element of a licensee's established pension deficit that solely relates to the activity of the transmission business and is, ultimately, funded by customers.

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
	performance, is a range of 15% - 50%. No final decision yet; considering whether to go with the lower of a notional allowance and actual tax payments. Using actual tax payments as the allowance would remove risk associated with this cashflow. An established regime exists with the ability to appeal decisions to relevant competition bodies.	at +/- £30m per annum. This has since been reduced significantly to +£15m to -£6m per annum. Moody's describe it as a "high-powered" incentive mechanism and that the profitability of the SO business has "always been driven by operational incentives". Differences between outturn expenditure and agreed business plan allowances will be considered in the incentives framework. An established regime exists with the ability to appeal decisions to relevant competition bodies.	GDNs rewarded or penalised for performance through adjustment to allowed revenues. Incentives apply to environment, social, customer service, safety, reliability and innovation. Totex incentive rate ranges from 63-64%. Risk is higher for GDN's relative to RIIO-T1. Notional tax allowance set. Tax trigger mechanism introduced. Tax clawback mechanism – timing of the revenue adjustment amended to annually, instead of every three years, to align with the annual iteration process. Regulatory tax losses – where these arise, they are carried forward on a nominal price base until the licensee has enough regulatory taxable profits to use them. An established regime exists with the ability to appeal decisions to relevant competition bodies.	The sharing factor with consumers, for over/under performance, is 44% for NGGT and 47%-50% for ET. Totex incentive rate for SHETL and SPTL is 50%, NGET is 46.9% and NGGT is 44.4%. Lower risk for NGGT and NGET, relative to SHETL and SPTL. License enforcement process is a backstop for areas where there is limited financial incentive associated with delivery failure. TO's performance against expected outputs monitored, generally, on an annual basis. Incentives apply to a higher number of areas for NGET than the gas TO's. Notional tax allowance set. Tax trigger mechanism introduced – dead band calibrated as the greater of a 1% change in the rate of mainstream CT and a 0.33% change in base revenues. These amounts are fixed throughout the price control for each licensee. Tax clawback mechanism – timing of the revenue adjustment amended to annually, instead of every three years, to align with the annual iteration process.	In RIIO-ED1, Totex Incentive Mechanism replaced the DPCR5 RAV Rolling Incentive. The DNO sharing factors with consumers, for over/under performance, ranges from 53% to 70%. Notional tax allowance set. The DNO businesses are modelled, for price control purposes, as standalone entities. All expenditure is treated as though it is directly incurred by the DNO. Regulatory tax losses – where these arise, they are added up and deducted from forecast tax allowances. DPCR5 tax clawback mechanism for excess gearing is maintained for RIIO-ED1. Tax trigger mechanism, introduced in DPCR5, is continued into RIIO-ED1. An established regime exists with the ability to appeal decisions to relevant competition bodies.

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
				Regulatory tax losses – where these arise, they are carried forward on a nominal price base until the licensee has enough regulatory taxable profits to use them. An established regime exists with the ability to appeal decisions to relevant competition bodies.	
Firm Structure					
Mix of fixed and variable costs	No offsetting risks, so no assessment required.				
Asset intensity	Significant asset base reduces fluctuations in profits from changes in revenues and costs (see Appendix A.2).	Sector is relatively exposed to profit fluctuations given mix of revenues (see Appendix A.2).	Significant asset base reduces fluctuations in profits from changes in revenues and costs (see Appendix A.2). The share of operational cashflows has a smaller proportion of return than the previous price controls for these sectors, which means reduced buffer before the value of capital is eroded and increased risk (see Appendix A.2).		
Sources					
	Various Rating Actions Taken on U.K. Gas Networks Amid Upcoming Regulatory Review and Tougher Operating Conditions, S&P Global, 2020. RIIO-2 Sector Specific Methodology Decision – Finance, Ofgem, 2019. RIIO-2 Sector Specific Methodology Decision – Core Document, Ofgem, 2019.		RIIO-GD1: Final Proposals – Overview, Ofgem, 2012. RIIO-GD1: Final Proposals – Finance and uncertainty supporting document, Ofgem, 2012. RIIO-GD1: Final Proposals – Supporting document – Cost efficiency, Ofgem, 2012. Various Rating Actions Taken on U.K. Gas Networks Amid Upcoming Regulatory Review and Tougher Operating Conditions, S&P Global, 2020.	RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas – Final decision – Overview document, Ofgem, 2012. RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas – Financing Supporting document, Ofgem, 2012. RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas – Outputs, incentives and	RIIO-ED1: Final Determinations for the slow-track electricity distribution companies – Overview, Ofgem, 2014. RIIO-ED1: Final Determinations for the slow-track electricity distribution companies – Business plan expenditure assessment, Ofgem, 2014. Reasons for our decision on the treatment of real price effects for RIIO-ED1 slow-track electricity distribution network operators, Ofgem, 2014.

Category	RIIO2	RIIO2 – ESO	RIIO GD1	RIIO T1	RIIO ED1
				innovation Supporting document, Ofgem, 2012. RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas – Cost assessment and uncertainty Supporting document, Ofgem, 2012. RIIO-T1: Final Proposals for SP Transmission Ltd and Scottish Hydro Electric Transmission Ltd – Final decision – Overview document, Ofgem, 2012. RIIO-T1: Final Proposals for SP Transmission Ltd and Scottish Hydro Electric Transmission Ltd – Final decision – Supporting document, Ofgem, 2012. Various Rating Actions Taken on U.K. Gas Networks Amid Upcoming Regulatory Review and Tougher Operating Conditions, S&P Global, 2020. RIIO-GT1 Annual Report 2017-18, Ofgem, 2019. RIIO-ET1 Annual Report 2015-16, Ofgem, 2017.	RIIO-ED1: Draft determinations for the slow-track electricity distribution companies – Overview, Ofgem, 2014. RIIO-ED1: Draft determinations for the slow-track electricity distribution companies – Financial Issues, Ofgem, 2014. RIIO-ED1 Annual Report 2017-18, Ofgem, 2019.

Table A.2: Set 2 Risk Assessment: Descriptions

Category	GDPCR	TPCR4	DPCR5
Market Risk			
Demand, regulatory framework and political risk	RAB framework with clear licensing. Licences are associated with obligations/conditions. Revenue cap regulation is applied. RPI inflation indexation. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life for new assets of 45 years. Energy represents a necessary product with an income elasticity of demand likely below 1.	RAB framework with clear licensing. Licences are associated with obligations/conditions. Electricity Transmission licences have no set expiration, it continues until Ofgem provides at least 25 years notice, unless it is revoked. Revenue cap regulation is applied. RPI inflation indexation. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life of 40 years. Energy represents a necessary product with an income elasticity of demand likely below 1.	RAB framework with clear licensing. Licences are associated with obligations/conditions. Revenue cap regulation is applied. RPI inflation indexation. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life of 20 years. Energy represents a necessary product with an income elasticity of demand likely below 1. Limited demand risk due to nature of product and revenue cap regulation which removes risk linked to price and volume.
Dynamic risk	Future technological change and usage of the network is relevant and increasing in visibility, but not seen as an issue in the immediate future. Potential innovation discussed, but remains untested. Examples include the growth of alternative fuels (LNG, biomethane, hydrogen). Distributed generation is relevant in respect of the operational asset stranding risk of the network. Limited discussion of future competitive changes to the sector. Gas network is associated with greater discussion of future stranding, with renewable penetration also impacting on electricity networks.	Future technological change and usage of the network is relevant and increasing in visibility, but not seen as an issue in the immediate future. Potential innovation discussed, but remains untested. Examples include the growth of alternative fuels (LNG, biomethane, hydrogen). Distributed generation is relevant in respect of the operational asset stranding risk of the network. Limited discussion of future competitive changes to the sector. Gas network is associated with greater discussion of future stranding, with renewable penetration also impacting on electricity networks.	Future technological change in the future seen as relevant to electricity distribution, for example the impact of storage. Distributed generation is relevant in respect of the operational asset stranding risk of the network. Limited discussion of future competitive changes to the sector. Electricity distribution not associated with discussions of stranding to the same extent as the gas network.
Price control building block risks			
Total expenditure	Ex-ante incentive regime.	First price control where gas and electricity transmission were reviewed at the same time.	Ex-ante incentive regime applied on a totex basis.

Category	GDPCR	TPCR4	DPCR5
	Volume driver[77] not included in this price control. Correction mechanism[78] with a two-tier recovery mechanism and deadband of 3%. Reopener mechanism for number of cost areas. Opex allowances set using benchmark data across the GDN's. Capex allowances set through combination of benchmarking across GDN's and bottom-up unit cost and workload analysis. IQI mechanism applied to capex and repex. Notional RPEs set but not indexed. Greater scale and complexity in investment than water, but not as much as transmission. Has a higher totex-to-RAV ratio, compared to other price controls, which means higher regulatory framework risk (see Appendix A.2).	Ex-ante incentive regime. Capex allowance set individually for each network by evaluating the spend needed for the price control period, and then establishing an assumed profile of annual expenditure consistent with the total requirement. Opex allowance set for each licensee through taking a normalised base year of controllable costs, and then considering the scope for efficiency improvements over the price control period. For the Rollover year - Opex allowance set in line with 2010/11 expenditure, adjusted for considered efficiency scope. Capex allowance used forecasts from RIIO business plans. No mention of RPEs. Both Gas and Electricity have uncertainty mechanisms in place for pass-through costs and revenue drivers[79]. Gas have an additional uncertainty mechanism on logged-up costs. Transmission investment has greater scale and complexity than Distribution sectors and water. Has a higher totex-to-RAV ratio, compared to other price controls, which means higher regulatory framework risk (see Appendix A.2).	Network investment (capex) allowance set through combination of benchmarking and trend analysis. Operational activities (opex) allowances set using comparative benchmarking, mainly regression analysis. Notional RPEs set and indexed. IQI mechanism applied to most costs (excludes areas such as business support and pensions). Pass-through costs excluded from RAV calculations. Number of uncertainty mechanisms put in place. Reopener mechanism for number of cost areas. Has a lower totex-to-RAV ratio, compared to other price controls, which means lower regulatory framework risk (see Appendix A.2).
Financing	Fixed allowance for both cost of equity and cost of debt. No return adjustment mechanisms.	Fixed allowance for both cost of equity and cost of debt. No return adjustment mechanisms.	Fixed allowance for both cost of equity and cost of debt. No return adjustment mechanisms.

[77] In the previous price control, 35% of allowed revenues varied with gas throughput. This throughput-based revenue (volume) driver was in place to account for opex costs increasing as overall capacity requirements of the network increased.

[78] Adjusts the price control for any over/under recovery against allowed revenues in the previous price control.

[79] Allow for revenues to be adjusted automatically as network user requirements become known.

Category	GDPCR	TPCR4	DPCR5
Pensions	Ongoing pension costs included in operating expenditure, as is pension deficits funding. Any difference between actual and allowed pension costs are corrected for through an ex-post review in the subsequent price control. There is a pass-through for payments to the NTS representing the cost to each GDN of former employees.	Pensions costs considered separately to opex. Allowance made for both ongoing pension costs and future repair of current deficits, with a 10-year notional deficit recovery period. For the TPCR4 Rollover year, pension deficits were funded over a 15-year period. The extent to which pension contributions differ from the pension allowances is offset against actual future pension costs in determining future pension allowances.	Pension deficit funding allowance - covers the DNOs full pension deficit costs, with a 15-year notional deficit repair period. Ongoing pensions costs set to allow DNOs to recover full ongoing pension cost projections. DNOs will carry 20% of any overspend, above the upfront allowance, and keep 50% of any underspend. Introduced a trigger mechanism to undertake a full efficiency review of historical pension liability costs ex post.
Other	Incentive regime applied to counteract any perverse incentives from RPI-X regulation. The sharing factor with consumers, for over/under performance, ranges from 33% to 36%. Incentives are rolling. Incentives applied to costs are capex rolling, mains replacement, capacity outputs and loss of meter work revenue driver. Opex rolling incentive not applied to this price control. Notional tax allowance set. Regulatory tax losses carried forward, on a nominal price base, until the licensee has sufficient regulatory taxable profits to use them. Additional tax shield benefits clawed back ex-post. An established regime exists with the ability to appeal decisions to relevant competition bodies.	Innovation Funding Incentive introduced in this Price Control for both gas and electricity sectors. Both sectors have an incentive on efficient capex, with a sharing factor of 25%. Electricity Transmission also have a system performance incentive. Gas Transmission also have an entry capacity and offtake incentives. Incentives remained unchanged for the Rollover year. Notional tax allowance set, with ex post adjustments made where actual gearing and actual interest expense are higher than assumed levels. Tax clawback mechanism in place – an ex-post assessment to deal with ‘excess’ gearing. An established regime exists with the ability to appeal decisions to relevant competition bodies.	A relatively high-powered incentive regime applies across a package of expected outputs. Incentives based around environment, customers and efficient investment. Most incentive mechanisms have a cap and collar to protect shareholder exposure. The sharing factor ranges from 49% to 55% for the sector. Tax allowance set ex ante. DNOs retain risks and rewards of efficient tax liability management. Tax clawback for excess gearing in place, as per previous three price controls. Introduced a tax trigger mechanism An established regime exists with the ability to appeal decisions to relevant competition bodies.
Firm Structure			
Mix of fixed and variable costs	No offsetting risks, so no assessment required.		
Asset intensity	Significant asset base reduces fluctuations in profits from changes in revenues and costs.		

Category	GDPCR	TPCR4	DPCR5
	The share of operational cashflows for these price controls has a larger proportion of return than RIIO-1, which means more buffer before the value of capital is eroded and less risk (see Appendix A.2).		
Sources			
	Gas Distribution Price Control Review Final Proposals – Decision Document, Ofgem, 2007. Gas Distribution Price Control Review Final Proposals – Supplementary Appendices, Ofgem, 2007.	Transmission Price Control Review: Final Proposals (Decision Document), Ofgem, 2006. Transmission Price Control Review: Final Proposals (Appendices), Ofgem, 2006. TPCR4 Rollover: Final Proposals, Ofgem, 2011.	Electricity Distribution Price Control Review Final Proposals, Ofgem, 2009. Electricity Distribution Price Control Review Final Proposals – Incentives and Obligations, Ofgem, 2009. Electricity Distribution Price Control Review Final Proposals – Financial methodologies, Ofgem, 2009. Electricity Distribution Price Control Review Final Proposals – Allowed Revenues and Financial Issues, Ofgem, 2009. Electricity Distribution Price Control Review Final Proposals – Allowed revenue – Cost assessment, Ofgem, 2009.

Table A.3: Set 3 Risk Assessment: Descriptions

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
Market Risk					
Demand, regulatory framework and political risk	RAB framework with clear licensing. Licences are associated with obligations. Licence continues until the Secretary of State dissolves it – there is no set expiration. RPI inflation. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Base assumption on asset life of 21 years (industry position from Final Determination) for cost recovery; operational lives may be significantly longer. Price cap regulation is applied, meaning water companies face demand risk within the price control. Water represents a necessary product with consensus that demand is inelastic, likely below 1 (study produced for Ofwat suggests it is generally well below 0.5). Income elasticities of demand are likely similar between residential water and residential electricity.	RAB framework with clear licensing. Licences are associated with obligations. Licence continues until the Secretary of State dissolves it – there is no set expiration. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Average asset life varies notably between companies and also waste and water assets. Minimal future developments regarding use of network. Revenue cap regulation is applied. Water represents a necessary product with consensus that demand is inelastic, likely below 1 (study produced for Ofwat suggests it is generally well below 0.5). Income elasticities of demand are likely similar between residential water and residential electricity. Renationalisation threat pronounced during the PR14 price control itself.	RAB framework with clear licensing. Licences are associated with obligations. Licence continues until the Secretary of State dissolves it – there is no set expiration. Partial switch to CPI/H indexation, with 50% RCV indexed to RPI and the remainder plus RCV additions indexed to CPI/H. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Under PR19, water companies are generally protected from volume risk, with a revenue cap regulation applied. However, for certain elements of the price control, such as bioresources activities, Ofwat has introduced some volume risk. Water represents a necessary product with consensus that demand is inelastic, likely below 1 (study produced for Ofwat suggests it is generally well below 0.5). Increasing rhetoric about renationalisation most pronounced in the run up to PR19.	RAB framework exists for firms assessed to have market power and subject to a licence from the CAA. If the licence is not in place, the asset stranding risk increases. Heathrow's current licence came into force in April 2014 and will continue until it is revoked. Airports may be exposed to technological obsolescence risks, but these are likely to be minimal. Despite significant capex on long-life assets, asset stranding risk is low due to regulation in place. Price cap regulation means airports face demand risk within a price control i.e. until reset. Air travel demand elasticity is elastic, and generally higher than electricity, gas and water consumption, so faces higher risk. Air Travel demand is seen as being elastic, with the level of elasticity increasing as the length of travel arises (route/market level elasticity ~1.4). Aviation is also exposed to large non-economic demand shocks, resulting from terrorist attacks, viral epidemics, etc.	NATS licence, unless revoked, runs for 20 years before the Secretary of State can give 10 years written notice that it will be terminated. RAB-based regulation so generally unlikely. However, government has power to terminate the licence with ten years' notice, risking stranding assets not depreciated before then. Shorter life assets can mitigate some of this risk. Average asset life of 20 years. Investment tends to involve a greater proportion of opex than other asset intensive regulated sectors. NERL has full exposure to changes in traffic volumes below 2% - then 30% below 10% variance – and no exposure (i.e. fully protected) from any variances over 10%. NERL can seek additional non-regulated income to offset volume risk, e.g. can provide commercial services via its unregulated arm, NSL. Capacity constraints are less relevant to NERL. Air travel demand elasticity is elastic, and generally higher than electricity, gas and water

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
				Heathrow is capacity constrained, so a buffer exists around demand. Discussion existed around the potential for a negative skew in returns.	consumption, so faces higher risk. Air Travel demand is seen as being elastic, with the level of elasticity increasing as the length of travel arises (route/market level elasticity ~1.4).
Dynamic risk	Technological change and future use of the network not seen as being materially different in the future relative to the past. Future issues could arise due to climate change affecting availability and usage patterns. New charging arrangements to be introduced and discussion of greater future competition across the value chain.	Technological change and future use of the network not seen as being materially different in the future relative to the past. Future issues could arise due to climate change affecting availability and usage patterns. Introduced more competition across the value chain with separate controls. Companies have retail activities, which can increase overall systematic risk, as indicated by Ofwat's financing approach.	Technological change and future use of the network not seen as being materially different in the future relative to the past. Future issues could arise due to climate change affecting availability and usage patterns. Greater competition exists across the value chain. Companies have retail activities, which can increase overall systematic risk, as indicated by Ofwat's financing approach.	Heathrow is subject to a market power assessment, linked to the need for economic regulation. New capacity expansion at Heathrow or other airports can have a significant impact on future cashflows and the value of the airport. Competing transportation services and technology will also impact on value.	With shorter asset lives, investment can be responsive to changing needs and less risk to an existing investment.
Price control building block risks					
Total expenditure	Base service operating expenditure set based on outturn spend in the base year. Bespoke assessments made for enhancement opex. Capital expenditure uses the new Capex Incentive Scheme (CIS). Decide baseline level of spend for each company, compare company forecast to the baseline and use this to calculate the allowance. The provide an outperformance incentive, declining as the ratio of a	Totex approach to cost allowance introduced in this price control. For wholesale, comparative benchmarking used to set totex allowance. Uncertainty mechanism in place for water business rates. Menu regulation for totex – companies make choices that determine revenue allowance and cost sharing rate.	For both wholesale and retail activities, ex-ante regime applies for totex. Incentive strength linked to confidence in business plan (for wholesale). Efficient levels of totex are estimated using benchmark data across multiple firms over many years. Bespoke approach taken to enhancement activities.	Separate treatment of opex and capex. Opex with ex-ante determined costs and capex through an envelope with a governance process, with possible ex-post review. Ex-post efficiency reviews have made relatively few disallowances. For Q5, £30 million of Heathrow's spending was disallowed out of a total of £5 billion in capex spending.	Separate treatment of opex and capex. Opex with ex-ante determined costs and capex through an ex-post approach. New capex governance introduced, but historically the regulator has applied a relatively light touch approach to capex efficiency reviews. Customer engagement is a significant input into setting an opex allowance.

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
	company's forecast to baseline increases. Ex-ante incentive regime in place. Incentive strength linked to accuracy of business plan. Introduced a revenue correction mechanism to remove any risk associated with household demand. Has a medium totex-to-RAV ratio (see Appendix A.2).	Has a medium totex-to-RAV ratio (see Appendix A.2).	For residential retail activities, cost allowances are set purely through benchmarking, with no glide-path provided. For both wholesale and retail, there is little protection for input price uncertainty. Slightly increased totex to RAV ratio relative to previous water price controls (see Appendix A.2).	CAA places greater weight on constructive engagement relative to benchmarking, given available comparators. For opex, limited use of uncertainty or pass through mechanisms. Airports also face risk around commercial revenues. Has a lower totex-to-RAV ratio, compared to other price controls, which means lower regulatory framework risk (see Appendix A.2).	Uncertainty mechanisms apply to traffic risk (see below), unforeseen costs (get added to the RAB) as well as a capex contingency and Opex Flexibility Fund. Has a high totex-to-RAV ratio, of over 45%, which means higher regulatory framework risk (see Appendix A.2).
Financing	Fixed allowance for cost of equity and debt. Have assumed, at an industry level, ratio of existing to new debt is 75:25.	Fixed allowance for cost of equity and debt (varies for enhanced and non-enhanced companies). Have assumed, at an industry level, a ratio of embedded to new debt of 75:25.	Reconciliation around the cost of new debt. Fixed allowance for the cost of equity. Adjustment mechanism applies to disincentivise high levels of gearing.	Fixed allowance for both debt and equity. Embedded debt allowance considers HAL's own company specific costs (not just industry).	Fixed allowance for both debt and equity.
Pensions	Pensions included in opex allowance. Ofwat allowed the full projected ongoing service contributions. Allowed half of the deficit recovery.	Companies able to recover a proportion of their pension deficit repair costs, as per PR09.	Size of pension deficits assessed during PR09, with different companies taking different lengths of time to reduce deficit (with many extending beyond PR14). Half of pension scheme deficits are passed on to consumers, with remainder dealt with through management action or shareholder contributions. Allowances in PR14 and PR19, consistent with PR09 decision.	Pension costs are less substantial than air traffic control. Ex-ante allowance is set and included as part of opex costs, covering all efficient pension deficit recovery costs.	Deficit recovery costs are passed through. Pension costs represent a significant portion of NERL's staff costs (around 25% in RP3). NERL discusses having limited control of future obligations due to PPP legal arrangements.

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
Other	Incentives in place to encourage outperformance. Incentive mechanisms include a performance-related price adjustment. Higher performers can charge customers slightly more, and poorer performers slightly less, through the overall performance assessment incentive (OPA). Sharing factors for the companies range from 15% to 45%. Introduce Capital Expenditure Incentive Scheme (CIS) – each company recovers actual capex plus/minus an incentive allowance dependent upon forecast and actual capex. Operating expenditure incentive allowance. Ofwat took a company-specific approach to tax in the PR09 review. Tax shield on interest – calculate tax using companies actual level of gearing when it exceeds their gearing assumption. If actual gearing is above the assumption underpinning the cost of capital, tax is based on the companies' actual gearing projections in their business plans. If it is below, gearing of 57.5% is used. Tax losses surrendered to group companies without full payment,	Menu regulation provides incentive for companies to reveal accurate and realistic information to Ofwat. Cost sharing incentive - sharing factors for the companies range from 44% to 59%. Wholesale revenue forecasting incentive – encourages companies to manage demand risks. An established regime exists with the ability to appeal decisions to relevant competition bodies.	Two measures introduced for residential retail, customer measure of experience (C-MeX) and developer services measure of experience (D-MeX), building on PR14 incentive regime. Companies receive up to 6% of allowed residential retail revenue outperformance payments and incur up to 12% underperformance payments. Sharing factor for the fast-tracked companies is 50%, and for slow-tracked water companies, the average sharing factor for outperformance is 43% and underperformance is 59%. For wholesale activities, Ofwat has included broader Outcome Delivery Incentives. The RoRE at risk varies by firm, depending on expected performance and characteristics of each company's business plan. Explicit cap on range of return at risk removed in favour of indicative range (RORE ±1 to ±3%). Changes in corporation taxes and business rates are passed through to customers. Includes a mechanism to remove the tax benefit from gearing above 60 per cent.	CAA included Quality of Service incentives. Quality of Service incentives for airports were capped at 7% of revenues, compared with 0.5% to 3% of revenues for companies regulated under PR14 and RIIO1. Tax impacts did not feature in risk analysis during Q6. However, changes to business and rates taxes are passed through to customers. Airports are not protected from demand effects related to changes in aviation taxes. An established regime exists with the ability to appeal decisions to relevant competition bodies.	Several service quality incentives represent a relatively low proportion of costs. Environmental performance in terms of flight efficiency, as a proxy for carbon emissions (3Di). Capped at +/-0.5% of Determined Costs. Capacity incentive mechanisms as follows: C2 metric is asymmetric and ranges from +0.05% to –0.25% of determined costs; C3 metric is asymmetric and range from +0.25% to –0.75% of determined costs; and C4 is penalty only (-0.25% of determined costs). Unforeseen and significant changes in national taxation law are passed through to customers. But there is a mechanism in NERL's licence which removes the tax benefit from gearing above 60 per cent. An established regime exists with the ability to appeal decisions to relevant competition bodies.

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
	since 2005/06, were added back in the base year. An established regime exists with the ability to appeal decisions to relevant competition bodies.		An established regime exists with the ability to appeal decisions to relevant competition bodies.		
Firm Structure					
Mix of fixed and variable costs	No offsetting risks, so no assessment required.				
Asset intensity	The share of operational cashflows has a medium proportion of return (see Appendix A.2). Significant asset base reduces fluctuations in profits from changes in revenues and costs.	The share of operational cashflows has a medium proportion of return, smaller than the previous price control, which means less buffer before the value of capital is eroded and greater risk (see Appendix A.2). Significant asset base reduces fluctuations in profits from changes in revenues and costs.	The share of operational cashflows has a medium proportion of return, smaller relative to previous price controls, which means less buffer before the value of capital is eroded and slightly greater risk (see Appendix A.2). Significant asset base reduces fluctuations in profits from changes in revenues and costs.	The share of operational cashflows has a large proportion of return, which means more buffer before the value of capital is eroded and less risk (see Appendix A.2). Significant asset base reduces fluctuations in profits from changes in revenues and costs.	The share of operational cashflows has a very small proportion of return, which means minimal buffer before the value of capital is eroded and high risk (see Appendix A.2).
Sources					
	Future water and sewerage charges 2010-15: Final determinations, Ofwat, 2009. Setting price limits for 2010-15: Framework and approach, Ofwat, 2009. Water Act 1989, Parliament of the United Kingdom, 1989. The long term potential for deep reductions in household water demand, Artesia Consulting, 2018.	PR14 Final Determinations – Investor Reference Pack, Ofwat, 2014. Final price control determination notice: policy chapter A8 – financeability and affordability, Ofwat, 2014. Final price control determination notice: policy chapter A7 – risk and reward, Ofwat, 2014. Final price control determination notice: policy chapter A3 –	PR19 final determinations: Allowed return on capital technical appendix, Ofwat, 2019. Delivering Water 2020: Our final methodology for the 2019 price review, Ofwat, 2017. Treatment of companies' pension deficit repair costs at the 2014 price review, Ofwat, 2013. PR19 final determinations: Customer measure of experience (C-Mex) and developer services	Review of Heathrow Airport's Q6 Capex Governance Framework, CEPA, 2017. Economic regulation at Heathrow from April 2014: final proposals, 2013. Relative Risk of London Heathrow: A Report for London Heathrow, NERA, 2013. Estimating Air Travel Demand Elasticities Final Report, InterVISTAS, 2007.	Modernising the Licensing Framework for Air Traffic Services: Consultation, Department for Transport, 2016. UK RP3 CAA Decision Document, Civil Aviation Authority, 2019. Estimating Air Travel Demand Elasticities Final Report, InterVISTAS, 2007. Air Traffic Services Licence for NATS (EN ROUTE) PLC, UK Civil Aviation Authority, 2019.

Category	PR09	PR14	PR19	Q6 – Heathrow	RP3 – Air traffic
		wholesale water and wastewater costs and revenues, Ofwat, 2014. Final price control determination notice: policy chapter A2 – outcomes, Ofwat, 2014. Treatment of companies' pension deficit repair costs at the 2014 price review, Ofwat, 2013. Water Act 1989, Parliament of the United Kingdom, 1989. The long term potential for deep reductions in household water demand, Artesia Consulting, 2018.	measure of experience (D-Mex) policy appendix, Ofwat, 2019. Delivering Water 2019: consultation on PR19 methodology – Appendix 13: Aligning risk and return, Ofwat, 2017. PR19 Final Determinations: Securing cost efficiency technical appendix, Ofwat, 2019. Water Act 1989, Parliament of the United Kingdom, 1989. The long term potential for deep reductions in household water demand, Artesia Consulting, 2018.		

A.2. COMPARATIVE DATA ACROSS SECTORS

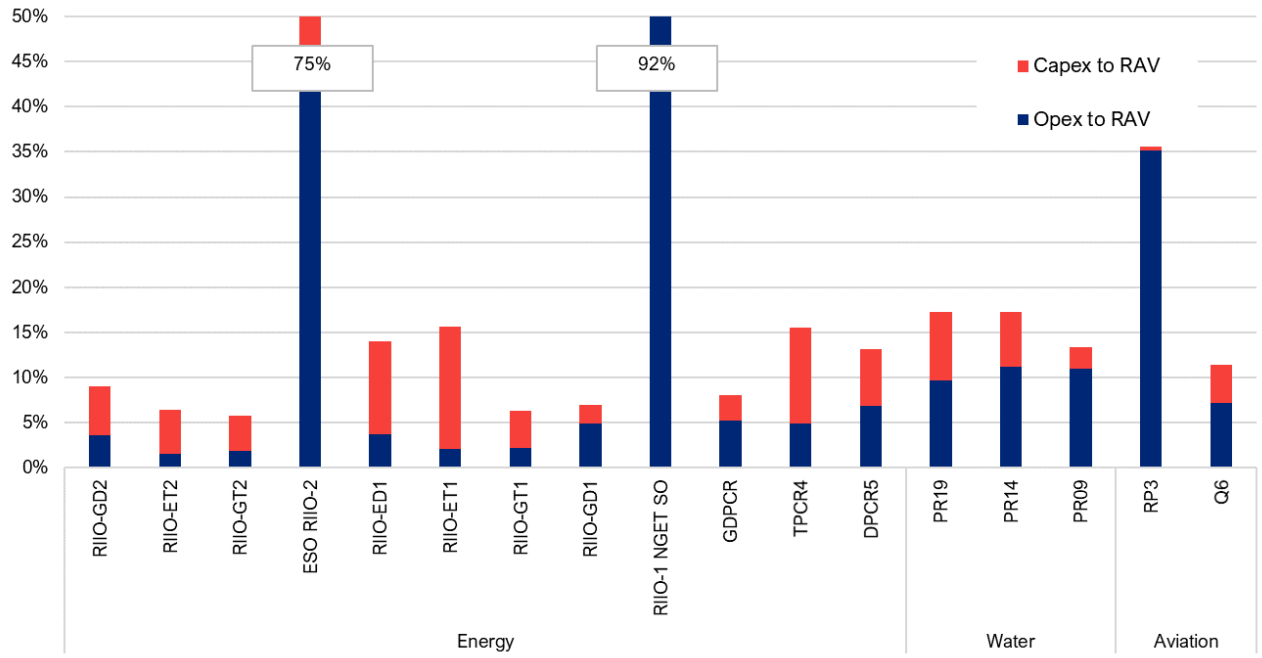
Our descriptive tables include quantitative metrics where possible. In this section, we provide additional quantitative data in relation to three factors:

- Totex-to-RAV ratios: this is relevant for the total expenditure risk category under the regulatory building blocks. The higher the ratio, the higher the risk.
- Share of operational cashflows: this is relevant in relation to asset intensity, captured under firm structure. A greater share of return and depreciation creates a buffer to protect against risk.
- Return on Regulated Equity (RoRE): this is relevant for the regulatory building blocks section, including incentives, totex, financing and other sources of potential outperformance.

A.2.1. Totex to RAV

The totex to RAV ratio is relevant for the total expenditure (totex) risk category. Where a company faces exposure to performance on totex, an extra pound of totex under the same regulatory arrangements creates a risk in the near term. In the longer term, the additional totex creates a larger asset base, therefore impacting on other metrics that we consider.

Figure A.1: Totex to RAV across regulated sectors



Source: Regulatory determinations. RIIO2 based on company submissions.

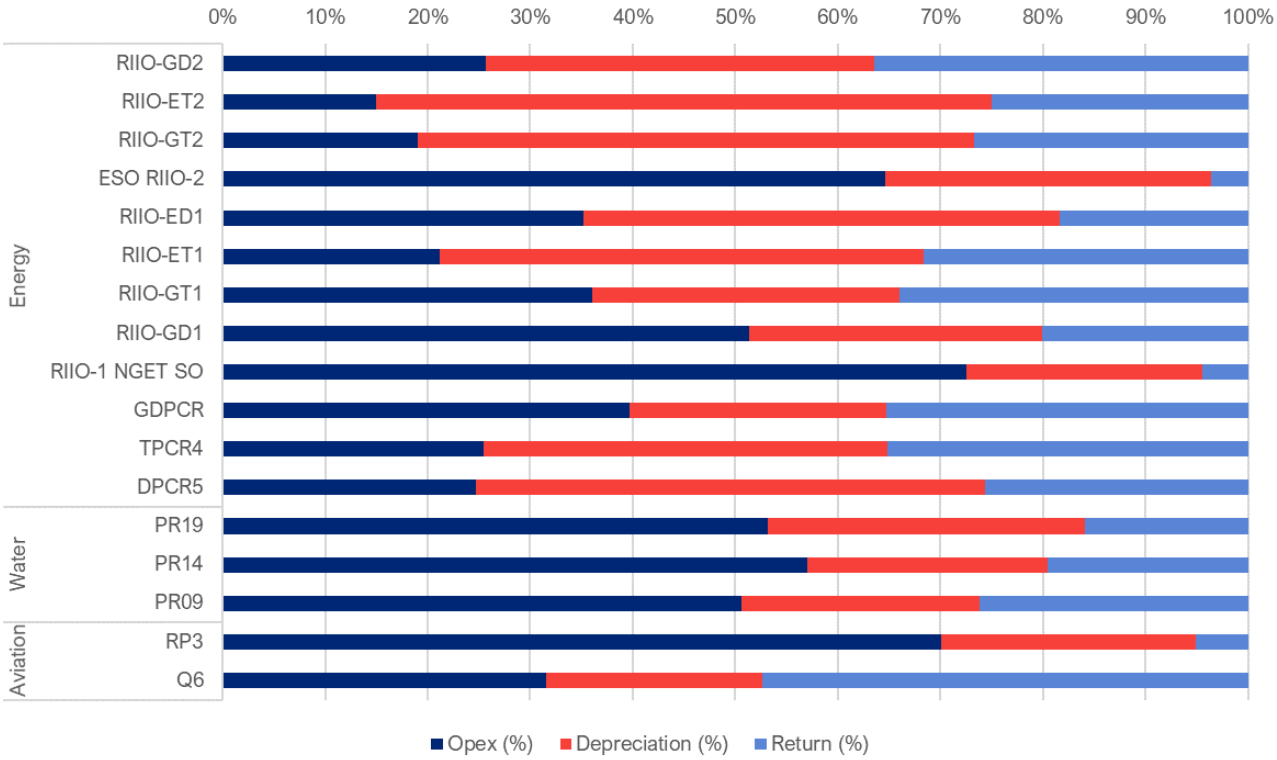
The figures show that the 'asset light' companies of the ESO and NATS in RP3 have significantly higher totex to RAV ratios than other networks being considered. Based on current submissions, RIIO2 figures look broadly comparable to RIIO1 and less than water for PR19.

Totex to RAV is one element of the consideration here, so risks are impacted by other factors e.g. whether an ex-ante or ex-post regime is in place, the incentive strength applied and application of uncertainty mechanisms.

A.2.2. Share of operational cashflows

We are interested in the breakdown of allowed revenues within a price control. Where the proportion accruing to the return is lower, there is less of a buffer before the value of capital is eroded.

Figure A.2: Share of operational cashflows by type



Source: Regulatory determinations. Opex refers to fast money and PAYG equivalents where relevant.

A.2.3. RoRE: expected and outturn

We have considered the Return on Regulatory Equity (RoRE) across sectors. This includes the range set out prior to the price control and then the outturn results. Where values are reported as returns on the asset base, we have converted these into a RoRE equivalent, assuming 60% gearing.

There is a challenge in comparability for anticipated RoRE across sectors and over time in relation to what is considered 'plausible' going into the price controls. This may be explicit e.g. P10/P90 or more implicit.

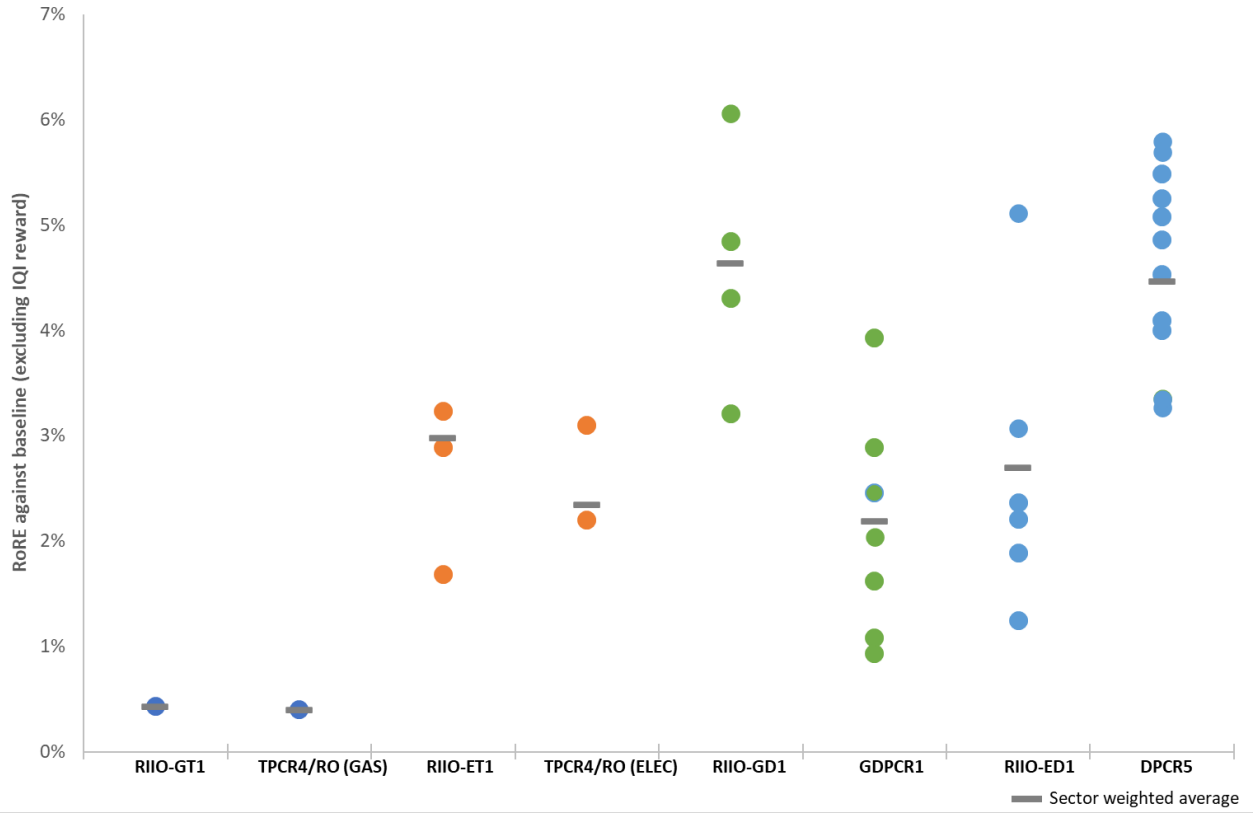
For outturn RoRE, there is less of a concern around comparability, but the outturn values are one outcome from a spectrum of possible outcomes.

Energy

Outturn RoRE

The figures below represent the RoRE from energy price controls. Figures for RIIO1 cover the period up to 2018/19 inclusive.

Figure A.3: Outturn RoRE outperformance from energy price controls



Source: Ofgem data

We are interested in the level of returns only in as much as understanding how different potential outcomes in relation to return may be. The distribution of returns within a sector can be informative, where sufficient data points are available.

We do not see evidence of any companies underperforming and all companies are in a range of 0.4% to 6.1% RoRE outperformance.

Anticipated RoRE

We have also considered the anticipated RoRE at the start of the price control. This includes published ranges.

RIIO2 – SSMD

We understand from Ofgem that financeability modelling has included a +/- 2% RoRE range and that this reflects a plausible outcome for RIIO2.

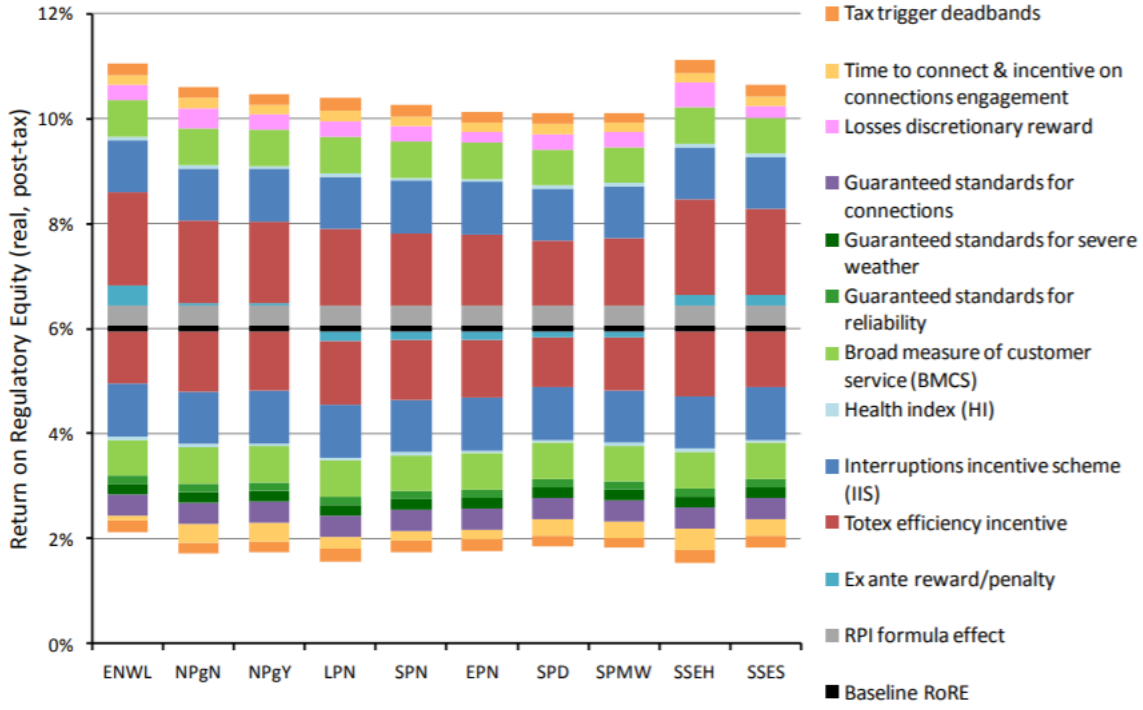
RIIO2 – ESO

We understand from Ofgem that the range of potential financial rewards and penalties are from +£15m to -£6m on an annual basis. This equates to a +5% to -2% RoRE outcome, based on an average RAV of £303m.

RIIO ED1

We present below the ex-ante expectations of RoRE for the RIIO-ED1 price control, as published by Ofgem. The plausible range around the base cost of equity is approximately +/- 4% on a RoRE basis.

Figure A.4: RIIO-ED1 ranges for RoRE

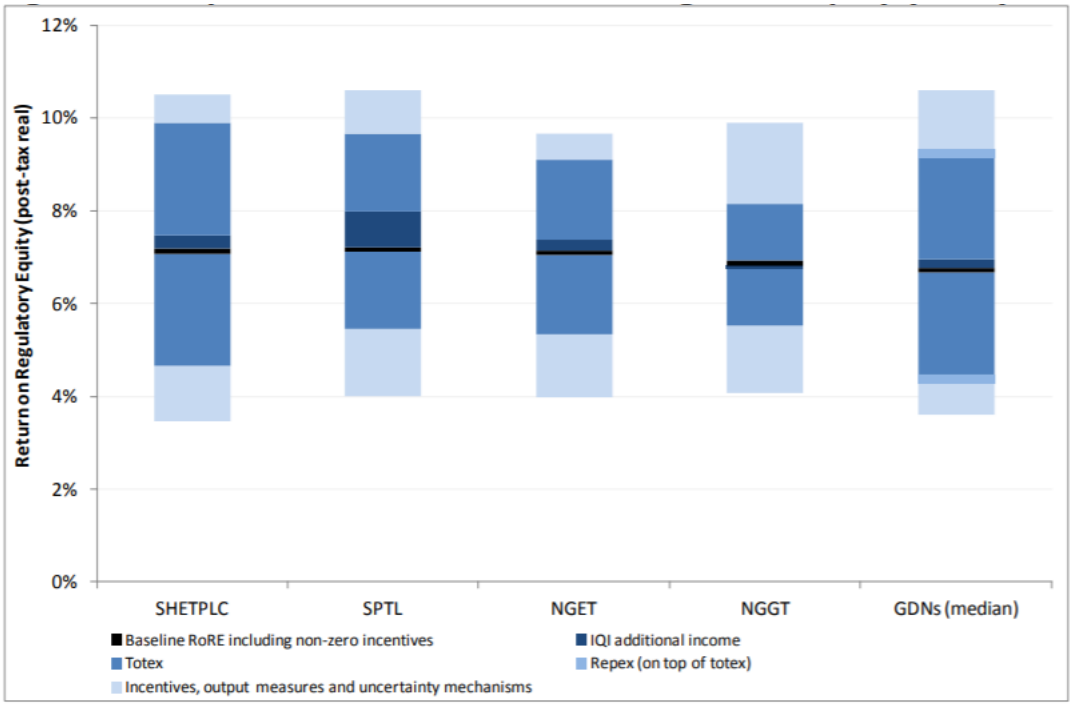


Source: Ofgem

RIIO-T1 and GD1

The figure below shows the expected variation in RoRE for both RIIO-T1 and RIIO-GD1. An approximation of the plausible outcomes highlighted were +/- 3% on a RoRE basis.

Figure A.5: RIIO-T1 and RIIO-GD1 ranges for RoRE

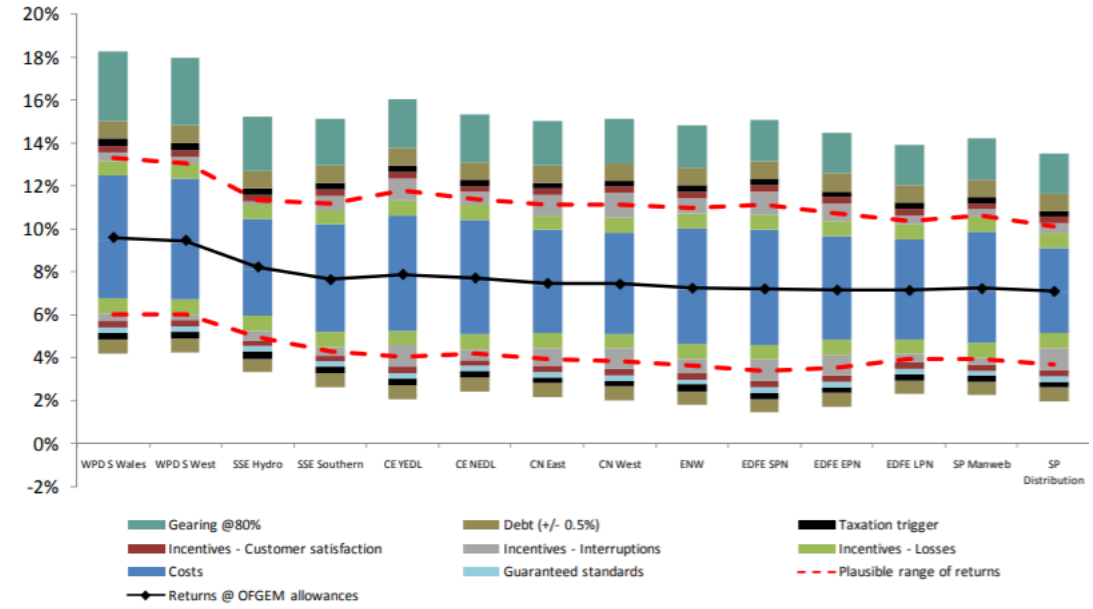


Source: Ofgem

DPCR5

The figure below highlights the expected variations in RoRE for DPCR5. The range was broader than for RIIO-1.

Figure A.6: DPCR5 plausible range for RoRE



Source: Ofgem

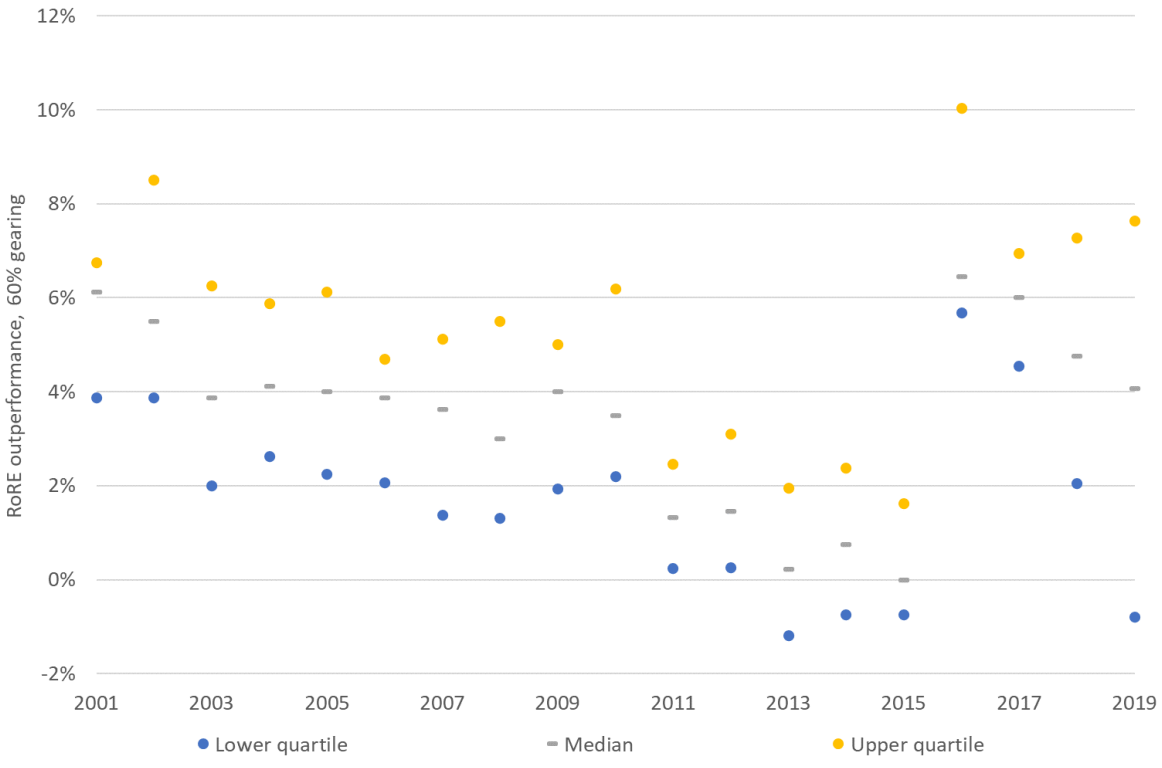
Water

We present similar evidence in the water sector as per the energy sector. Outturn values include annual results.

Outturn RoRE

The figure below shows annual performance on a RoRE basis relative to the base cost of equity. The data was gathered based on Ofwat reporting and using a return on capital measure. We present the lower quartile, median and upper quartile for each year.

Figure A.7: Outturn RoRE outperformance distribution in England and Wales water



Source: Ofwat

Across PR99 to PR09 we saw a gradual reduction in returns, with a typical interquartile range of around 3-4%. However, the evidence became more volatile in the PR14 data that we have available. Outperformance and interquartile range breadth increased significantly.

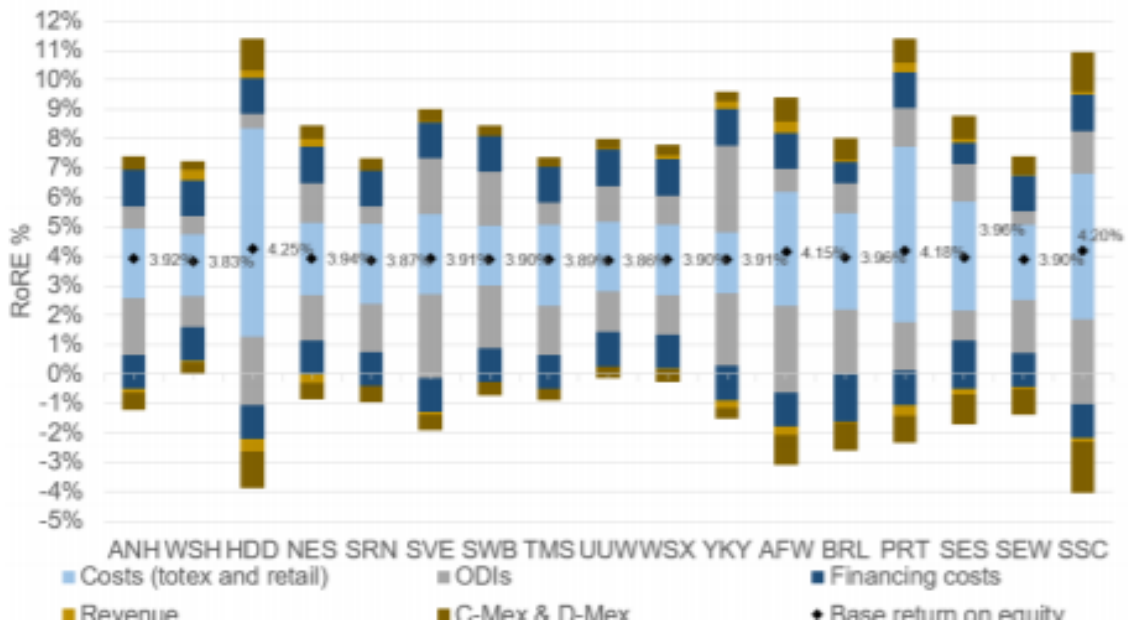
Anticipated RoRE

We present evidence below in relation to expected RoRE ranges in the water sector ahead of price controls.

PR19 Final Determination

The figure below shows the PR19 final determination ranges. There are material differences across firms, with some exhibiting RoRE risk of +/- 3.5% compared to +/- 8% on a RoRE basis.

Figure A.8: PR19 final determination risk ranges, calculated as a percentage of regulatory equity



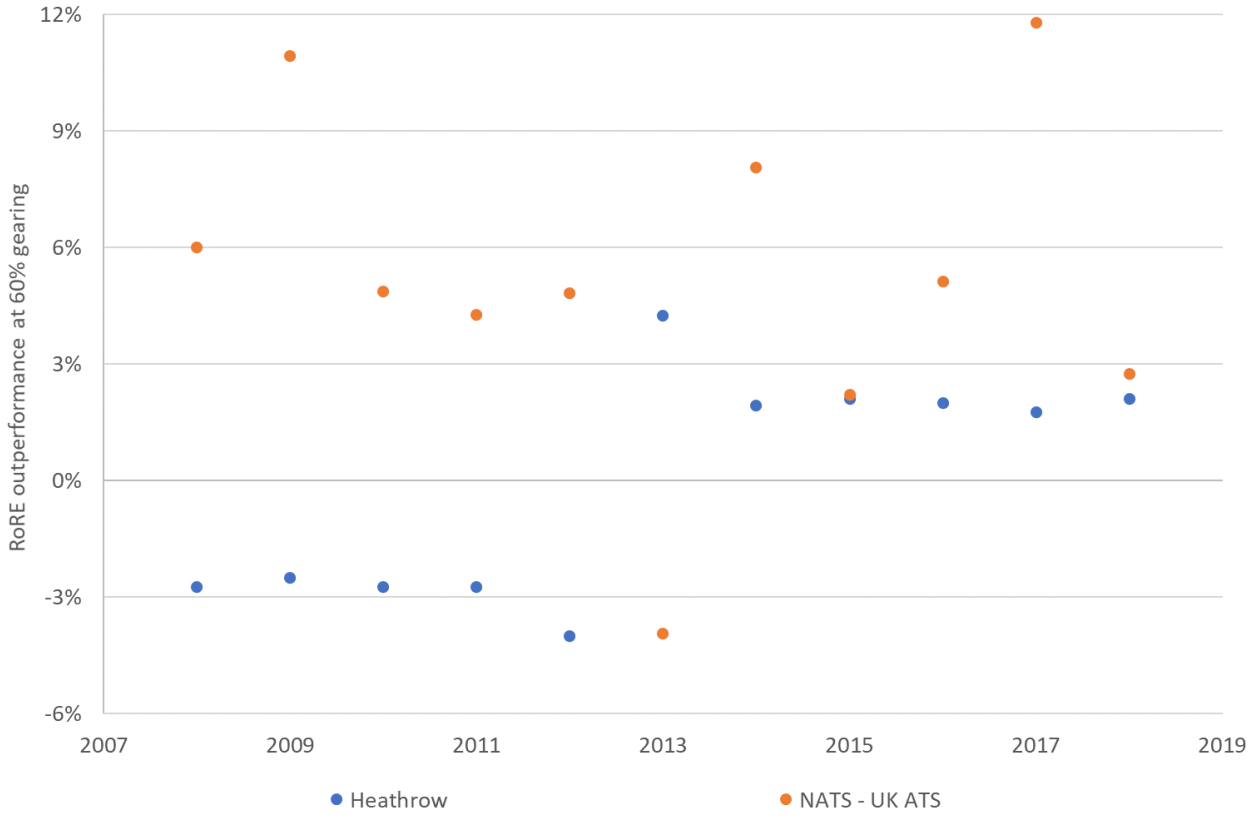
Source: Ofwat

Aviation

Outturn RoRE

In aviation we do not have anticipated RoRE evidence but do have outturn returns. We present this evidence below for both Heathrow and NATS. For NATS we focus on the UK Air Traffic Services business.

Figure A.9: Outturn RoRE outperformance distribution in UK Airports and Air Traffic Services



Source: Heathrow and NATS regulatory accounts

Relative to energy and water, we arguably see a broader range of outcomes in aviation, however with fewer data points it is difficult to be confident in these results. For Heathrow in particular, the presence of volume risk creates material potential exposure.

Appendix B SELECTION OF US BETA COMPARATORS

We are interested in selecting suitable US comparators for our beta decomposition analysis for National Grid. The comparators should face similar risks to National Grid's US operations and have robust data.

This appendix covers the different steps contained in selecting these comparators:

- Identifying a longlist of potential comparators.
- Comparability to National Grid's US activities.
- Testing of the robustness of US comparator data.
- Selection of a shortlist of comparators.

We note that the selection of comparators is covered in less detail than for the European comparators. This is linked to the selection only being relevant for one company for beta decomposition analysis, one part of our analysis of beta. We acknowledge that the choice of comparators often involves subjective decisions.

B.1. SELECTION OF LONGLIST OF COMPARATORS

We discuss analysis undertaken by both Indepen and Frontier Economics on beta decomposition in the main report. We considered the sample included by both parties in developing our longlist of comparators. There are a vast number of potential comparators in the US; we have focused on a narrow set.

We use an asterisk to denote the US comparators included in Frontier Economics' narrower sample of 8 firms.

Table B.1: US comparators selected in previous decomposition analysis

Indepen (2018)	Frontier Economics (2020)
Consolidated Edison	Consolidated Edison*
Eversource Energy	Eversource Energy*
Until	Unitil
	CenterPoint Energy*
	DTE*
	NextEra*
	TC Pipeline*
	PSEG*
	Dominion*
	Avangrid
	UGI

Source: Indepen, Frontier Economics

We included the 11 listed companies from the analysis above in arriving at a longlist. From external review, we did not find other firms that should be included within this longlist.

B.2. COMPARABILITY TO NATIONAL GRID'S US ACTIVITIES

As with our European comparators, we have drawn upon a range of evidence to arrive at our assessment of the comparability of our longlist of companies. This includes Bloomberg, investor relations material and analyst reports. Due to the composition of companies and the regulatory and legal framework, there are challenges in

interpretation. As noted previously, different measures (e.g. revenues, profits, assets) give a different picture of the proportion of regulated transmission and distribution network activities.

We use a traffic lights assessment for scoring. A green rating suggests the company does predominantly regulated transmission and distribution activities (90%+). An amber rating suggests that regulated transmission and distribution activities represent the majority of activities, while a red rating is suggestive of the regulated activities being less than 50%.

Table B.2: Assessment of comparability – US comparators

Company	Rating	Rationale/ proportion of regulated activities
Unitil		>95% revenues and assets in electricity and gas distribution.
ConsolidatedEdison		>95% revenues, operating income and net income from network utilities.
Eversource		>90% revenues, assets, operating and net income from energy networks.
TC Pipelines		Exclusively gas transmission activities.
Avangrid		>80% revenue and operating income, >60% net income, EBITDA, assets.
PSEG		>70% net income, operating income, assets.
CenterPoint		Estimated 60-80% share of regulated activities; limitation by availability of fully segmented data.
DTE		Estimate of c.50% of regulated activities; limited by availability of fully segmented data.
Dominion		Estimated 40-90% share of regulated activities; limited by availability of fully segmented data.
NextEra		c.50% assets, >50% revenue, operating income, net income.
UGI		<35% US regulated network proportion.

Source: CEPA analysis of Bloomberg, investor relations reports and analyst reports.

We proceed to consider the robustness of the data available to us.

B.3. Robustness testing

For robustness testing we are interested in three items: the liquidity of trading on the stock (proxied by the bid-ask spread), whether a data series is available for the full 10yr horizon and whether there are issues linked to negative gearing. This is presented below.

Table B.2: Assessment of robustness – US comparators

Company	Rating	Bid-Ask spread, 5yr average	Bid-Ask spread, 10yr average	Full series available	Positive gearing only
Unitil		0.08%	0.09%	✓	✓
ConsolidatedEdison		0.02%	0.02%	✓	✓
Eversource		0.02%	0.03%	✓	✓
TC Pipelines		0.10%	0.16%	✓	✓
Avangrid		n/a	n/a	×	✓
PSEG		0.02%	0.03%	✓	✓
CenterPoint		0.04%	0.06%	✓	✓
DTE		0.01%	0.02%	✓	✓
Dominion		0.02%	0.02%	✓	✓
NextEra		0.01%	0.02%	✓	✓
UGI		0.03%	0.03%	✓	✓

Source: Bloomberg.

With the exception of Avangrid, there are no problems arising from the robustness checks above.

However, we note that TC Pipelines is set up as a Master Limited Partnership. In light of this corporate structure and limitations on who can invest in the asset, we do not include TC Pipelines in our sample.

B.4. SELECTION OF SHORTLIST

Our preferred sample includes the five companies with at least a green and amber rating for both the comparability and robustness assessments. The companies selected are:

- Unitil.
- Consolidated Edison.
- Eversource.
- CenterPoint.
- PSEG.

The Frontier Economics shortlist included four of the five companies in the CEPA shortlist. The exception is Unitil, which is one of the three US comparators included in the Indepen study.

The asset betas deriving from this sample do not differ materially to the longlist of companies, using a 0.05 debt beta.

Table B.3: Asset betas for US comparators

Company	5yr average asset beta	10yr average asset beta
Preferred comparators		
Unitil	0.34	0.35
ConsolidatedEdison	0.21	0.26
Eversource	0.28	0.35
PSEG	0.36	0.43
CenterPoint	0.42	0.43
Other comparators		
TC Pipelines	0.56	0.46
DTE	0.29	0.35
Dominion	0.28	0.34
NextEra	0.31	0.35
UGI	0.45	0.47
Avangrid	0.34	n/a
Preferred sample	**0.32**	**0.36**
Full sample	**0.35**	**0.38**

Source: Bloomberg.

The preferred sample evidence is used for our beta decomposition analysis to represent National Grid's US business segment.

Appendix C EUROPEAN AND US COMPARATORS ASSET BETA

In this appendix we provide contextual evidence on asset betas from both European and US comparators discussed in Section 4 of the report.

C.1. EUROPEAN COMPARATORS

We present our European comparators against both the local indices and the Eurostoxx index.

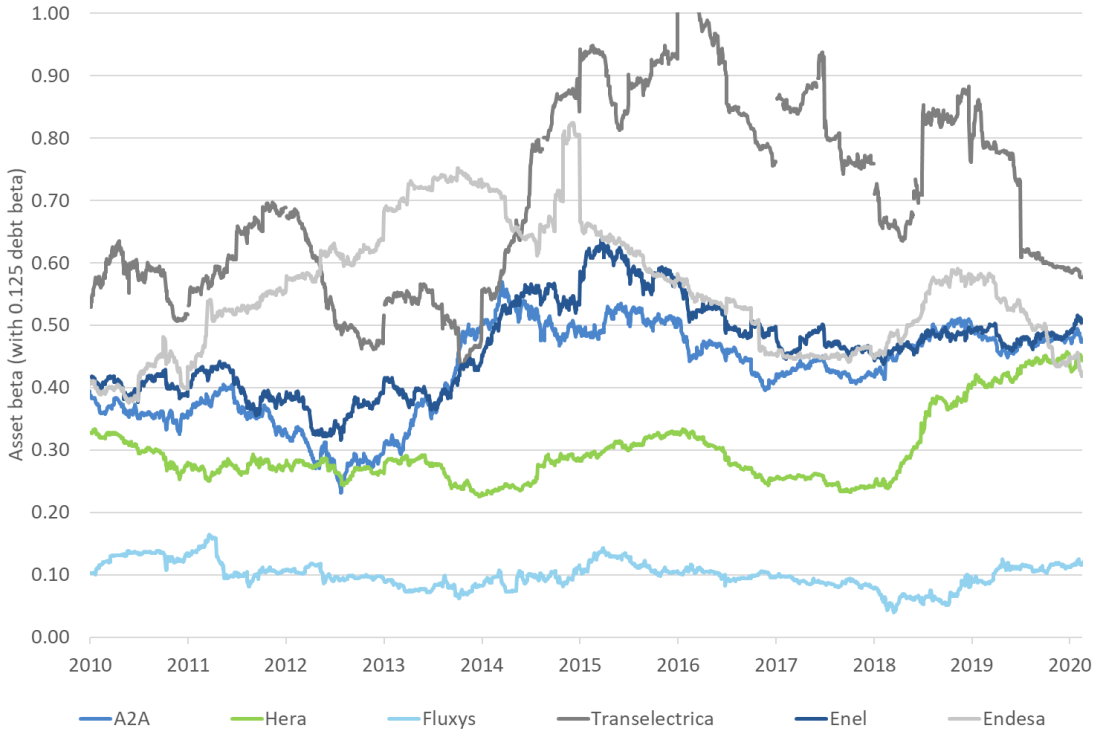
C.1.1. European asset betas, relative to local indices

We present below evidence on our European comparators relative to local indices.

Figure C.1: European asset betas versus local indices; set 1

Source: CEPA analysis of Bloomberg data

Figure C.2: European asset betas versus local indices; set 2

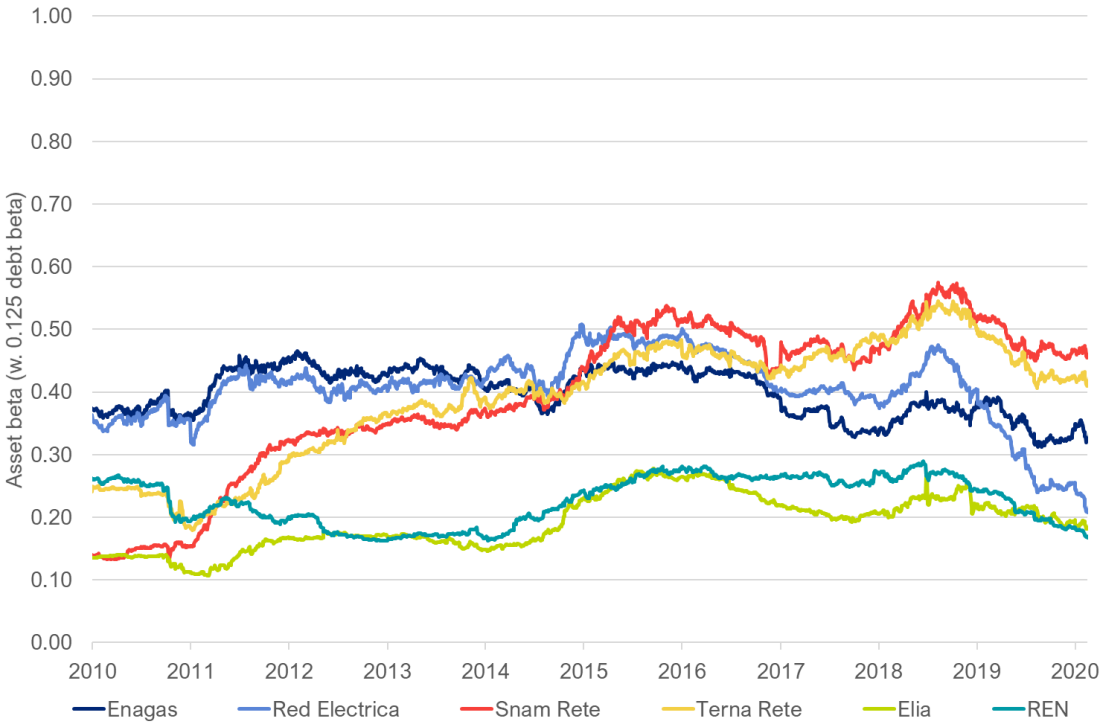


Source: CEPA analysis of Bloomberg data

C.1.2.European asset betas, relative to Eurostoxx index

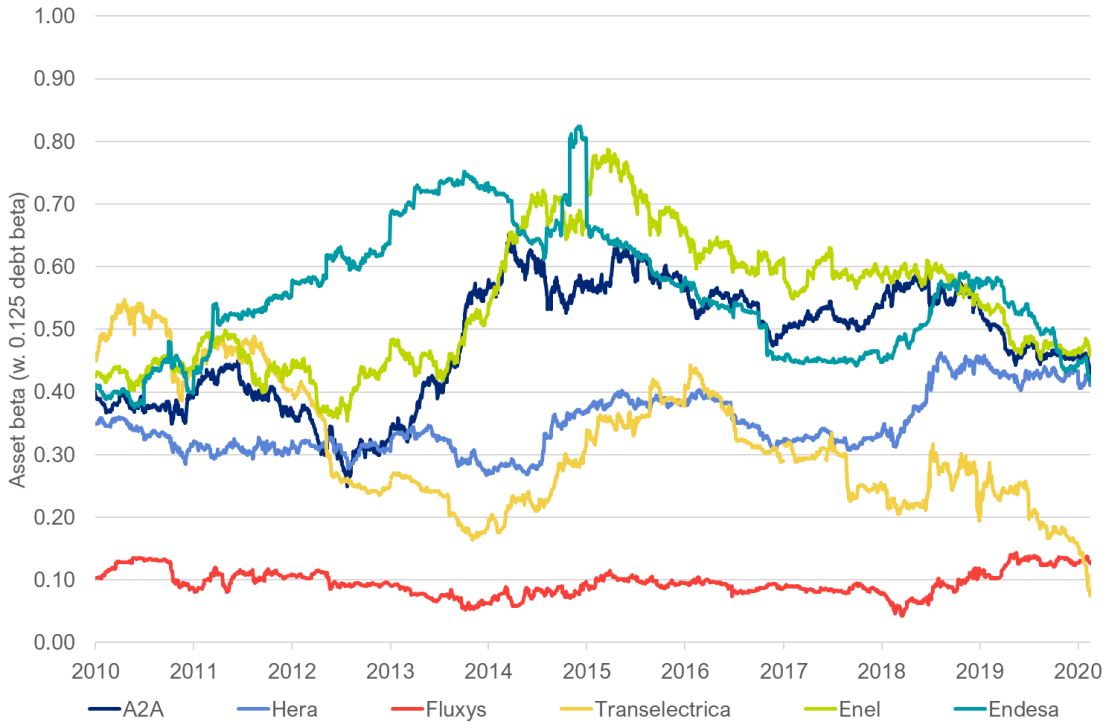
We present below evidence on our European comparators relative to the Eurostoxx rather than local indices.

Figure C.3: European asset betas versus Eurostoxx index; set 1



Source: CEPA analysis of Bloomberg data

Figure C.4: European asset betas versus Eurostoxx index; set 2

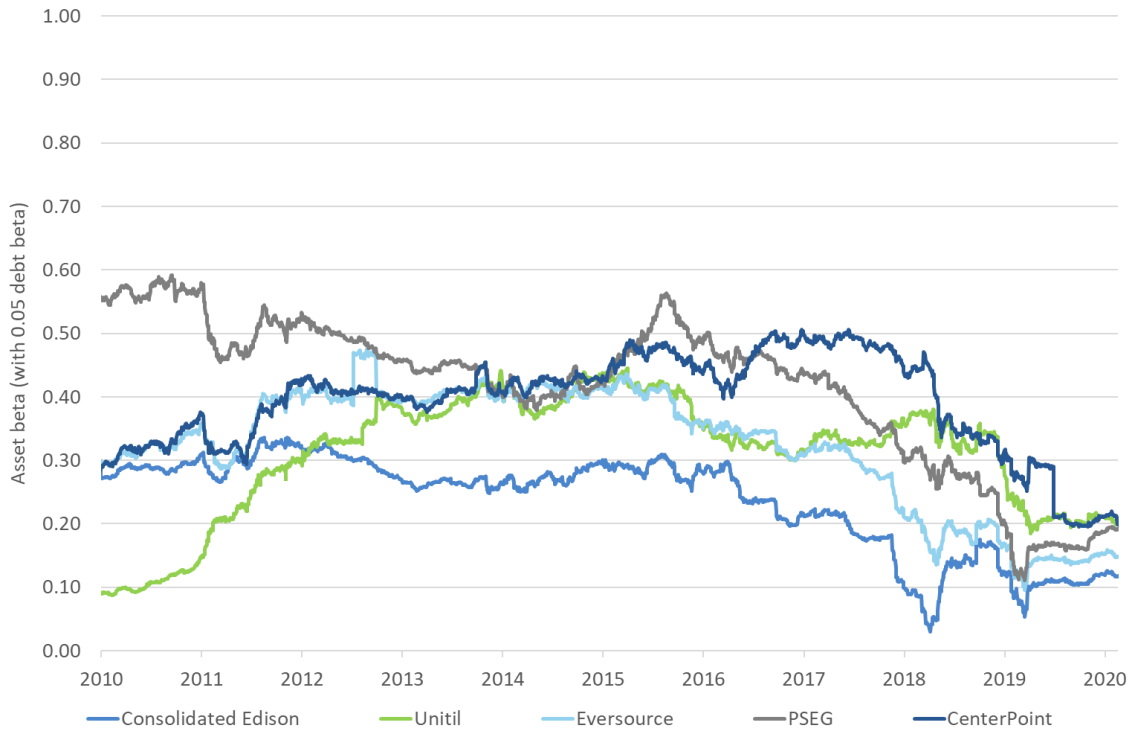


Source: CEPA analysis of Bloomberg data

C.2. US COMPARATORS

We present below evidence on our longlist of US comparators, using a 0.05 debt beta assumption.

Figure C.5: US asset betas; set 1



Source: CEPA analysis of Bloomberg data

Figure C.6: US asset betas; set 2

Source: CEPA analysis of Bloomberg data

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