RIIO-ET3: Economic Lives of Electricity Transmission Network Assets

Ofgem

June 2024

FINAL REPORT

Important notice

This document was prepared by Cambridge Economic Policy Associates Limited (trading as CEPA) for the exclusive use of the recipient(s) named herein on the terms agreed in our contract with the recipient(s).

CEPA does not accept or assume any responsibility or liability in respect of the document to any readers of it (third parties), other than the recipient(s) named in the document. Should any third parties choose to rely on the document, then they do so at their own risk.

The information contained in this document has been compiled by CEPA and may include material from third parties which is believed to be reliable but has not been verified or audited by CEPA. No representation or warranty, express or implied, is given and no responsibility or liability is or will be accepted by or on behalf of CEPA or by any of its directors, members, employees, agents or any other person as to the accuracy, completeness or correctness of the material from third parties contained in this document and any such liability is expressly excluded.

The findings enclosed in this document may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties.

The opinions expressed in this document are valid only for the purpose stated herein and as of the date stated. No obligation is assumed to revise this document to reflect changes, events or conditions, which occur subsequent to the date hereof.

The content contained within this document is the copyright of the recipient(s) named herein, or CEPA has licensed its copyright to recipient(s) named herein. The recipient(s) or any third parties may not reproduce or pass on this document, directly or indirectly, to any other person in whole or in part, for any other purpose than stated herein, without our prior approval.

Contents

1. EXECUTIVE SUMMARY

In setting its depreciation policy for RIIO-ET2, Ofgem used an economic asset life assumption of 45 years. As part of its RIIO-3 Sector Specific Methodology Consultation (SSMC), Ofgem sought views and evidence on the need to amend its economic asset life assumption for electricity transmission, either for the whole sector or a company-specific basis.[1]

CEPA has been commissioned by Ofgem to investigate:

- whether there is evidence that the average technical asset life of electricity transmission network assets has materially changed from the 2010 data that was used to inform the assumption of an economic asset life of 45 years first set for RIIO-ET1[2,3]; and
- the outlook for a change in average technical asset life by 2036 (the end of RIIO-ET4) because of anticipated changes to the asset mix driven by the expected transmission network investment to support the delivery of the UK Government's decarbonisation and net zero targets.

The analysis of technical asset lives is one piece of evidence that Ofgem will use to inform its position on economic asset lives and depreciation policy for RIIO-ET3. However, there are wider considerations for that decision that have been raised by the network companies but fall outside the scope of our report – for example, sector cashflow and financeability, and impact on consumer bills.

This report sets out our quantitative assessment of statutory, technical and economic asset lives for the current electricity transmission networks in Great Britain (GB). This is accompanied by an engineering-based review of public data and literature on the future technical and economic life of electricity transmission network assets.

Evidence on current technical asset lives

We analysed data on the current electricity transmission network assets provided confidentially by the three electricity transmission companies in response to a consultation question from Ofgem (SSMC FQ25 - Asset lives) and supplementary information requests. Given the large number of assumptions inherent in any estimation of technical asset life data and the fact that this data was not part of formal business plan submissions, the average figures resulting from our analysis should be seen as an indication of direction of travel, rather than detailed precise estimates.

Table 1-1 summarises the findings from both this analysis and the previous CEPA study in 2010. The statutory life is the asset life that network companies report in their annual regulatory and financial statements for accounting purposes. The technical life is broadly how long the asset can be expected to last from an engineering/safety perspective before it becomes either unsafe or not fit for purpose.

---

[1] Question FQ25 in Ofgem (2023), RIIO-3 Sector Specific Methodology for the Gas Distribution, Gas Transmission and Electricity Transmission Sectors – available at: https://www.ofgem.gov.uk/publications/riio-3-sector-specific-methodology-gas-distribution-gas-transmission-and-electricity-transmission-sectors

[2] RIIO-1 is the collective term used to refer to the price control review periods for the electricity and gas transmission and distribution sectors, which ran from 1st April 2013 to 31st March 2021 for transmission and gas distribution network companies, and 1st April 2015 to 31st March 2023 for electricity distribution network companies. The term RIIO-ET1 refers solely to the electricity transmission price control review period.

[3] This assumption was informed by this report: CEPA, SKM and GL Noble Denton (2010), The Economic Lives of Energy Network Assets. A report for Ofgem. – available at: https://www.ofgem.gov.uk/sites/default/files/docs/2010/12/cepa-econ-lives.pdf

Table 1-1: Summary of existing position and calculations

	CEPA 2010 study, pre-RIIO-1	Updated analysis on current asset mix using latest information
Statutory life	10 – 80	5 – 100
Estimated average age of network	33	35
Estimated technical life (range and weighted average)	10 – 90 (54)	5 – 120 (55)

Compared to the 2010 analysis, National Grid Electricity Transmission (NGET) and Scottish Hydro Electric Transmission (SHET) both report an increased range in statutory asset lives across their asset portfolio – the range presented by NGET has widened from 15-60 years to 15-100 years, and the SHET values now span 5-80 years (from 10-80 years in the 2010 data set). However, Scottish Power Transmission (SPT) now use a single figure of 40 years, compared to the range of 30-60 years in the 2010 study.

Based on the central estimates provided by the network companies, the weighted average technical asset life for GB as a whole was estimated at 55 years, which is similar to what was estimated in the 2010 study (54 years). This is consistent with the commentary provided by the companies in their responses.

In summary, the findings of the 2010 analysis for average technical life appear to still hold for the current set of electricity transmission assets in GB.

We carried out detailed analysis of the current dataset on asset lives in terms of variations between transmission network companies, and low/high ranges given the uncertainty inherent in technical lives data.[4] This analysis was not reported in the 2010 study, and therefore, we cannot say the values have changed since then.

The headline findings of this analysis were that:

- There was some variation across the companies with the network-specific average technical asset life ranging from 48 to 58 years.
- The 'low' weighted average technical asset life across all three electricity transmission network companies was estimated at 41 years, and the 'high' weighted average technical asset life was estimated at 70 years.

Outlook for technical asset lives

High levels of investment in and expansion of the transmission network driven by a shift towards renewable energy generation technologies are expected to result in changes to the transmission asset mix over the next decade. Although traditional assets such as overhead lines, underground cables, transformers, and switchgear will continue to be important, the incorporation of shorter-lived assets, including subsea cables and smart grid assets[5], has the potential to reduce the network's average technical life going forward.

However, there is a sizeable degree of uncertainty regarding the quantification of any reduction in technical asset life. This is because:

- **there is evidence of extensions in the technical life of traditional network assets** e.g. through continued improvements in asset management.
- **technologies that will be more widely deployed during RIIO-ET3 and beyond have a lower asset life than traditional network assets.**

---

[4] 'High' and 'Low' broadly represents the latest and earliest onset of significant unreliability for an asset or asset category based on information submitted by network companies which was informed by observed data or engineering judgement.

[5] Such as HVDC converters, FACTS controllers, and modern control and protection systems.

Therefore, from the data currently available, we are not able to confidently estimate any possible reduction in the overall asset life of installed assets from the scale of investment in new technologies.

Considerations for RIIO-3

The current asset life policy implicitly assumes that much of the investment in a price control period will be in assets that are similar to those already on the network. In these circumstances, the average asset life of the current network is a good guide to the average asset life of new and replacement assets installed across a price control period. There is no evidence that this assumption has been breached since 2010 as we found no compelling evidence of a change in asset lives when using a consistent methodology to evaluate updated data.

However, our analysis has identified some uncertainties about the evolution of the average asset life over RIIO-ET3 and beyond:

- Updating of asset life assumptions for all categories to reflect relevant experience and new operating and maintenance (O&M) techniques – which will typically increase asset lives.
- The importance of new asset types with shorter lives in new investment, compared to their weighting in the current asset mix – which will tend to reduce average asset lives.

Therefore, network companies should clearly evidence as part of their RIIO-ET3 business plan submissions how both of these uncertainties will impact the technical asset lives of their networks.

If Ofgem decides to implement any change to the asset life assumption, it could consider:

- The extent to which drivers of changes in technical lives may vary across networks – for example, the proportion of expenditure on subsea cables and HVDC convertors may be particularly high for SHET. This would support consideration of different asset life assumptions for different companies, if needed to reflect major differences in the mix of new assets being added to the system.
- The average asset life of new assets rather than the whole asset mix, if it decided to adjust asset lives for new assets only.

With respect to economic asset life assumptions, the 2010 study proposed economic life assumptions in line with technical life assumptions for electricity transmission network assets on the basis that demand and investment was expected to grow – i.e. there was little risk of the assets not being useful during their technical life. We have seen no evidence that this position has changed since 2010. The companies have raised a question about the useful economic life of assets that are replaced early because the need to accommodate rapid changes in electricity demand and/or supply. This issue is outside the scope of this report, which is focused on updating the 2010 analysis.

One network company, in response to Ofgem's SSMC and our requests for information, raised questions about the treatment of IT assets which are currently excluded from the calculations, and OHL towers which are included. It also stated that Ofgem should use different average asset lives for each asset type in calculating depreciation, rather than a single weighted average asset life. The majority of IT spend is attributable to operational expenditure (opex) and typically this expenditure category is not capitalised i.e. its not added to the RAV and depreciated. This needs to be considered further when shorter-lived assets, like IT assets, are discussed in the context of asset lives. This issue is outside the scope of this report, which is focused on updating the 2010 analysis rather than changing the scope or methodology of the calculation.

2. INTRODUCTION

2.1. CONTEXT FOR THE STUDY

Regulatory depreciation determines how network companies' allowed revenues are recovered from customers over time. This makes it one of the key technical design elements or 'building blocks' of a price control. There are two important components of regulatory depreciation policy:

- the assumed economic asset life (or lives); and
- the depreciation profile.

These elements determine the speed at which additions to the Regulatory Asset Value (RAV) are paid for by customers as part of the return of capital to investors.[6] While this is a technical and financial issue, it is central to the question of inter-generational equity and fairness.

Ofgem's current policy is to depreciate the RAV at a rate that broadly reflects the economic life and use of the assets, so that customers pay network charges in line with the value of the network services they receive. For example, if networks are expected to provide useful services for 45 years, then Ofgem's view for RIIO-1 and RIIO-2 is that the RAV should be depreciated over 45 years.[7]

In simple terms, the economic life of an asset is the period over which it is useful. A ceiling value on the economic life is typically set by the technical life of an asset. This is the time between the asset being commissioned and it no longer being fit for purpose, for reasons including safety and whether it can perform the function(s) that it was intended to perform. However, the economic life would typically consider the expected profile of usage. For example, if there is evidence that network assets may cease to be useful before the end of their technical life, then the RAV may need to be depreciated over a shorter period and/or at a faster rate.

In RIIO-1 and RIIO-2, Ofgem has set a common figure of 45 years for economic asset life across network companies and sectors, and across price control periods. However, the technical life of an asset will vary based on factors such as asset type and specification, and the economic life will fundamentally depend on how networks will be used in the future. The overall decision on regulatory depreciation also typically takes into account broader considerations such as the implications for network companies in terms of financeability, cash flow and customer bill impact.

2.2. SCOPE OF THIS STUDY

The scope of this study is to investigate whether there is evidence of significant changes in the technical and economic lives of electricity transmission network assets compared to the analysis used to inform Ofgem's decision on a 45 year economic asset life for electricity transmission assets at RIIO-ET1, which was retained for RIIO-ET2.

Specifically, CEPA has been commissioned by Ofgem to investigate:

- whether there is evidence for a change in the assumed technical asset life of electricity transmission network assets from the data that was used to inform the assumption of an economic life of 45 years that was first set for RIIO-ET1; and

---

[6] This is at the core of a RAV-based regulatory model whereby any expenditure that is not recovered within year is added to the RAV of the network company. The RAV is then depreciated each year with network company recovering a share determined by the asset lives and depreciation profile.

[7] Ofgem Sector Specific Methodology Consultation (SSMC) – Finance Annex, paragraph 8.4 – available at: https://www.ofgem.gov.uk/sites/default/files/2023-12/RIIO-3%20SSMC%20Finance%20Annex.pdf

- the outlook for a change in average technical asset life by 2036 (the end of RIIO-ET4) because of changing asset mix driven by the expected transmission network investment to support the delivery of the UK Government's decarbonisation and net zero targets.

Unlike the study we carried out in 2010, our analysis has been limited to reviewing the evidence relating to asset lives. The narrower scope that has been set for this study means that we have not considered the implications of different asset life assumptions, e.g. on customer bills, sector cashflow or financeability.

2.3. OUR APPROACH TO ASSESSING EVIDENCE ON ASSET LIVES

In order to assess the evidence on technical and economic asset lives in the electricity transmission sector, we have partnered with Blake Clough Consulting. The rest of this report is structured as follows:

- Chapter 3 sets out the background for this report in terms of Ofgem's previous decisions on technical and economic asset lives, and the discussion around the RIIO-3 SSMC on the approach to asset lives for RIIO-ET3.[8]
- Chapter 4 describes the results of analysis on the current asset mix to explore any changes since the 2010 study. We have analysed information provided by the three electricity transmission network companies on the assets in place today – this includes asset volume, statutory asset life, age profile, and modern equivalent asset value (MEAV)[9].
- Chapter 5 discusses evidence on changes in the technical and economic lives of different asset types, including over the next few price control periods, and possible changes in the asset mix resulting from the expected large scale investment programmes proposed for RIIO-ET3 and beyond.

The number of asset classes considered in our analysis in Chapter 4 has been broadly consistent with the categorisations used in the price control reviews and as submitted by network companies to Ofgem. This allows for a consistent set of asset groups to be used with sufficient disaggregation and robust information to enable meaningful analysis to be carried out. In our assessment we have used the views of the network companies about their technical asset lives across the various asset categories. This information on technical lives provided by network companies has been informed by actual disposal information where available, and engineering judgement where not available.

---

[8] Electricity transmission asset lives was the specific topic for Question FQ25 in Ofgem (2023), RIIO-3 Sector Specific Methodology for the Gas Distribution, Gas Transmission and Electricity Transmission Sectors – available at: https://www.ofgem.gov.uk/publications/riio-3-sector-specific-methodology-gas-distribution-gas-transmission-and-electricity-transmission-sectors

[9] MEAV is defined as the cost of replacing an asset, a group of assets, or the network as a whole, with a modern day equivalent and provides a useful measure of the scale of a network, and a distinct valuation of the network compared to the RAV.

3. BACKGROUND TO ASSET LIVES DISCUSSION FOR RIIO-ET3

In this chapter, we summarise:

- the approach to asset lives in the ET price controls before the start of RIIO-1 in April 2013;
- the Ofgem decision on asset lives for RIIO-ET1, which was retained for RIIO-ET2; and
- the position of Ofgem and the three electricity transmission network companies set out in the consultation on the Sector Specific Methodology for RIIO-ET3.

3.1. BEFORE RIIO-ET1

Prior to RIIO-1, the regulatory asset lives differed by sector. For electricity transmission, assets that had been added to the network after privatisation (post-vesting assets) initially had asset lives of between 40-48 years. This was later changed to an asset life of 20 years at TPCR4.

The reduction in regulatory asset lives to 20 years was not made in response to evidence of any significant changes to the assets expected technical or economic lives. Instead it was intended by Ofgem to address a financeability issue caused by the 'cliff edge' of depreciation on assets that had been added to the network before privatisation (pre-vesting assets).

Pre-vesting assets would be fully depreciated by the end of 2010 for NGET and SPT and 2012 for SHET. Once pre-vesting assets were fully depreciated, a smoothing depreciation adjustment relating to the post-vesting assets was introduced to create supplementary depreciation for an additional period (15 years for SPTL, 30 years for SHETL and 50 years for NGET) on a straight line basis.

In summary, prior to RIIO-1, the assumed regulatory asset lives had been used by Ofgem as a cash flow profiling instrument as part of its financeability assessment. The approach to regulatory asset lives was not considered to be a sustainable or long term solution as it led to uncertainty and a lack of transparency and predictability.

3.2. RIIO-ET1 AND RIIO-ET2

Ofgem's decision on the approach to regulatory depreciation for RIIO-ET1 was informed by analysis undertaken by CEPA in 2010 in conjunction with two engineering partners.[10] The study assessed available evidence on existing statutory, regulatory and technical lives for existing and new electricity and gas network assets in GB possible future scenarios for energy usage and how this could affect economic and technical lives of these assets. The study also considered scenario analysis of the financial effects of the choice of asset lives, modelling the impact of adopting longer asset lives on the financeability of the sectors.

In summary, the headline findings of the 2010 CEPA study were that:

- The electricity transmission network in 2010 was largely comprised of assets whose technical lives range between 10 and 90 years, with an overall weighted average technical life of 54 years.
- The current weighted age of the electricity transmission network was 33 years.
- The statutory accounts produced by transmission network companies used an assessment of useful economic asset lives of between 10 to 80 years, with the majority being between 30 and 60 years.

---

[10] CEPA, SKM and GL Noble Denton (2010), The Economic Lives of Energy Network Assets. A report for Ofgem. – available at https://www.ofgem.gov.uk/sites/default/files/docs/2010/12/cepa-econ-lives.pdf

- Future use of and investment in the electricity network was increasing under all scenarios based on the UK's future renewables and carbon emission targets. Therefore, there was seen to be little risk of asset stranding, and the estimated economic asset life was set equal to the estimated technical asset life.

The CEPA study presented a range of asset lives of between 45-55 years for electricity transmission, with a recommendation on using a figure below the existing technical life to reflect some of the uncertainty about the longer-lived assets. The study also recommended a straight-line depreciation profile, given the expected profile of continued usage.

Ofgem decided to set a regulatory asset life of 45 years in electricity transmission from RIIO-ET1[11]. This was despite the electricity transmission network companies at the time suggesting shorter asset life assumptions. [12] This decision represented a significant move away from the previous approach, which assumed a 20 year asset life.

By using an asset life of 45 years, at the bottom end of the recommended range in the 2010 report, Ofgem stated that it had created a buffer against future net reductions in economic life resulting from more shorter-lived assets, such as smart grid technologies for monitoring and control, in the overall asset mix.[13]

Ofgem retained the assumed asset life of 45 years for RIIO-ET2.

3.3. OFGEM'S RIIO-3 SSMC

3.3.1. Summary of Ofgem's RIIO-3 SSMC on Asset Lives

In December 2023, Ofgem published its SSMC for the next set of price control for electricity and gas transmission, and gas distribution sectors (RIIO-3), which commences on 1st April 2026.

One of the areas that Ofgem consulted on was the RIIO-3 financial framework. In summary, Ofgem set out its aim to keep the financial policies and methodologies that underpin the financial framework predictable and stable for RIIO-3. This was in recognition of that broad regulatory stability gives investors the confidence to continue to invest in the sector.

Ofgem did however note that the appropriate evolution of the financial framework would likely underpin regulatory credibility and support the ongoing attractiveness of investment in the sector. For example, this evolution may be to address macro developments that create new challenges or where updates to best practice can be identified.

Ofgem reiterated the key aims of the regulatory depreciation policy i.e. that it allocated costs fairly between current and future consumers, and that it ensures company revenues reflect the licensee's need to make annual and economic investments.

Ofgem consulted on whether there was a need to review its approach to asset life assumptions. In particular, it sought views and evidence as to whether, and why asset lives have materially changed from the 2010 analysis used to inform the existing assumption of 45 years.

Ofgem set out that they would welcome views on two alternative approaches for it to consider in the event that it decided that updated evidence supported a move away from the current 45 year asset life assumption:

- Change the asset life assumption across the sector based on a best view of evidence and regulatory judgement so that every company had the same assumed asset life (e.g. 40 years).

---

[11] A 45 year asset life was also introduced across the electricity distribution, gas transmission, and gas distribution sectors.

[12] Such as 30 years, 35-40 years, or no more than 40 years

[13] Ofgem (2011), Decision on strategy for the next transmission and gas distribution price controls – RIIO-T1 and GD1 Financial issues – available at: https://www.ofgem.gov.uk/sites/default/files/docs/2011/03/t1decisionfinance_0.pdf

- Set out a methodology that would apply different asset lives to different asset categories and asking network companies to apply these categories to their asset base based on actual weightings.

3.3.2. Summary of Responses to Ofgem's RIIO-3 SSMC on Asset Lives

All three electricity transmission network companies, and one electricity distribution network company, provided a response to Ofgem's SSMC on the consultation question around regulatory depreciation policy and whether there was a need to amend the existing asset life assumptions in electricity transmission. In the rest of this section we summarise the responses to the consultation question. The responses covered issues outside the scope of this particular study e.g. discussing cash flow and financeability impacts.

One respondent agreed with the principle that regulatory depreciation policy should align with the average economic life of the assets it is associated with, maintaining the economic principle of intergenerational fairness. The respondent noted the increasing use of uncertainty mechanisms across RIIO-2, relative to RIIO-1, and the increasing risk this presented for companies around future funding and the knock-on impacts for resource planning and procurement. The respondent also identified the potential risks of stranding, particularly around technological investments. With this in mind, the respondent considered whether it would be more appropriate to consider new additions to the RAV in discrete groupings that have similar characteristics e.g. capitalised items that have short asset lives like technology-related assets.

Another respondent considered that there was a need to reduce the existing RIIO-ET2 asset life assumptions due to the unique circumstances of the sector going forward and the significant investment required going forward. The respondent argued that while a reduction in asset lives would offer a partial remedy to the cash flow challenges faced by network companies during periods of heightened capital outlay, there was also a technical narrative that supports a reduction in asset lives. Based on an evaluation of its own assets, the respondent argues that new assets being built into the transmission network are exhibiting a reduction in economic useful lives on average from the current 45 year policy. The expectation is that in RIIO-ET3, there will be a continued transition towards shorter-lived assets for specific elements of the electricity transmission network.

This shift is attributed to the increasing deployment of "intelligent" substations, characterised by an increased reliance on electronic and digital components as opposed to traditional mechanical installations. As a result, the longevity of such assets is expected to be shorter. Furthermore, investments in the Accelerated Strategic Transmission Investment (ASTI)[14] projects will see an increase in certain transmission assets being built, such as HVDC submarine cables. The respondent stated that these assets will have an economic useful life that is shorter than the currently assigned regulatory asset life of 45 years.

The respondent considers that these factors collectively suggest a rationale for a lower asset life than the current assumed regulatory asset life of 45 years. The respondent also noted that while longer asset lives may yield short-term reductions in consumer bills, they impose upward pressure on future consumers, who will bear the brunt of higher returns on a higher RAV. This creates intergenerational inequality; wherein present-day consumers benefit at the expense of future generations.

Another respondent considered that the regulatory asset life should broadly reflect the statutory calculated economic asset life, thus preserving the equitable inter-generational amortisation of the RAV. The respondent also set out the view that the regulatory asset life could be set on a company specific basis, with the companies including proposals and supporting justification as part of the business plan submission.

Another respondent predicts the asset mix for RIIO-ET3 will significantly differ from what has been seen by the sector over previous price controls. With the inclusion of ASTI and Large Onshore Transmission Investment

---

[14] ASTI is a regulatory mechanism designed to speed up the delivery of strategic energy projects to feed in more electricity generated by offshore wind to the electricity transmission networks.

(LOTI)[15] project, the respondent anticipates that c£20bn will be spent in the enhancement of its network, with over 50% of that spend in relation to offshore assets. Owing to their nature, and weather extremes they are exposed to, these offshore assets are expected to have much shorter asset lives than onshore network assets.

The respondent stated that asset lives should reflect the statutory life of the assets, ensuring the depreciation rate is fairly allocated across the years the consumer will benefit from the services these assets provide. However, it also noted that the asset life assumption can be used as a lever to improve cashflows for network companies. The respondent's view was that given the unprecedented rate of investment in the electricity transmission networks over the next decade, the requirement to accelerate and support company cashflows is vital. A shorter asset life would assist from a practical cashflow perspective, but also help to drive down the level of debt funding from the sector. This would have a positive knock-on effect to the gearing ratios, improve financeability ratings, and ensure lower cost of borrowing, which ultimately benefits consumers through lower costs.

---

[15] LOTI is a regulatory mechanism that provides electricity transmission network companies with a route to apply for funding for large investments in the network.

4. ELECTRICITY TRANSMISSION NETWORKS TODAY

In this chapter, we describe the results of our analysis of the current asset mix, including:

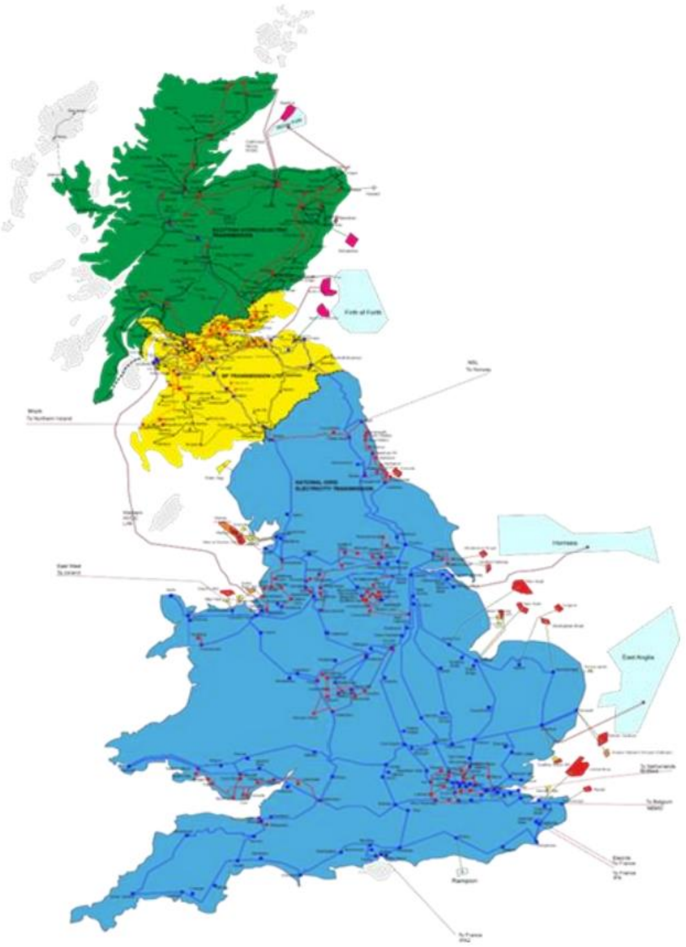
- overview of existing electricity transmission networks;
- the statutory lives as reported by electricity transmission network companies and how this has changed since the 2010 study; and
- the age, age profiles, and technical asset lives of the electricity transmission networks.

4.1. Overview

The electricity transmission networks in GB comprise a mixture of assets such as overhead lines, underground cables, transformers, switchgear and subsea cables, operating at 400kV and 275kV (and 132kV in Scotland). NGET is responsible for the transmission network in England and Wales, while SHET and SPT are responsible for the transmission networks in the North and South of Scotland respectively.

Figure 4-1 presents a map of the electricity transmission networks in GB, colour coded by the three different operators. NGETs operating region is coloured blue, while SPT and SHET's regions are coloured yellow and green respectively.

Figure 4-1: Map of electricity transmission networks



Source: National Grid ESO Electricity Ten Year Statement 2023

4.2. STATUTORY ASSET LIVES

Electricity transmission network companies use an expected useful economic life for their network assets as part of their depreciation accounting policy disclosed in their statutory and regulatory accounts.

Table 4-1 compares the set of accounting lives used at the time of the 2010 study with the values in the latest set of regulatory accounts published by the network companies. The accounting values for useful economic lives across the three electricity transmission network companies at the time of the previous CEPA study in 2010, ranged between 10 and 80 years, with the majority being between 30 and 60 years.

Compared to the 2010 analysis, NGET and SHET both report an increased range in statutory asset lives across their asset portfolio – the range presented by NGET has widened from 15-60 years to 15-100 years, and the SHET values now span 5-80 years (from 10-80 years in the 2010 data set). However, SPT now use a single figure of 40 years, compared to the range of 30-60 years in the 2010 study.

Table 4-1: Accounting economic asset lives from regulatory accounts[16,17,18]

Electricity Transmission Network Company	Asset Type	Accounting economic life 31 March 2010	Asset Type	Accounting economic life 31 March 2023
National Grid Electricity Transmission plc	Towers	40 - 60	Electricity Transmission plant	15 - 100
	Substation plant, overhead lines and cables	40 - 50		
	Protection, control and communication equipment	15 - 25		
Scottish Hydro Electric Transmission Limited	Transmission assets	10 - 80	Network assets	5 - 80
SP Transmission Limited	Transmission plant	30 - 40	Transmission facilities	40
	Towers, lines and underground cables	40 - 60		

While the range in accounting economic lives has widened to 5 to 100 years, across all three network companies, it is difficult to determine what is driving this change or whether this is impacting particular asset types, from the regulatory accounts alone.

4.3. AGE OF EXISTING ASSETS

We have estimated the weighted average age of the electricity transmission networks using two sources of information provided by network companies the number of assets in service by year of installation, and by asset type, and MEAV.

The average age of the electricity transmission networks range across the three network companies, from 29 to 37 years. The weighted average for GB as a whole is 36 years. This is similar to the average age of 33 years estimated in the 2010 study.

---

[16] National Grid plc annual reports – available at: https://www.nationalgrid.com/investors/resources/reports-plc

[17] Scottish Power Transmission plc annual reports – available at: https://www.spenergynetworks.co.uk/pages/annual_reports_accounts.aspx

[18] Scottish Southern Electricity Networks annual reports – available at: https://www.ssen-transmission.co.uk/information-centre/financial-information/

Figure 4-2 and Figure 4-3 show the age profile of the existing assets on the electricity transmission networks by network MEAV by year. They are characterised by a peak of electrification investment in the UK in the 1950s-60s, followed by a gradual increase in investment over the last two decades as a result of existing infrastructure being renewed, and new infrastructure being added to address the challenges associated with decarbonisation. This includes the addition of offshore HVDC cabling in the last 10 years, which is shown as light blue in Figure 4-2 and Figure 4-3.

Figure 4-2: MEAV and year of installation for existing electricity transmission network assets

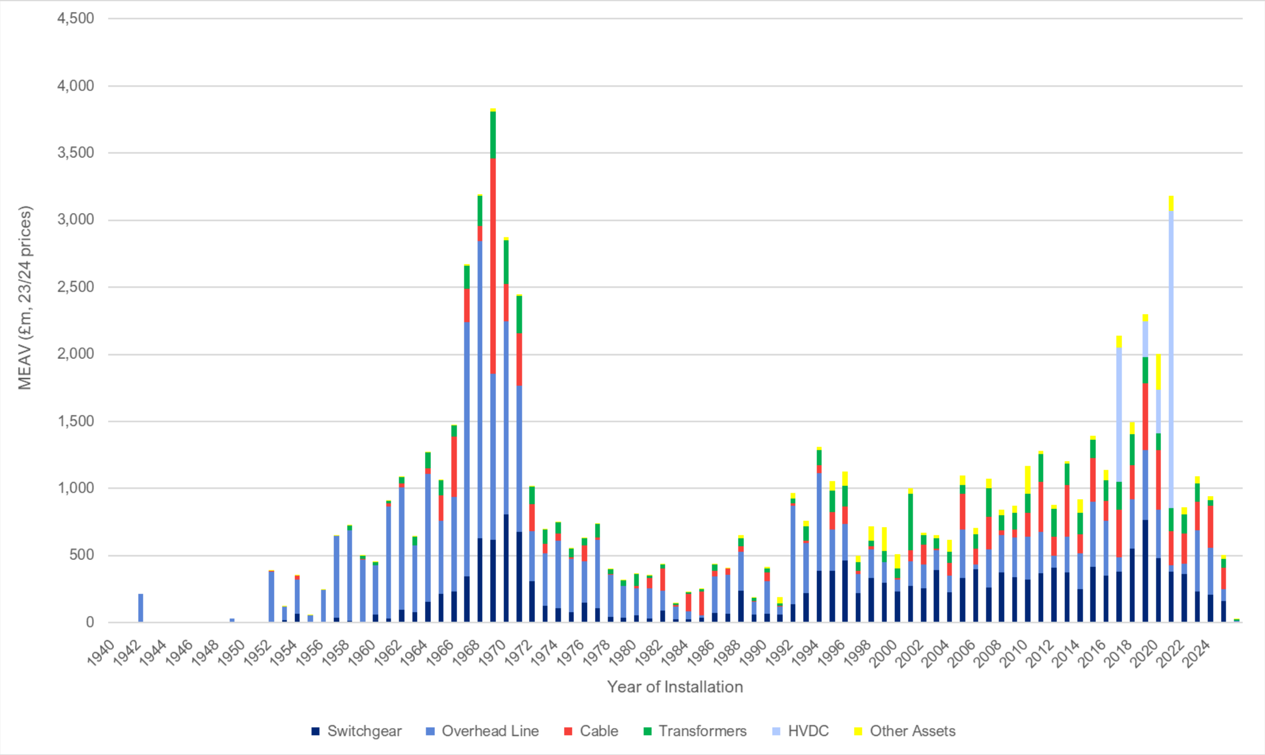
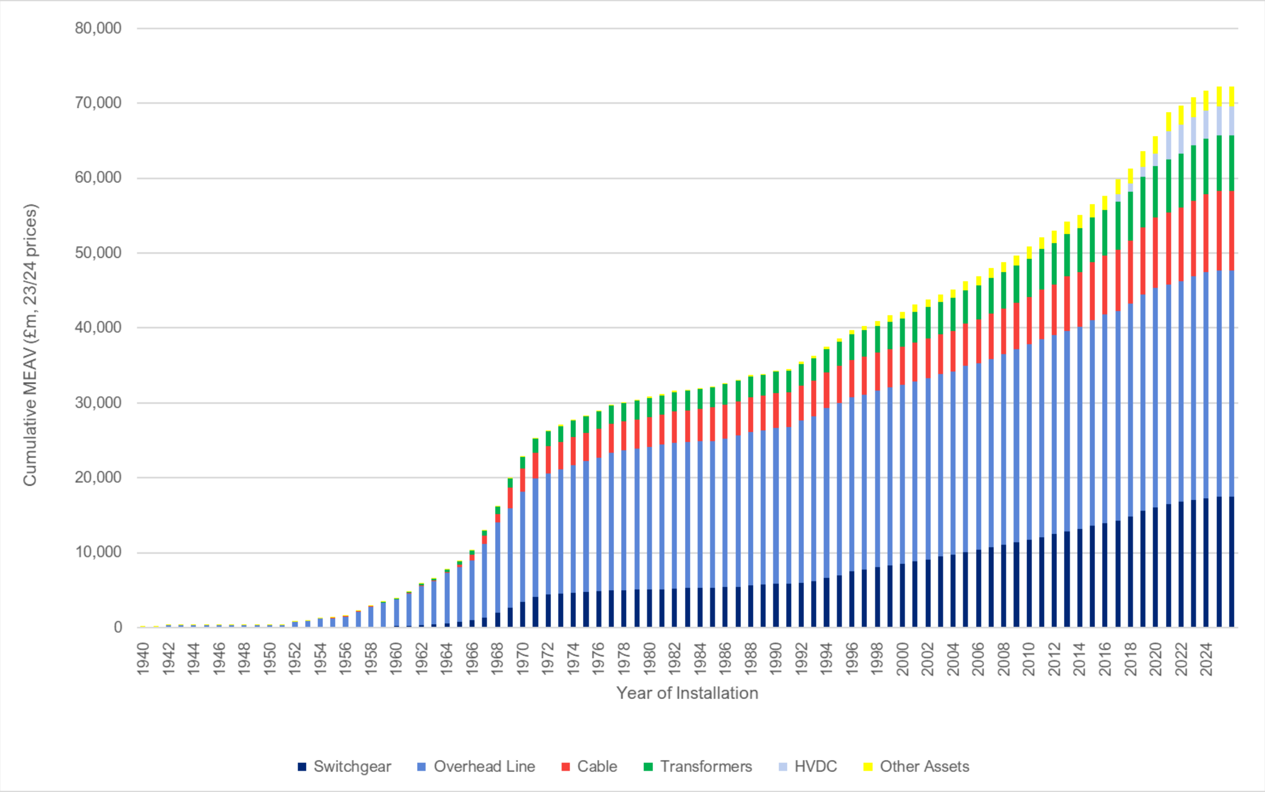


Figure 4-3: Cumulative MEAV for current electricity transmission networks by year of installation



4.4. WEIGHTED AVERAGE TECHNICAL LIFE OF EXISTING ASSETS

In the data provided by the electricity transmission network companies, the technical asset life for electricity transmission network assets ranges from 5 to 120 years across the different asset categories.

We have estimated the weighted average technical life of the electricity transmission networks using two sources of information provided by network companies:

- the technical life of the asset or asset category; and
- MEAV.

The technical lives for each asset category are informed either by network company disposal information or ‘engineering judgement’, so any attempt to provide a precise average figure could be misleading in terms of level of accuracy that can be achieved. Furthermore the average technical asset life of the network does not describe nor necessarily correspond to any real asset in the network. Therefore, we use a range to describe the average technical life of the network.

The estimated weighted average technical asset life for GB as a whole is 55 years. It varies by network company, ranging from 48 to 58 years across the three electricity transmission networks. NGET is the largest electricity transmission network company, with its MEAV representing 78% of the overall MEAV for the sector. Therefore, its weighted average technical asset life of 55 years drives the overall weighted average technical asset life for GB.

Given the uncertainty around technical asset life assumptions, our analysis also considered high and low ranges for weighted average technical asset lives using data and assumptions provided by each network company.[19] The ’low’ weighted average technical asset life for the sector was estimated at 41 years, and the ‘high’ weighted average technical asset life was estimated at 70 years.

Figure 4-4 presents the weighted average technical asset life for assets that are currently on the network, grouped by the year of installation. Therefore the annual fluctuation is a product of the types of assets installed in that specific year. For example, assets that were installed in 1954 had a weighted average technical asset life of 80 years. Assets that were installed in 2024 had a weighted average technical asset life of 49 years, as shown in Figure 4-5, which focusses on the years since 2010 only. Although we can observe some year on year variation in the annual weighted average technical asset life the five year moving average has been relatively flat between 45 and 50 years, since the late 1980s.

---

[19] ‘High’ and ‘Low’ broadly represents the latest and earliest onset of significant unreliability for an asset or asset category based on information submitted by network companies which was informed by observed data or engineering judgement.

Figure 4-4: Annual Weighted Average Technical Asset Life (WATAL) by year of installation (1950 to 2024)

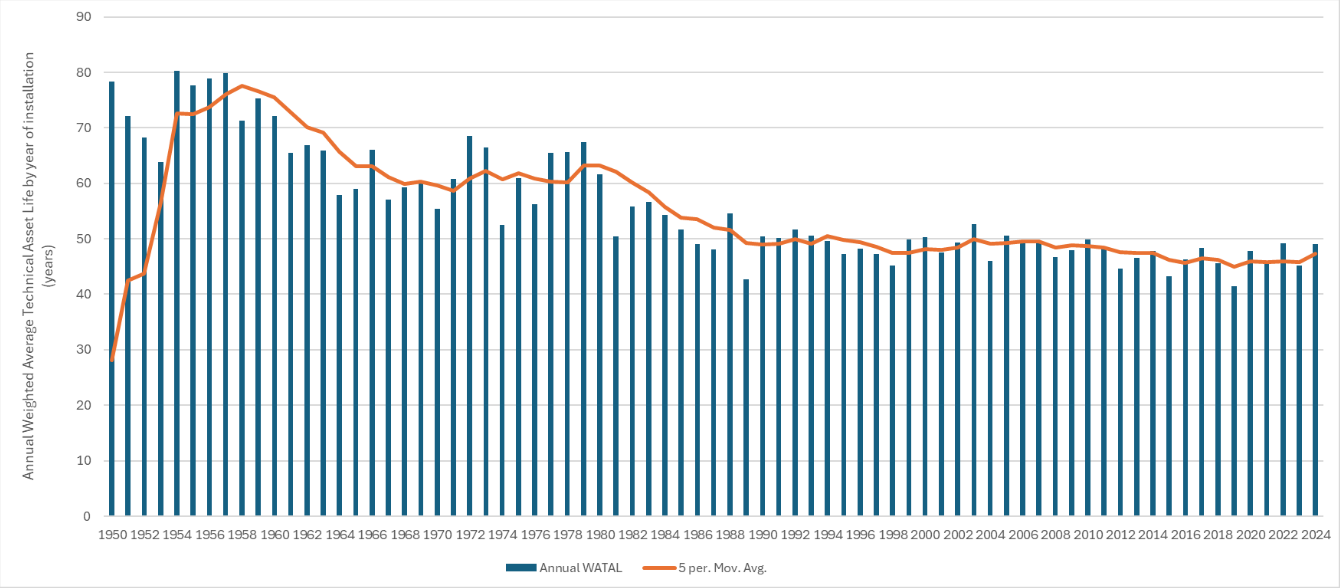
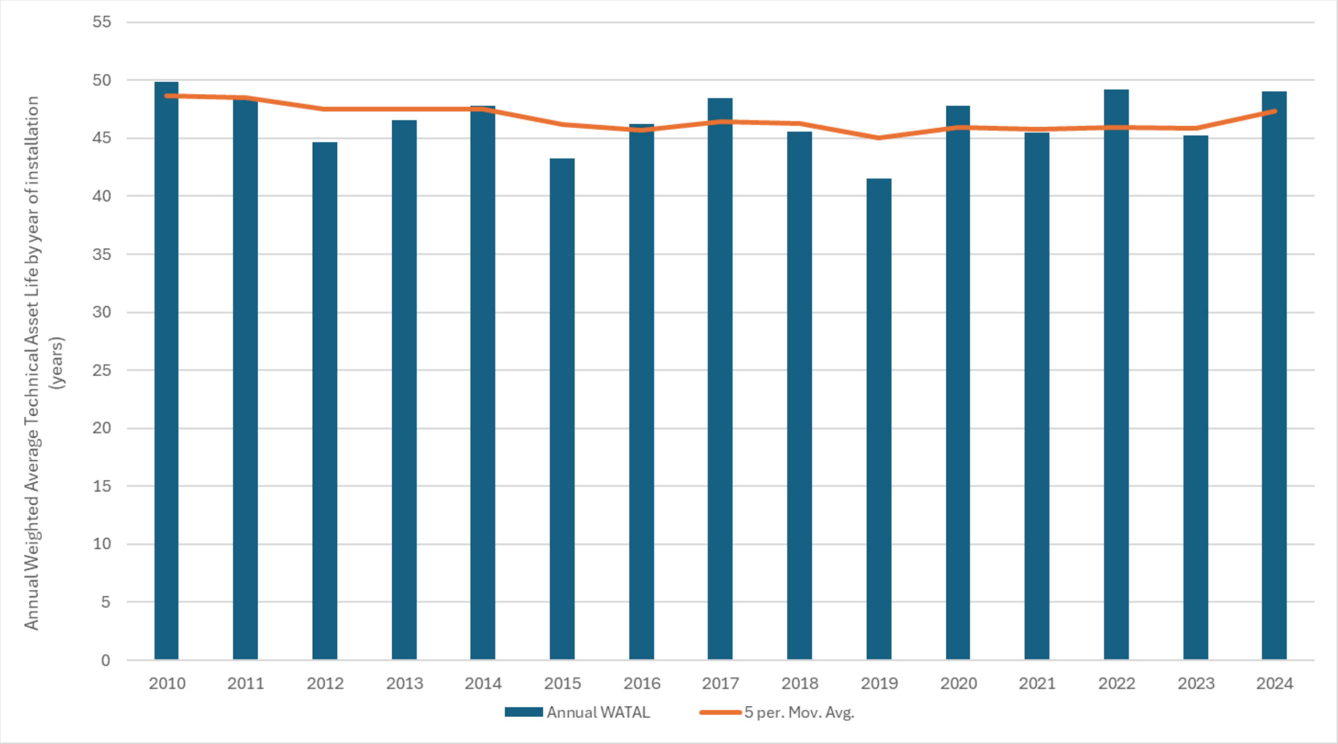


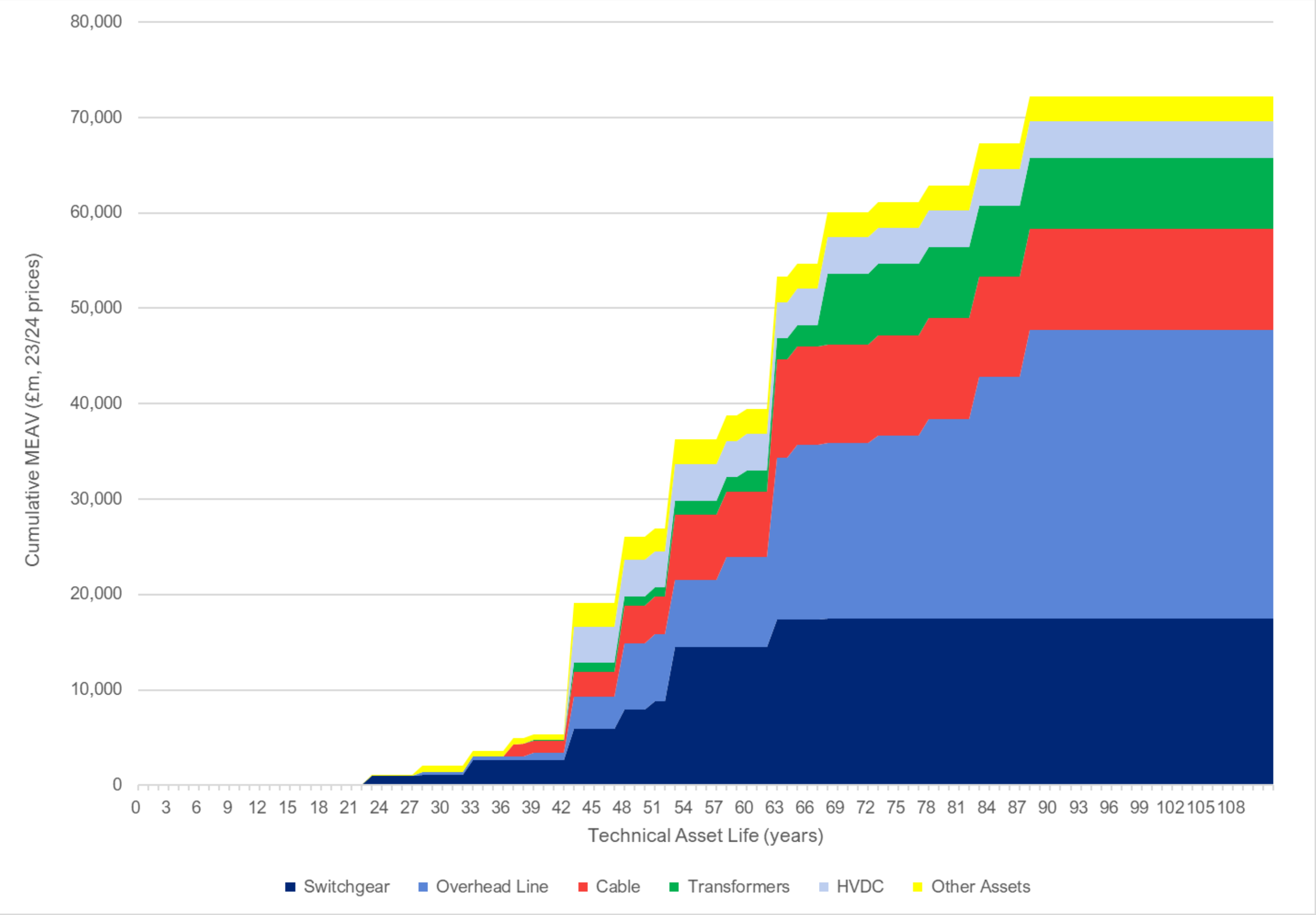
Figure 4-5: Annual Weighted Average Technical Asset Life (WATAL) by year of installation (2010 to 2024)



4.6. TECHNICAL LIVES BY ASSET TYPES

Figure 4-6 presents the asset life values and cumulative MEAV for each asset category on the electricity transmission networks. It shows that of the total sector MEAV of £72bn, approximately £53bn (74%) of current network assets have a technical asset life of at least 45 years.

Figure 4-6: Cumulative MEAV value by technical life for each category of existing assets



5. CHANGING LANDSCAPE OF ELECTRICITY TRANSMISSION NETWORKS

In this chapter, we discuss evidence gathered in an engineering-based review of:

- the changing asset mix and the impact that this might have on technical asset lives for RIIO-ET3 and beyond; and
- improvements in asset management and how this might impact asset lives.

5.1. OVERVIEW

In order to achieve the UK government's goal of achieving net zero carbon emissions by 2050, the electricity transmission network is expected to undergo transformative changes. These changes are primarily driven by the integration of renewable energy resources, which are often located far from demand centres. Renewable energy sources, particularly offshore wind farms off the east coast and Scotland, and onshore wind farms in the north of GB, bring a significant shift from traditional, centrally-located, fossil fuel-based generators. Integrating these renewable energy sources will require strategic reinforcements and innovations in transmission infrastructure. For example, expanded north-south transfer capacity will be needed to transport this generation to the south where demand is concentrated.

These developments will drive substantial increases in the use of HVDC subsea cables and HVDC converters. While some of these assets will be owned by Offshore Transmission Owners (OFTOs), subsea links will also be developed and be owned by the three onshore TOs. Each subsea link will typically require substantial reinforcements in the surrounding onshore region in order to support additional power flows to and from the onshore HVDC converter substation.

Accommodating the rapid deployment of renewable energy sources has required new strategies for working with tighter and more variable operating conditions. Intermittency of renewable energy sources requires network operators to be more flexible in managing power flows and in maintaining the frequency and voltage of electricity on the grid, and the acceleration of grid connections ahead of reinforcement works introduces tighter operating conditions. Adapting to these conditions has been supported by the deployment of smart grid solutions. Smart grid assets like Flexible Alternating Current Transmission System (FACTS) controllers can enhance grid stability and facilitate congestion management, Modern control and protection systems including Supervisory Control and Data Acquisition (SCADA) systems and digital protection relays can facilitate dynamic network management schemes. While many of these solutions are and will be deployed on the electricity distribution networks, some use of power electronics and control systems will also be made by the electricity transmission network companies.

The transition towards a low-carbon economy is also expected to grow demand within the electricity network. Widespread adoption of electric vehicles (EVs) and electric heat pumps (HPs) for residential and commercial heating are expected to increase electricity demand substantially. This rise in demand will require the network to have the capacity and flexibility to meet higher demand peaks. This strengthens the need for smart grid solutions, demand-side management, and storage technologies to optimise the transport and use of electricity. While the management of these challenges will largely take place on the distribution networks, the transmission network will need to accommodate larger flows of power to meet the expected peaks in demand. This will involve substantial network reinforcement to grow the capacity of the onshore transmission networks.

In summary, the UK Government's ambitious net zero targets are set to bring about wide structural changes in the electricity transmission network in GB. From substantial reinforcements in traditional network assets to the deployment of subsea cables and smart grid solutions, the network will undergo changes in how power flows and where it is sourced from. The changing mix of assets on the network is liable to change the average technical asset life of the network. The following sections discuss the scale of these changes and their resulting impact on the technical asset life of the network.

5.2. DRIVERS OF ASSET LIFE ESTIMATES FOR DIFFERENT ASSET CATEGORIES

The electricity transmission network companies anticipate that the evolution of the network with greater use of technologies such as subsea cables, HVDC converter substations, and smart grid solutions will put downward pressure on the average technical life of their networks. For example, subsea HVDC cables and the associated HVDC converters are estimated to form up to 16% of the total network MEAV by the end of RIIO-ET3.[20]

An asset's technical life may be limited by a variety of factors including physical degradation and obsolescence. We discuss below the evidence for current values of and possible changes in technical asset lives for the following categories of transmission network assets, whose estimated technical lives are listed in parentheses:

- subsea cables (20 – 40 years);
- smart grid assets, including control and protection equipment (digital protection relays and SCADA systems; 10 – 25 years) as well as equipment containing power electronics (FACTS controllers and HVDC converters; 35 – 40 years); and
- traditional network assets (overhead lines, underground cables, transformers, and switchgear; 41 - 70 years).[21]

These categories form virtually all of the network MEAV, and therefore have the greatest weighting in the calculation of a weighted average technical life. The following subsections therefore also consider the impact of the asset life assumptions of each asset categories on the overall average for the technical life of the network.

In summary, the low proportion of the network's MEAV allocated to subsea cables and smart grid assets are estimated to result in a limited effect on the average technical asset life of the network.

By the end of RIIO-ET3, new subsea cables and HVDC converters are estimated to lower the network average technical asset life by at most 5 years. This is obtained using a conservative estimate of 20 years for the average technical asset life of subsea cables and HVDC converters.

On the other hand, smart grid assets are only able to have a substantial impact on the network average technical asset life if the average cost of short-lived smart grid assets (such as digital protection relays and SCADA systems) amounts to at least £12.8 million per transmission connection. Since this is far beyond the likely cost of these systems, smart grid assets are not expected to have a significant impact on the network average technical asset life.

5.2.1. Growing Offshore Networks

The end of a cable's life is expected to be brought on by a series of failures that render it unsafe or not viable to repair. A higher rate of failures is therefore associated with shorter technical lives. By presenting an analysis of data and trends in failures in subsea cables, this section provides an assessment of the primary drivers for estimates of technical lives for subsea cables. However, in recent years, subsea cables have experienced tremendous development in terms of design and surveying. Since cables making use of these new developments have not yet reached their end of life, empirical data of the impact of recent design and surveying improvements on technical lives is limited.

The most recent publicly available data regarding failures of subsea cables is described in CIGRE TB 815, "Update of service experience of HV underground and submarine cable systems". This contains a survey of subsea cables

---

[20] The 16% figure is calculated using the upper bound cost estimate for subsea transmission projects in section 5.3.1, £13.2bn and the lower estimate for network MEAV in 2031, £84.6bn.

[21] The 41-70 years is the 'low' to 'high' range of weighted average technical asset life for the electricity transmission sector as set out in section 4.4.

operated throughout the period 2006 - 2015. The survey recorded 22 failures from a total of 6,098km of subsea cable, where each failure was associated with a de-energisation event.

Our assessment focuses on statistics comparing the primary drivers of degradation of subsea cables. In particular, we expect the subsea transmission cables to be heavily protected, whereas a significant fraction (31%) of the surveyed installed cables were laid unprotected on the seabed. Considering that the survey found that the large majority (89%) of cable faults with external cause occurred on unprotected cables, we can expect the subsea transmission cables to experience substantially longer lives than the average cable surveyed.

The survey also found that the overall failure rate has fallen by over 50% relative to the previous survey by CIGRE spanning 1991 - 2005. It cites improvements in surveying, cable laying and protection, and increased focus on protection (for example by burial) as the primary reasons for the industry-wide reduction in failures. We can expect that the subsea transmission cables installed in the future will benefit from these improvements.

On the network side, many failures of subsea cables have occurred on the distribution level. These are lower-capacity cables that extend shorter distances and require less capital investment. They are therefore less likely to be protected to an extent comparable with the subsea transmission cables under consideration. For example, as part of a consultation with Ofgem to obtain funds to mitigate uncertain costs associated with subsea cables, Scottish Hydro Electric Power Distribution (SHEPD) reported in 2019 that its portfolio of 396km of subsea cable had experienced a total of 9 failures to date. This translates to a rate of at least 1.5 failures per 100km per year - about three times the failure rate found from CIGRE's survey on all subsea cables.

Finally, significant advancements have been made in the surveying of subsea cable routes and the design of cable subsystems including cable protection systems, terminations, sheaths, and fibre optic tubes. Although the industry might face a rise in failures associated with learning how to implement these advancements, we can expect that the large transmission interconnector projects will use technologies and techniques that have been appropriately tested elsewhere.

In summary, the new subsea transmission cables should have longer technical lives than the average subsea cable existing today. The new cables will be better protected from external damage and they are expected to make use to improved designs and surveying techniques, all of which have been shown to reduce failure rates. Furthermore, the higher failure rate of existing subsea distribution cables cannot be extrapolated to the new subsea transmission cables.

5.2.2. Smart Grid Solutions

Smart grid solutions are characterised by the use of power electronics and information and communications technology (ICT) to accomplish a variety of objectives on the grid. These objectives include maintaining a constant frequency and voltage, ensuring that no grid element experiences an overload of current, and converting power between alternating and direct current.

The processing of digital information is accomplished by integrated circuits. As these are engineered with little tolerance for defects, they are susceptible to failure even under small scales of degradation. Semiconductor power electronics devices like thyristor valves experience similar processes of degradation; although they are more likely to be engineered to withstand the harsh operating conditions associated with high temperatures, voltages, and currents. Additionally, these devices are often tightly integrated with software and specialised equipment that quickly become obsolete.[22]

---

[22] Obsolescence can be caused by a variety of reasons. As manufacturers develop new products and cease to support older generations, there may be a lack of spare parts to replace failing components or a lack of expertise to maintain the equipment. If the equipment needs to interface with other pieces of hardware or software, its mode of interoperation may no longer exist as the other equipment is upgraded.

Assets used for smart grid solutions therefore often experience shorter technical asset lives compared to traditional network assets. Specifically, while integrated circuits have technical lives of 30 years,[23] the typical software and equipment lifecycle of 10 - 15 years can limit the technical lives of these assets. In this subsection we focus on control and protection equipment, FACTS controllers, and HVDC converters.

The use of control and protection equipment on the grid has evolved over the years, with increasing digitalisation and integration between control and protection systems. Electro-mechanical protection relays have been phased out with the introduction of digital protection relays, and SCADA systems continue to grow with the introduction of network management schemes based on protective monitoring and control protocols.

Early generations of digital protection relays have been found to reliably experience at least 20 - 25-year technical asset lives.[24] Compared with modern SCADA systems and intelligent electronic devices (IED) used for protection, control, monitoring, and metering, these early generations of digital protection relays were less integrated with networked computing systems and, as a result, protected from the short lifecycles associated with software. Modern control and protection assets are therefore susceptible to having their technical lives limited to 10 - 15 years by the obsolescence of software and digital standards. However, they may also be designed with this obsolescence in mind; for example, by using common standards and protocols instead of proprietary ones that are less likely to be supported by the next generation of technology.

FACTS controllers and HVDC converters are power electronics-based assets that require significant capital investment. As such, they are designed to outlast the short lifecycles typical of software and specialised equipment. Modern FACTS controllers and HVDC converters have integrated digital control and protection systems that form the shortest-lived components of the assets. According to CIGRE’s TB 649 on HVDC converters and Green Book on FACTS, this integrated control and protection system is expected to have a technical life of 12 - 15 years, meaning that at least one replacement of this system is expected throughout the asset’s design life of 35 - 40 years. These short-lived components are therefore expected to be accounted for in the ongoing cost of operations and maintenance for FACTS controllers and HVDC converters, leaving their technical lives at 35 - 40 years.

5.2.3. Improvements in Asset Management

Some advances have been made since 2010 in extending the technical lives of assets on the electricity transmission network. These have largely been technological developments allowing TOs to better understand degradation in overhead lines, transformers, and insulation systems.

Furthermore, the asset management strategies used by TOs have also undergone development. Seeking to justify maintenance and replacement works on the basis of quantified reductions to monetised long-term risk, RIIO-T2 required TOs to quantify the probability and monetised consequences of failure for each of their lead assets.[25] This new approach using Network Asset Risk Metrics (NARMs) stands in contrast with the old approach using Network Output Measures (NOMs), where asset health and the criticality of asset management works were assessed on a more qualitative level. There has also generally been a move towards increased utilisation of condition assessments to inform decisions regarding asset management, in a shift away from performing works on a fixed schedule. Although it is difficult to infer definitively how developments in asset management strategy affect the technical life of the asset base, we can expect to see gains in asset lives coming from improvements in standardisation and knowledge-sharing between the TOs in the process of developing and updating the NARM methodology.

---

[23] Srinivasan, Adve, Bose, and Rivers (2004). “The case for microarchitectural awareness of lifetime reliability”. In Proc. of the 31st Annual Intl. Symp. on Comp. Arch.

[24] The survey by Haas, Leoni, Zimmerman, Genz, and Mooney (2019) of over 10,000 digital protection relays manufactured between 1992 and 2018 found that early generations of digital relays “can reliably perform within specification during, and beyond, their intended service life of 20 years”.

[25] Lead assets refer to circuit breakers, overhead line conductors, overhead line fittings, overhead line towers, reactors, transformers, and underground cables.

Overhead lines

Given the large volume of overhead lines in operation, developments in extending their technical lives have focused on improving the time- and cost-efficiency of performing condition assessments. NGET introduced the use of LineCore technology to non-destructively infer corrosion levels in the steel core of Aluminium Conductor Steel Reinforced (ACSR) conductors. Compared to destructively removing a section of conductor for forensic analysis, they found that by using LineCore testing they were able to inspect over ten times more spans of conductor for the same cost.

Coupled with developments in identifying defects and using geographical maps of expected wind energy and corrosion, NGET reported in their RIIO-ET2 Business Plan Submission that they have obtained an extension of fully greased ACSR conductor lives by 5 years and an extension of All Aluminium Alloy Composite (AAAC) conductors by 10 years. They have similarly improved their capacity for performing visual inspections of overhead line fittings by using helicopter high-definition camera assessments (HDCA), which led to an increase in "route inspection cycle frequency from every 10 to every 8 years".[26]

Looking forward, NGET are piloting a Network Innovation Allowance (NIA) project to use autonomous drones to perform electrical testing of overhead line insulators. We can expect to see increasing use of autonomous drones in the future, given recent developments in computer vision and growing economies of scale in autonomous drone systems.[27]

Underground cables

The GB transmission network has largely transitioned away from using oil-filled cables, such that all new cables in RIIO-ET2 use cross-linked polyethylene (XLPE) rather than oil for electrical insulation. Therefore, one of the major questions for asset lives of underground cables in the GB transmission network is how the lives of cables insulated using XLPE compare with those of oil-filled cables, with terminations in XLPE cables providing the leading point of failure in RIIO-ET1.

A large survey of faults in underground cables operated throughout the period 2006 – 2015 is described in CIGRE TB 815. The survey recorded 744 failures from a total of 30,395km of underground cable. While 3.6% of the cable length were Direct Current (DC) cables, they accounted for only 2 of the 744 failures. The survey found that while failures in cable terminations account for more failures in XLPE cables than in oil-filled cables (26.8% vs 9.4%), oil-filled cables have an overall failure rate about two times as high as that for XLPE cables. The survey also found that whereas most faults in XLPE cables occur within the first 10 years of operation, and most within the first few years, the number of faults on oil-filled cables tends to increase with time after 25 years of operation. Coupled with SPT's acknowledgement that problems with XLPE cable terminations were "partly due to flaws in the earliest designs and some quality issues in installations", this data from CIGRE suggests that the initially high incidence rate of failures in XLPE cables is expected to slow down as the cables remain in service, resulting in overall lower rates of failure and longer asset lives than would be experienced by oil-filled cables.

Transformers

Advancements have also been made in performing condition assessments for transformers. A core method for condition assessment continues to be sampling of its insulating oil in order to perform a diagnostic Dissolved Gas Analysis (DGA) of the sample. While DGA is most economically performed in an offline laboratory setting, the capability to perform online DGA was introduced in RIIO-ET1. By connecting a monitoring device directly to a transformer, online DGA can continuously assess the condition of the transformers oil towards the end of its life.

---

[26] NGET (2019), RIIO-2 Business Plan: Investment Decision Pack – Overhead Line (OHL) Conductor and Fittings – available at: https://www.nationalgridet.com/document/132516/download

[27] NGET (2023), National Grid and University of Manchester pilot drone-mounted electric field sensors for pylon inspections – available at: https://www.nationalgrid.com/national-grid-and-university-manchester-pilot-drone-mounted-electric-field-sensors-pylon

The monitoring device can then be moved and reused once the transformer is no longer deemed to be at risk. With this and other advances, NGET reported in their RIIO-ET2 Business Plan Submission that they obtained an extension of transformer lives from 60 to 65 years.[28]

A variety of other advanced online sensors can probe aspects of the transformer such as the level of moisture in the oil and solid (paper) insulation, the phase and amplitude deviation between parallel bushings and voltage transformers, and the vibro-acoustic response of the tap-changer. These can provide early warning signs of failure and allow for pre-emptive interventions.

The increased rate of sampling also allows for the use of machine learning techniques. For example, by comparing continuous measurements of the top-oil temperature with the output of a neural network (trained on data obtained with an intact transformer cooling system), Hydro-Québec is able to detect deterioration of the cooling system.[29] In this case, the neural network helps them to establish a model for extreme ambient temperature conditions beyond the scope of standard loading guide models. Overall, the introduction of new and integrated sensor systems has improved condition assessments for transformers.

Monitoring and testing of high-voltage assets

Finally, advancements in partial discharge (PD) monitoring have improved condition assessments of insulating media in high voltage assets. PD monitoring enables TOs to non-destructively detect defects or deterioration in a wide variety of insulation systems, including gas-insulated substations (GIS) and XLPE cables. Transportable PD monitoring solutions have been introduced in order to focus expenditure on testing in the 'infant' phase of the GIS, when its insulation system has the highest probability of failure. Similar to devices used for online DGA monitoring, transportable PD monitoring solutions can be moved and reused once the GIS is no longer deemed to be at risk. With the transition in insulation technology from oil-filled to XLPE cables, oil sampling is no longer a feasible method of condition assessment for newly installed XLPE cables. Instead, transportable PD monitoring provides a natural solution for assessing insulation degradation in XLPE cables. Advancements in PD monitoring have therefore aided cost-efficient monitoring of GIS and allowed for a smooth transition from oil-filled to XLPE cables.

5.3. CHANGES IN FUTURE ASSET MIX, AND IMPACT ON AVERAGE ASSET LIVES

The electricity transmission network has seen a period of heightened reinforcements since 2010, with the total RAV projected to increase from £11.9 billion to £30.9 billion by the end of RIIO-ET2.[30, 31] The bulk of these reinforcements has been associated with overhead lines and underground cables, as well as equipment including transformers, switchgear, and protection and control systems.

We expect a high pace of network reinforcement to continue until at least 2030, when the UK government's first major net zero targets are due.

---

[28] NGET (2019), RIIO-2 Business Plan: Investment Decision Pack – Condition Monitoring – available at: https://www.nationalgrid.com/electricity-transmission/document/132486/download

[29] Hydro-Quebec is the largest electricity network operator in Canada, and published a discussion of their use of sensors and machine learning techniques in Picher et al. (2023), Development and implementation of transformer condition monitoring models for the interpretation of sensor and SCADA data.

[30] Ofgem (30 January 2024), ET2 Price Control Financial Model – available at: https://www.ofgem.gov.uk/publications/et2-price-control-financial-model

[31] Unless stated otherwise, we will use 2023/24 prices indexed by the Consumer Prices Index including owner occupiers' housing costs (CPIH).

Overhead lines

Appendix B of the 2023 Electricity Ten Year Statement (ETYS) published by NGESO records planned net additions of 2,897 circuit kilometres of overhead line, 651 circuit kilometres of underground cable, and 146 transformers to the transmission network between 2024 and 2032.

Net additions to overhead line towers are particularly noteworthy since they are the most long-lived assets on the network and comprise a substantial fraction of the total network MEAV (42%).[32] Although business plans for the coming RIIO-ET3 price control period have yet to be submitted to Ofgem, various plans have been made for new overhead line routes and the necessary towers. NGET estimated in 2023 that "likely transmission asset installation" in England and Wales will require the addition of over 5 times more overhead lines and underground cables by 2030 than has been built in the last 30 years.[33] A significant portion of this is expected to be apportioned for overhead lines. Appendix B of the 2023 ETYS records that over 9 times as many circuit kilometre additions have been planned for overhead lines relative to underground cables. Similarly, SPT's RIIO-ET2 business plan estimated that over 2,000 new towers would be added in the RIIO-ET2 and RIIO-ET3 periods.[34] With significant net additions over the current and coming price control periods, we expect overhead line towers to continue to play an important role in determining the weighted average technical life of the network.

Subsea transmission cables

The 2021/22 Network Options Assessment (NOA) Refresh states that 1,900km of subsea transmission cable will be built during the RIIO-ET3 period. The projects associated with delivering this have been classified as essential for achieving the UK's target for 50GW of offshore wind capacity by 2030. These assets are largely associated with transmission links between mainland Scotland and England. This figure does not include the sizeable volume[35] of subsea export and array cables used by offshore wind farms that will be owned by OFTOs and offshore wind farm operators.

Smart grid assets

The volume of smart grid assets in the transmission network is expected to experience substantial growth as operation of the grid continues to be modernised. For instance, each HVDC subsea interconnector will connect into the onshore transmission network through an onshore HVDC converter. This will require the construction of 12 onshore HVDC converters over the RIIO-ET3 period.

More assets associated with control and protection will be required to implement network management schemes in order to accelerate grid connections ahead of network reinforcements. However, the large majority of these schemes (and associated assets) are implemented on the distribution side of the network, with transmission-level assets only monitoring super grid transformers (SGTs) at grid supply points (GSPs) and 132kV assets in Scotland. Other smart grid assets like digital protection relays and FACTS controllers are expected to be added to the grid alongside traditional network assets as part of modern protection and control systems.

5.3.1. Possible impacts on average asset life of the network

The total MEAV of the network has been estimated at £72.2 billion (in 2023/24 prices) in 2024. The impact of additional subsea transmission cables and smart grid assets on the network's weighted average technical life will depend on their share of the network MEAV (i.e. the weighting).

---

[32] Which includes overhead line conductor, fittings, and towers.

[33] National Grid (2023), Delivering for 2035: Upgrading the grid for a secure, clean and affordable energy future – available at: https://www.nationalgrid.com/document/149496/download

[34] SPT (2019), RIIO-T2 Business Plan Data Tables – available at: https://www.spenergynetworks.co.uk/userfiles/file/RIIO-T2_Annex_11_BPDT_SPT.xlsx

[35] Over 3,300km in 2018, according to El Mountassir and Strang-Moran in "Offshore Wind Subsea Power Cables: Installation, Operation and Market Trends" (2018).

The subsea transmission cables expected to be added in the RIIO-ET3 period are associated with the four Eastern Green Link (EGL) projects connecting Scotland and England, Spittal-Peterhead Subsea Link, and Suffolk-Kent Sea Link. Before the submission of the RIIO-ET3 business plans, it is difficult to forecast the network MEAV in 2031, when these links are scheduled to be energised. However, we can estimate an upper bound on the impact of these assets using cost estimates from Appendix A of NOA Refresh 2021/22. The total estimated cost of the projects listed above is £9.8 - £13.2 billion, which includes the cost of both subsea cables and HVDC converters.

In the NOA Refresh 2021/22, a cost estimate is provided for about one third of the transmission reinforcement projects classified as HND essential. Adding the total estimated cost of HND essential projects (where provided) to the present network MEAV of £72.2 billion obtains a lower bound estimate of £84.6 - £93.4 billion for the network MEAV at the end of RIIO-ET3 in 2031.

The subsea transmission projects will therefore likely constitute no more than 16% of the network MEAV and would need to have an average technical asset life of under 5 years in order to lower the network average from 55 to below 47 - 50 years (depending on which cost scenario is used from the NOA refresh).[36] 5 years is considerably lower than the estimated technical asset life of either the subsea cables (20 – 40 years) or the HVDC converters (35 – 40 years),[37] their impact on the network average remains limited even in this extreme case. A more typical average technical asset life of 20 years for the subsea transmission assets would instead lower the network average from 55 to 50 - 51 years. Given that we have not accounted for the remaining two thirds of the projects classified as HND essential, we consider these estimates to be indicative upper bounds on the possible impact that the subsea transmission projects could have on reducing the technical asset life of the network up to 2031.

In the RIIO-ET4 period between 2031 and 2036, the rate of construction of subsea transmission cables is expected to slow down substantially, driven by 2030 50GW offshore wind capacity target. Therefore, their impact on reducing the average technical asset life of the network is expected to weaken in the RIIO-ET4 price control period.

In order to estimate the impact of short-lived assets on the transmission network's technical asset life, we can estimate the cost per transmission connection required to generate an appreciable impact. This follows the approach for the electricity distribution network used in section 4.4.1 of the 2010 CEPA report.

Focussing on smart grid assets with 15-year technical asset lives, such as SCADA systems and digital protection relays,[38] at least 12.5% of the total network MEAV is required to be short-lived assets in order to lower the network average technical asset life from 55 to 50 years.

5.4. FUTURE USE OF ASSETS AND THE IMPACT ON ECONOMIC LIVES

The economic life estimate aims to capture the effect of macroscopic changes including shifting demand and usage, and future implementation of energy policy - which could reduce the useful life below the technical asset live. In the 2010 study, we estimated that electricity demand was expected to rise and that, in general, electricity network assets would remain economically useful over their technical lives. Therefore, the estimated economic lives were set equal to the estimated technical lives.

Based on the Energy System Operators (ESOs) latest Future Energy Scenarios (FES) 2023, it is expected that electricity demand will increase significantly over the next few decades through to 2050, compared to today.[39]

---

[36] The range of figures here is associated with the range of estimated costs in NOA Refresh 2021/22.

[37] For example, the Western HVDC Link, which has experienced an unusually high number of failures in its first few years of service, will have been in full service for 5 years by the end of 2024.

[38] For smart grid assets with longer lives, for instance FACTS controllers with 35 - 40-year lives, 50 - 66.7% of the total network MEAV is required to be allocated to such assets in order to lower the average economic life to 45 years. These assets are therefore unlikely to have any appreciable impact on the economic life of the network.

[39] National Grid ESO (2023), Future Energy Scenarios (FES) 2023 – available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios-fes

Beyond 2050, it is expected that electricity networks will remain critical, with even greater reliance on the networks as a result of the electrification of heat and transport. This means that the assumption underpinning the 2010 view appears to still hold for the current forecasts of electricity demand.

There are uncertainties which affect the estimation of economic life, such as earlier than anticipated replacement of assets, as a result of new connections or strategic investment, leading to an asset being replaced before reaching the end of its technical life, or asset stranding. For example, sole use assets such as subsea cables that are built to connect offshore wind farms which reach the end of their life ahead of the cable’s technical life.

Network companies through their responses to Ofgem’s consultation have raised these issues. However, we have not seen any evidence that quantifies the extent or impact that this may have on the economic lives of network assets. Ofgem may wish to review this as part of its overall assessment of regulatory depreciation policy.

CEPA
economics matters

UK

Queens House

55-56 Lincoln’s Inn Fields

London WC2A 3LJ

T. **+44 (0)20 7269 0210**

E. **info@cepa.co.uk**

www.cepa.co.uk

Australia

Level 20, Tower 2 Darling Park

201 Sussex Street

Sydney NSW 2000

T. **+61 2 9006 1308**

E. **info@cepa.net.au**

www.cepa.net.au

Cepa-ltd **@cepaltd**