NATIONAL INFRASTRUCTURE COMMISSION

Better infrastructure for all

Electricity distribution networks: Creating capacity for the Future

Impact and costings for recommendations

February 2025

Contents

Introduction

The Commission is committed to transparency around the costs and impacts of its recommendations, as reflected in the remit letter from the Chancellor.[1] This document includes the Commission's assessment of the impact and costs of recommendations made within the *Electricity Distribution Networks* study. They consider how the recommendations could have implications on public spending, energy bills and the wider UK economy, carbon emissions and the environment. The recommendations from the study are additional to the energy sector recommendations from the second *National Infrastructure Assessment*, and therefore the impacts and costs in this document should be treated as additional too.

This document presents:

- the impact of the recommendations on the Commission's objectives to support sustainable economic growth across all regions of the UK, improve competitiveness, improve quality of life and support climate resilience and the transition to net zero
- the estimated costs of the recommendations and their impact on the Commission's fiscal and economic remits
- distributional costs and impacts of recommendations on protected groups
- uncertainty around estimates and the balance of evidence behind recommendations.

The Commission's objectives

This document sets out how the recommendations in the Study contribute towards the Commission's four objectives. A previous series of discussion papers set out the Commission's approach to how infrastructure contributes to each of these objectives.

Growth Across Regions interprets the objective of growth across all regions in the UK as supporting faster growth in low productivity regions and balancing this with maintaining the economic performance of high productivity regions.[2]

Improving Competitiveness identifies three ways infrastructure can contribute to competitiveness: improving access to markets, improving access to mobile labour and capital, and being a source of globally significant clusters and assets.[3]

Quality of Life sets out six domains by which the Commission assesses the impact of infrastructure on overall wellbeing.[4] The domains and their definitions are set out in **Table 1**, which are applied in each **Section 2.**

Support Climate Resilience and the Transition to Net Zero Carbon Emissions by 2050 covers both the government's legal target of net zero emissions by 2050 and other interim targets, such as carbon budgets.

In addition to the Commission's four objectives, *Natural Capital and Environmental Net Gain* sets out the ways that natural capital principles can achieve environmental net gain when developing infrastructure projects.[5] The Commission is also required to consider potential interactions between recommendations and the government's legal target to halt biodiversity loss by 2030 and implement biodiversity net gain. This document assesses the environmental

[1] HM Treasury (2021), Remit Letter to the National Infrastructure Commission
[2] National Infrastructure Commission (2020), Growth across regions
[3] National Infrastructure Commission (2020), Improving Competitiveness
[4] National Infrastructure Commission (2022), Quality of life
[5] National Infrastructure Commission (2021), Natural capital and environmental net gain

impacts of the Commission's recommendations against areas covered in the Environmental Improvement Plan in **Section 6.**

Table 1: The Commission's quality of life domains

Domain name	Definition
Health	The impact of infrastructure services on physical and mental health
Local and natural surroundings	The impact of infrastructure design and operation on the local and natural environment
Connections	The physical connections (transport networks) and digital connections (fixed and mobile broadband) that link people, communities and businesses
Affordability	The distributional impact of the cost of infrastructure services that domestic consumers pay through bills or fares and the overall cost of infrastructure over time
Comfort and convenience	Users' experience with infrastructure services including the level of satisfaction derived from these services
Employment	How infrastructure acts as an enabler for patterns of economic activity and therefore access to jobs

The Commission's remit

To satisfy its obligations to the fiscal and economic remits, the Commission has assessed the direct impact of these recommendations on public capital expenditure (fiscal remit) and public resource expenditure (economic remit), as well as other sources of infrastructure funding including consumer bills (economic remit). In addition, this considers the distributional impacts of the costs of infrastructure services paid through bills across income deciles, regions and protected characteristics.

Accounting for uncertainty

This document tests how recommendations made in the Study fare in different possible future states of the world and to changes in assumptions. While the Commission has modelled the cost of upgrading the distribution network under different scenarios, the Study does not recommend a specific level or pathway for investment. Instead, it makes recommendations about how the system can best take an adaptive approach to investment in order to manage this uncertainty. The Commission's uncertainty framework sets out three risk classifications to consider when managing a portfolio of infrastructure projects or policies when the probabilities of different future events or states of the world are unknown: [6]

- **Robust investment** – investments that perform acceptably well across a wide range of future scenarios, including significantly increased investment in the electricity distribution network to meet interim carbon budgets and net zero. This could also include low-regrets investment, such as unlooping domestic properties.
- **Strategic bet** – Investments that perform well in a small number of scenarios and so may not pay off, but when they do the payoff is very significant, such as investments to enable industrial decarbonisation and new housing, which require greater strategic planning.

[6] National Infrastructure Commission (2022), Managing uncertainty in the second National Infrastructure Assessment

- Hedge – Investments that pay off in scenarios where other investment, projects or policies would perform poorly.

The impact and costing note sees the Commission review these factors in a standard format for the electricity distribution network. All monetary values are presented in 2024 prices.

Section 1: Study recommendations and outcomes

The Commission has made 14 recommendations within the Study, in addition to the energy sector recommendations made in the second *National Infrastructure Assessment*.[7] [8] The Study sets out recommendations for the electricity distribution network, which moves electricity regionally using lower voltage wires. It is how the vast majority of end users, including most businesses and all households, connect to the electricity system.

Outcomes

The Commission's recommendations from this Study will support the electrification of the economy. Electricity demand is set to increase by around 50 per cent by 2035 as surface transport and heating are electrified and industry is increasingly powered by electricity.[8] The recommendations are designed to achieve:

- a reliable electricity supply
- households and businesses being able to get the electricity connection they need when they need it, including supporting the heat transition
- a more flexible, digitalised electricity distribution network

This will support the Commission's energy recommendations in the second *National Infrastructure Assessment,* designed to achieve a decarbonised energy system that meets net zero by 2050, as well as interim carbon budgets. The electricity system will need to run mostly from renewable power sources like wind and solar, increasingly connected to the electricity distribution network. An energy system predominantly running on low carbon electricity, rather than fossil fuels, is more efficient, cleaner and better insulated from volatile fuel prices. This should roughly halve the average household cost for energy compared to 2019 and 2022's high levels, which were the basis for comparisons in the second Assessment.[8]

Level of investment

To support the Study, the Commission procured modelling and analysis from Regen and EA Technology to understand the level of distribution network investment that could be required to achieve net zero. This covered two types of modelling:

- National analysis – using EA Technology's *Transform* model to assess the potential load related expenditure that could be required for the low voltage, high voltage and extra high voltage networks across Great Britain in different scenarios.
- Low voltage network case studies – considering how load growth could affect different parts of the network in different ways.

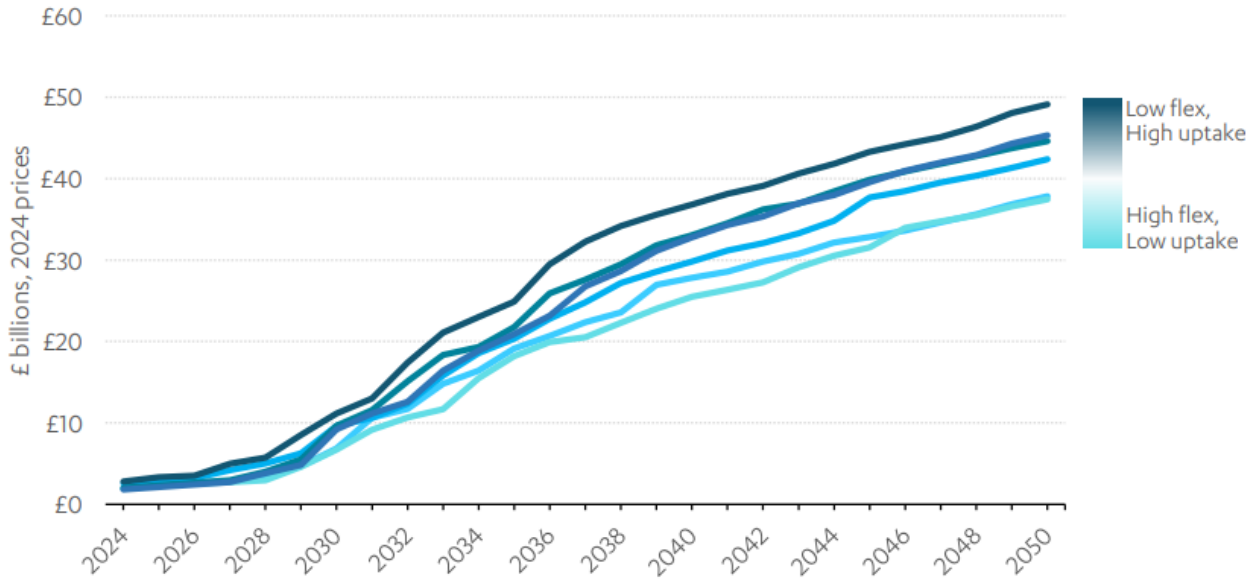
This modelling was not designed to identify a single investment pathway to make distribution networks fit for net zero. Rather, it was designed to understand the broad trajectory and the impacts of different behavioural and policy choices. The analysis looked at load related expenditure – that driven by increased demand – so this investment is additional to business-as-usual investment such as end of life asset replacement.[9] Load related expenditure is a small but growing proportion of total expenditure.[10]

[7] National Infrastructure Commission (2025), Electricity Distribution Networks study
[8] National Infrastructure Commission (2023), second National Infrastructure Assessment
[9] In reality, there would be expected to be some overlap between business as usual and load related expenditure – for example, replacing a transformer at the end of its life with one sized for future demand. This should create opportunities for distribution network operators to create efficiencies across programmes, reducing costs and distribution for consumers.
[10] Commission analysis based on historic data from Ofgem and Regen and EA Technology's modelling

The Commission has modelled the investment needs of the network under a number of different scenarios. The technology uptake scenarios were based on data from the (former) Electricity System Operator's *Future Energy Scenarios 2023 Consumer Transformation* scenario and load profile data from distribution network operators, with variations to the heat technology mix and levels of flexibility tested via sensitivity analysis. These scenarios are used to estimate peak demand (and generation) and are used in combination with EA Technology's *Transform* model to estimate network investment needed. Further details on the methodology can be found in the published reports from Regen and EA Technology.[11]

Figure 1: Investment is expected to increase significantly in all scenarios

Cumulative load related expenditure from 2024 to 2050



Source: Regen and EA Technology analysis for the Commission.

Note: This excludes non-load related expenditure and load related expenditure for 132 kV and low voltage service cables.

Figure 1 shows the cumulative profile of load related expenditure up to 2050 from the core scenarios in the national modelling. These scenarios tested different net zero compliant uptake scenarios for low carbon technologies and different levels of flexibility for heat pumps, electric vehicles and batteries. Across these core scenarios, £37-50 billion of load related expenditure could be required between today and 2050 to meet additional demand. 60 to 70 per cent of investment is projected to be on the low voltage network and a significant ramp up in investment is required in the 2030s. The expansive nature of the low voltage network – comprising 45 per cent of total wire length and 97 per cent of substations – drives this high share of investment.[12]

Figure 1 also shows the potential for flexibility to reduce the amount of network investment required. Compared to the low flexibility model scenarios, higher flexibility scenarios require roughly 15 per cent less distribution network investment by 2050. This represents a saving of £6.7-7.9 billion across the period from 2024 to 2050, depending on the heating uptake scenario used. Greater use of flexibility also has the impact of delaying when investment is needed, although a significant amount of investment is still needed even with high levels of

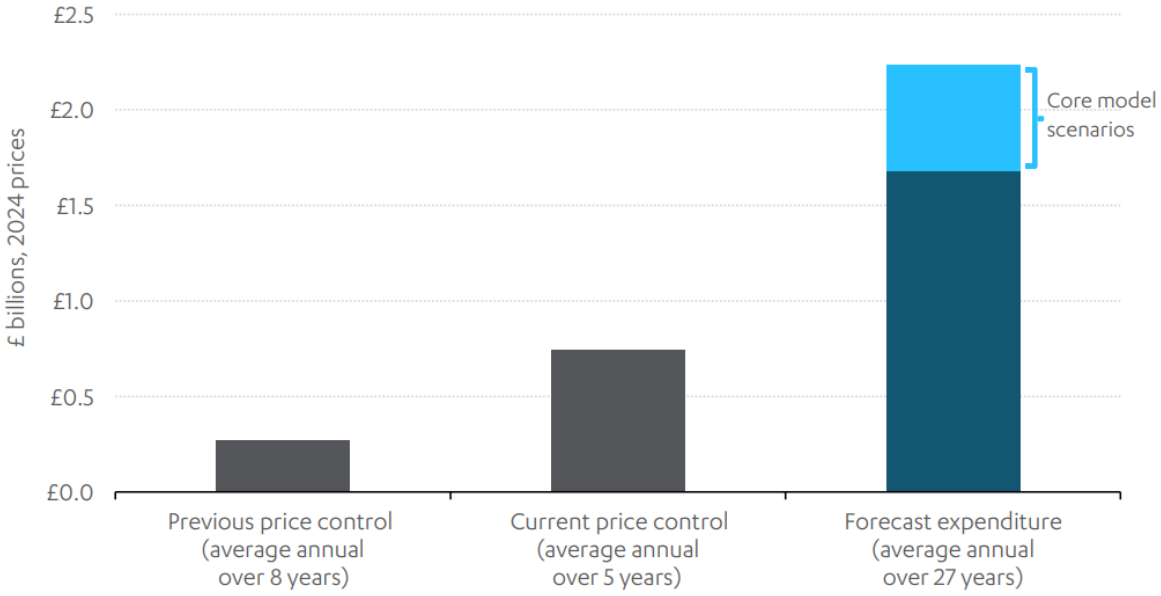
[11] Regen and EA Technology (2025), Electricity Distribution Network Capacity Analysis summary report
[12] Department for Business, Energy and Industrial Strategy (2022), Appendix 1: Electricity Networks Modelling; Energy Networks Association (2015) Climate Change Adaptation Reporting Power Second Round

flexibility. In this analysis, the value of flexibility is primarily through national deployment to reduce peak demand, rather than through flexibility to manage local network constraints. Enabling high levels of flexibility should therefore be a key objective for the distribution network and the electricity system as a whole.

Each of these scenarios would represent a significant step change on historic load related expenditure, although they would only have a small impact on bills overall. The previous electricity distribution price control period (2015 to 2022) delivered an annual average of £270 million of load related expenditure and the forecast average for the current price control (2023 to 2027) is £745 million per year. This compares to a range of £1.7-2.2 billion per year in the core scenarios for the national modelling – see **Figure 2**.

Figure 2: A step change in electricity distribution network investment is needed

Average annual load related expenditure from 2015 to 2050



Source: Commission analysis using Regen and EA Technology's modelling and data from the Department for Energy Security and Net Zero and Ofgem.

The *Transform* model does not include the highest 132 kV infrastructure or low voltage service cables that connect to properties. These forecast load related expenditure figures have therefore been uplifted (using estimates from Department for Energy Security and Net Zero for 132 kV infrastructure and expenditure data from Ofgem for low voltage service cables) by around 21 per cent per year on average, with higher uplifts in the short term due to more spending on these categories in earlier years. This means the load related expenditure estimates in **Figure 2** cover the entire distribution network in Great Britain and allow for better comparisons with Ofgem data.

Funding and financing

The electricity distribution network is built and operated by the private sector and paid for through energy bills. Ofgem regulates energy networks, including electricity distribution, through the price control process. Price controls set the amount of money that network companies can recover from consumers over a set period of time. The current price control period runs from April 2023 to March 2028. Distribution network operators submit business

plans to Ofgem outlining their estimated costs for operating and managing their networks – including growth to meet new demand – as well as their core business activity. Ofgem assesses these costs and sets baseline revenue allowances. Distribution network operators then recover their revenue through charges in consumer energy bills. The aim of the price control is to enable network operators to gain a fair return, while regulating the end cost to consumers.

The current price control set out a £29.2 billion (in 2024 prices) package of investment in the distribution network, including £4.8 billion in load related expenditure as well as allowances for non-load related and other expenditure.[13] At the time price control decisions were set in 2022, Ofgem estimated that the costs of the distribution network comprised around £100 per domestic billpayer within an average electricity bill of around £1,200 per year.[14] **Section 4** discusses the magnitude of impact of the Commission's energy recommendations on households, businesses and government as part of its economic remit. **Section 5** considers how the distribution of costs across households has been accounted for.

[13] Ofgem (2022), RIIO-ED2 Final Determinations Overview document
[14] Ofgem (2023), RIIO-1 Electricity Distribution Annual Report 2021-22 and Regulatory Financial Performance Annex to RIIO-1 Annual Reports; Department for Energy Security and Net Zero (2024), Annual domestic energy bills

Section 2: Contribution towards the Commission's objectives

This section explains how the Commission's recommendations set out in the *Electricity Distribution Networks* study contribute towards its four objectives.

Support sustainable economic growth across all regions

The Commission's recommendations in this Study are highly likely to support sustainable economic growth. Sufficient electricity distribution network capacity is needed to electrify the economy and move away from fossil fuels. It is also needed to enable new electricity demand, such as data centres, which further contributes to economic growth. Without this, investment could also be delayed or prevented altogether. Capacity for households and businesses to connect to the distribution network and preventing outages are necessary, but not sufficient, for sustainable economic growth. Recommendations in the second *National Infrastructure Assessment* and behavioural changes are still required to deliver this.

The consequences of failing to meet changing patterns of supply and demand have become clear at electricity transmission network level. Network connection dates have been pushed out significantly. In 2023, energy bill payers paid £1.4 billion in constraint costs because the transmission network did not have the capacity to transmit all the energy generated by renewables.[8] The lack of capacity on the transmission network has had knock on impacts for the distribution network too - around 40 per cent of the distribution connections queue is dependent on transmission reinforcement.[15]

The Study states that failing to meet changing patterns of supply and demand must not happen on the electricity distribution network as well. The network is owned and operated by six distribution network operators that cover all regions throughout Great Britain. A step change in electricity distribution network investment will be required across these regions, supporting economic growth across the country.

Improve competitiveness

The Commission's recommendations in this Study are likely to contribute positively to improving competition, within the wider context of Ofgem's approach to economic regulation. The Commission's recommendations around digitalisation could improve competition and lower costs through the increased use of flexibility to manage peak demand. The package of recommendations promote long-term stability and predictability of investment in the electricity distribution network, improving investor confidence and certainty within supply chains. Furthermore, sufficient network capacity is a necessary condition for investment, which is needed to ensure the UK is competitive globally.

Beyond the electricity distribution network, enabling the scale up of new forms of low carbon generation and heating technologies will increase competition with domestic energy markets, with an increasing proportion of generation expected to be connected to the distribution network. Increased competition typically reduces the cost of doing business, reducing the costs for new entrants as well as for incumbents. The role of the electricity distribution network in providing access to decarbonised electricity and maintaining high levels of reliability will allow UK firms to capture market share in global low carbon supply chains.

When combined with the recommendations from the second *National Infrastructure Assessment*, the recommendations from this Study are expected to support lower and less volatile energy bills through decoupling electricity from gas prices, lower marginal cost renewable electricity generation and spreading system costs over a growing demand base.

[15] Regen (2024), Toxic constraint coverage could damage Clean Power Plan

This will increase the ability of UK services and manufacturing to stay internationally competitive.

Improve quality of life

The Commission's recommendations in this Study are likely to improve quality of life by ensuring the electricity distribution network can meet growing electricity demand, connect customers in a timely manner and with good customer service, and maintain high levels of reliability across the network, particularly as customers move away from gas to electricity.

Table 2: Summary of quality of life impacts by domain

Domain	Summary of impacts
Health	The Commission's recommendations in this Study are likely to enable the positive health impacts of recommendations from the second *National Infrastructure Assessment*, such as improvements in air quality and the energy efficiency of homes, improving heat retention in cold periods.
Local and natural surroundings	The distribution network is expansive, comprised of over 838,000km of wires, more than 230,000 substations and 348,000 pole mounted transformers.[12] Electricity is moved by wires suspended by pylons, poles, or cables buried beneath the ground. The split varies regionally, with more rural areas reliant on poles and wires, and more urban areas using cables. The lower voltage level, which has the greatest proportion of cables, has over 80 per cent of its cabling buried beneath the ground.[12] The Commission's recommendations on planning for Nationally Significant Infrastructure Projects from the second *National Infrastructure Assessment* will ensure that projects which fall in this category have clear upfront standards to meet to ensure their impact on the natural and built environment is appropriately and strategically mitigated. This will provide communities with clarity on how the impact of large schemes will be managed. This means any negative impacts from building new energy infrastructure as a result of recommendations should be mitigated. Electricity distribution network infrastructure can intrude on local and natural surroundings though their visual impact can be mitigated.[16] The Commission's recommendations in this Study on improving the planning and consenting system could make it easier for distribution network operators to upgrade existing apparatus, allowing for an increased network capacity without the need for new equipment, minimising disruption and visual impact. The Commission's recommended 'touch the network once' approach should also reduce disruption.
Connectivity	The Commission's recommendations in this Study are highly likely to improve the reliability of journeys and help decarbonise transport through improved EV charging infrastructure. They could also improve digital connectivity through, for example, increasing data centre connections to the network and a more resilient network.

[16] National Grid (2017), Visual Impact Provision; National Grid (2017), Annex to Visual Impact Provision Policy

Affordability	The Commission's recommendations in this Study complement the package of recommendations in the second *National Infrastructure Assessment*. Despite the slight increase in network costs on energy bills, when these recommendations from the Study and second Assessment are taken together a lower proportion of income is expected to be spent on energy by households in the future, as detailed in **Section 4**.
Comfort and convenience	The Commission's recommendations in this Study are supported by modelling that assesses how the electricity distribution network can reliably meet higher levels of demand, either maintaining or improving comfort and convenience. This will be particularly important as more customers switch to electric heating technologies such as heat pumps.
Employment	The Commission's recommendations in this Study and supporting modelling indicate the need for a significant increase in investment in the electricity distribution networks. This will lead to an increase in construction employment to build, upgrade and repurpose the electricity distribution networks. Opportunities in this sector exist nationwide as the networks are owned and operated by six distribution network operators that cover all regions throughout Great Britain. The workforce needs to grow to deliver the required level of investment. Baringa has estimated that the overall energy workforce needs to double by 2028 to meet the government's net zero ambitions and a report from National Grid estimated that 400,000 new recruits would be needed between 2020 and 2050 to deliver the transition to net zero – 117,000 of which would be needed between 2020 and 2029.[17] There are likely to be indirect employment benefits in other sectors, including transport and digital. Moving to a more proactive approach to investment should have direct benefits for supply chains and skills. Providing higher levels of certainty, over a longer period of time, should make longer term skills and workforce planning easier for both networks and their supply chain. The involvement of strategic authorities with skills powers in the Regional Energy Strategic Plans can also help inform skills planning and delivery in local areas.

Support climate resilience and the transition to net zero carbon emissions by 2050

The Commission's recommendations in this Study will have a strongly positive (albeit indirect) contribution to this objective. Around 80 per cent of the UK's energy demand is currently met by fossil fuels.[18] The recommendations will support the electrification of the economy, with an increasing proportion of renewable electricity generation connected to the distribution network, as well as the electrification of heating and transport. The security of supply recommendations will mean the distribution network is designed for future electricity loads and weather events, ensuring the network is resilient to climate change and vulnerable customers are protected. Investing ahead of need will give businesses and households the choice to decarbonise when they need to, instead of waiting until the network is ready for

[17] Baringa (2024), UK renewables deployment supply chain readiness study - Executive summary for industry and policymakers; National Grid (2020) Building the Net Zero Energy Workforce
[18] Department for Energy Security and Net Zero (2023), Digest of UK Energy Statistics

them to decarbonise. This will significantly reduce carbon emissions and ensure the network is resilient to climate change. Taking the recommended actions will support the UK in meeting its legally binding climate targets.

Section 3: Impact on the Commission's fiscal remit

The electricity distribution network is built and operated by the private sector and paid for through energy bills. Businesses can also pass their costs of financing onto users. Therefore, the costs of economic infrastructure services are ultimately paid for by households. The Commission's recommendations do not require public capital to support the electricity distribution network being fit for net zero, so there is no impact on the Commission's fiscal remit.

Section 4: Impact on the Commission's economic remit

The recommendations made in the *Electricity Distribution Network Study* will have an impact on the economic remit through consumer energy bills and public sector resource expenditure. Households and businesses pay to use energy infrastructure and services through energy bills. The public sector incurs resource costs in delivering certain government policies, which are paid through general taxation.

Whilst the cost of the additional load related expenditure across the core scenarios developed for this study would amount to around £5-25 extra each year per household from now to 2050, the overall trajectory of energy expenditure by households is estimated to fall. This is in line with the conclusions and recommendations for the second *National Infrastructure Assessment*. Business spending on energy infrastructure will remain broadly similar over the period even with the additional distribution network cost.[19] Public sector resource costs are likely to increase by a small amount as a result of the recommendation to increase the capacity and capability of local authority energy planning.

Costs to households and businesses

Methodology

The Commission uses the network investment scenarios and sensitivities described in **section 1** as inputs to a regulatory financing framework. This determines how much revenue distribution network operators are allowed to charge consumers and how much return investors get on their capital. This is based on Ofgem's current price control period for the electricity distribution network, with the final determinations for the capitalisation rate, asset life, and weighted average cost of capital from the start of the price control period shown in **Table 3**.

Table 3: Regulatory financing assumptions

Variable	Central assumptions	Description
Capitalisation rate	85 per cent	Determines the split between investment that is fed into the Regulatory Asset Value (RAV) and investment that is recouped in the same year. This is the capitalisation rate for load related expenditure for most distribution network operators during the current price control period.
Asset life	45 years	The regulatory asset life of distribution network assets is set by Ofgem and is used to determine the depreciation based on the Regulatory Asset Value, using a straight line approach. Ofgem set the asset life at 45 years for the current (2023-2028) and previous (2015-2023) price control periods. It was previously 20 years.
Weighted Average Cost of Capital	3.93 per cent	A weighted average of the cost of debt and the cost of equity that is used to calculate distribution network operators' allowed return on investment for each year. This figure is based on debt contracts for distribution network operators as well as underlying UK government bond interest rates and market returns, so it is subject to

[19] Under the current charging framework, large industrial and commercial users will pay to connect to the network when reinforcement of the network is required – this not assessed directly but the average cost for non-domestic customers will capture this.

		change over time. Ofgem set the weighted average cost of capital at 3.93 per cent across most operators at the start of the current price control period (2023).[20]

The capitalisation rate apportions the additional network investment needed into fast money, that is returned pound-for-pound in the same year, and slow money, that goes into building the Regulatory Asset Value. The allowed revenue in each year is a combination of fast money, depreciation and investor returns on the Regulatory Asset Value, which is projected out to 2050.

Allowed revenue is divided into household and business portions (**Table 4**) using annual electricity demand from the *Future Energy Scenarios 2023 Consumer Transformation* scenario, excluding transmission connected electricity demand and transmission system losses.[21] **Figure 3** shows the split between household and business electricity demand, with businesses' electricity demand set to grow more than households' as energy intensive industries decarbonise and new sources of demand are connected, such as data centres. To ensure annual electricity demand reflects the variation in low carbon technology uptake and flexibility assumptions across the core models scenarios, annual electricity demand is scaled by the difference in peak demand across core model scenarios relative to the *Consumer Transformation* scenario.

Table 4: Additional allowed revenue for households and businesses, core model scenarios, £ millions, 2024 prices

Customer	2025 - 2029	2030 - 2034	2035 - 2039	2040 - 2044	2045 - 2049
Households	£80 - £390	£280 - £780	£430 - £850	£520 - £770	£560 - £760
Businesses	£140 - £700	£480 - £1,320	£770 - £1,490	£1,020 - £1,580	£1,200 -£1,790

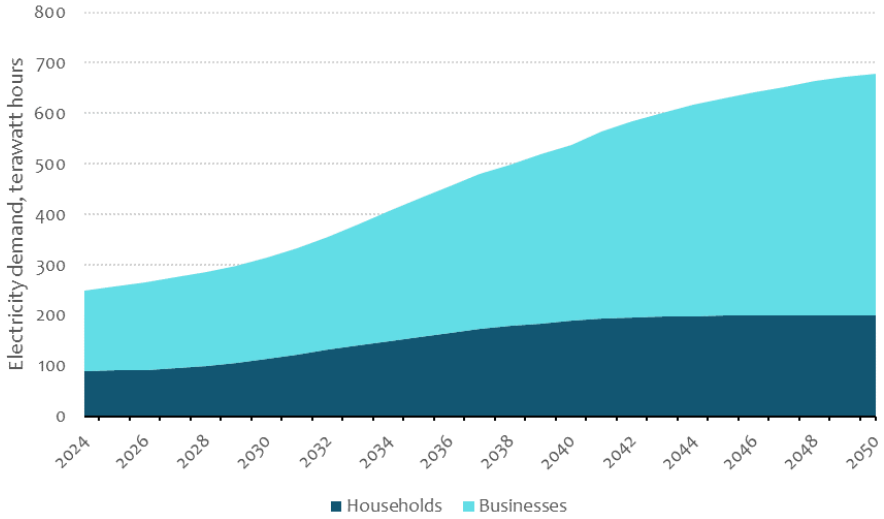
Note: Rounded to the nearest £10 million in 2024 prices.

The average cost per customer is then estimated by dividing the allowed revenue portions by the total number of household and business customers, using Ofgem customer connection data from 2010 to 2022 and Meter Point Administration Numbers data/forecasts from 2022 to 2030.[22] To forecast out to 2050, the high scenario uses the annual growth rate in domestic and non-domestic buildings from the *Future Energy Scenario 2023 Consumer Transformation* scenario. The low scenario uses a linear extrapolation based on Ofgem data from 2010 to 2021. **Figure 4** shows the central scenario, which is in the middle of the high and low scenarios.

[20] Ofgem (2022), RIIO-ED2 Final Determinations
[21] Electricity System Operator (2023), Future Energy Scenarios (FES)
[22] Distribution Connection and Use of System Agreement (2024), Annual Review Packs and Cost Information; Ofgem (2023) Regulatory Financial Performance Annex to RIIO-1 Annual Report 2021-22

Figure 3: Electricity demand is expected to grow faster for businesses than households

Annual electricity demand for households and businesses from 2024 to 2050, Consumer Transformation scenario

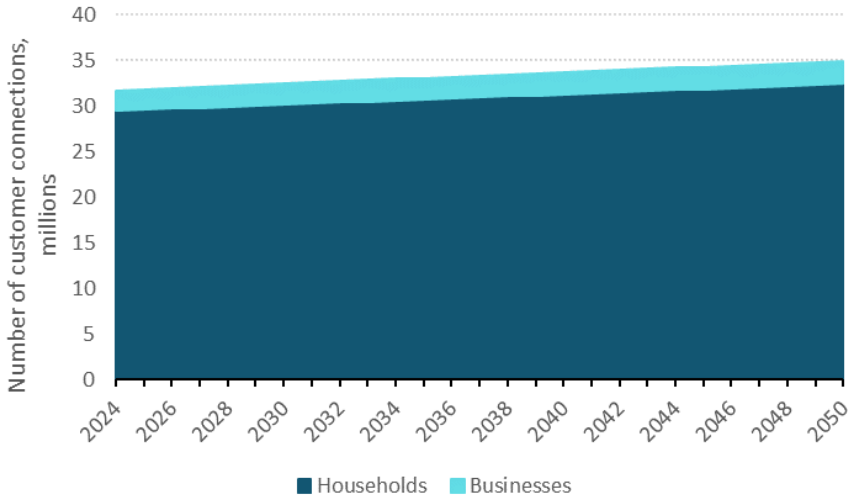


Source: Commission analysis of data from Electricity System Operator.

Note: This excludes transmission connected electricity demand and transmission system losses.

Figure 4: The number of customers connected to the electricity distribution network is expected to grow steadily

Number of households and businesses connected from 2024 to 2050, central scenario



Source: Commission analysis of data from Ofgem, distribution network operators and Electricity System Operator.

Overall results

The cost of additional network investment is expected to range from £5-25 each year per household between now and 2050 across our core model runs (**Table 5**). In the context of declining wholesale electricity costs and our recommendations on price re-balancing from the second *National Instructure Assessment*, this should still mean average household bills falling below 2019 levels by the mid 2030s (**Figure 5**).

Increased network costs will have a relatively greater impact on non-domestic customers because their electricity demand is expected to increase disproportionately (**Table 5, Figure**

3). However, total business spending on energy infrastructure is expected to remain broadly similar over the period even with the additional distribution network cost, though wider trends on other parts of the bill will determine the overall bill impact.

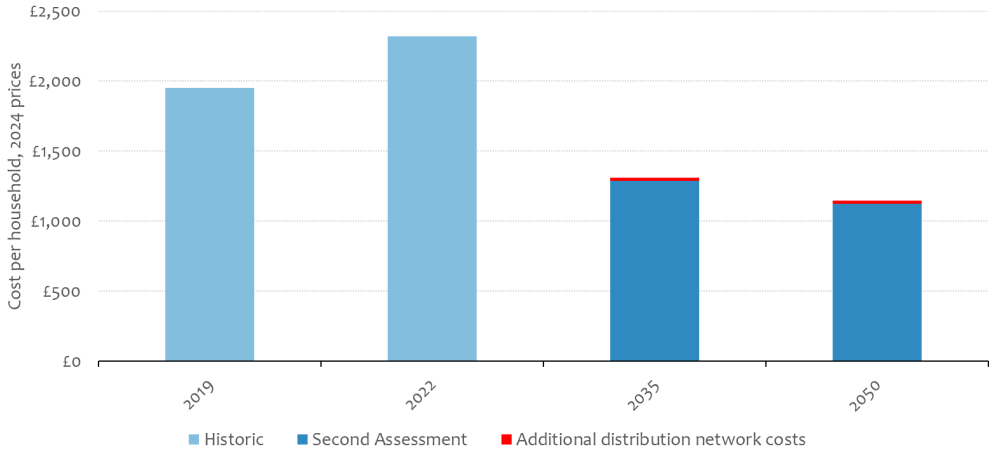
Table 5: Average additional cost per household and business, core model scenarios

Customer	2025 - 2029	2030 - 2034	2035 - 2039	2040 - 2044	2045 – 2049
Household	£5 - £10	£10 - £20	£15 – £25	£15 - £25	£20 - £25
Business	£85 - £275	£220 - £500	£335 - £585	£420 - £640	£505 - £690

Note: Rounded to the nearest £ five in 2024 prices.

Figure 5: Household energy bills should fall below 2019 levels by the mid 2030s

Average cost per household from 2019 to 2050, core model scenarios



Source: Commission analysis using Regen and EA Technology's modelling and data from the Department for Energy Security and Net Zero, distribution network operators, Ofgem and Electricity System Operator.

Household customer costs

For households, the average additional electricity distribution network cost ranges from £5-25 each year per household between now and 2050 across the core model scenarios (**Figure 6a**). It is important that the costs of additional network investment are considered within the context of energy and household bills overall, as distribution network costs are a relatively small component of bills – roughly five to ten per cent of average domestic electricity bills today.[23] The current average electricity bill is around £1,200, of which around £100 is for electricity distribution network costs.[24] Therefore, the average additional network cost is a fraction of overall bills.

Business customer costs

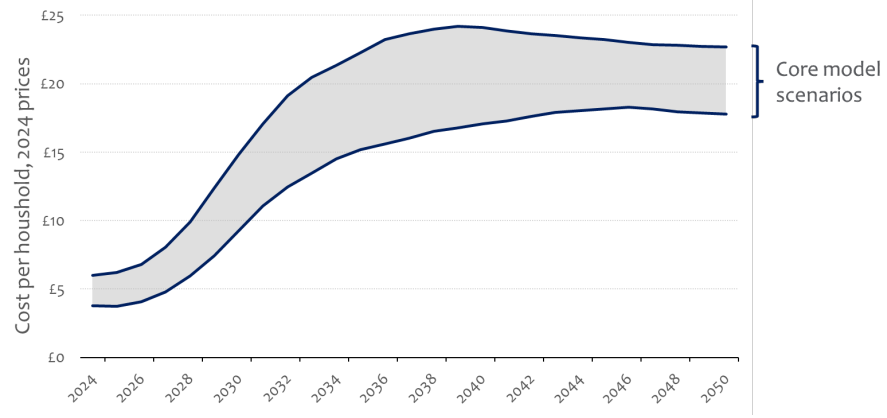
For business customers, the average additional electricity distribution network cost ranges from £85-690 each year per business between now and 2050 across core model scenarios (**Figure 6b**). However, average business spending on energy infrastructure is expected to remain broadly similar over the period, as per the second *National Infrastructure Assessment*, even with the additional distribution network cost. There is a wide variation in the type of business customers from small commercial business, such as shops and offices, to large energy

[23] Aurora Energy Research (2023), The impact of decarbonising heating on the power sector (C)
[24] Ofgem (2023), RIIO-1 Electricity Distribution Annual Report 2021-22 and Regulatory Financial Performance Annex to RIIO-1 Annual Reports; Department for Energy Security and Net Zero (2024), Annual domestic energy bills

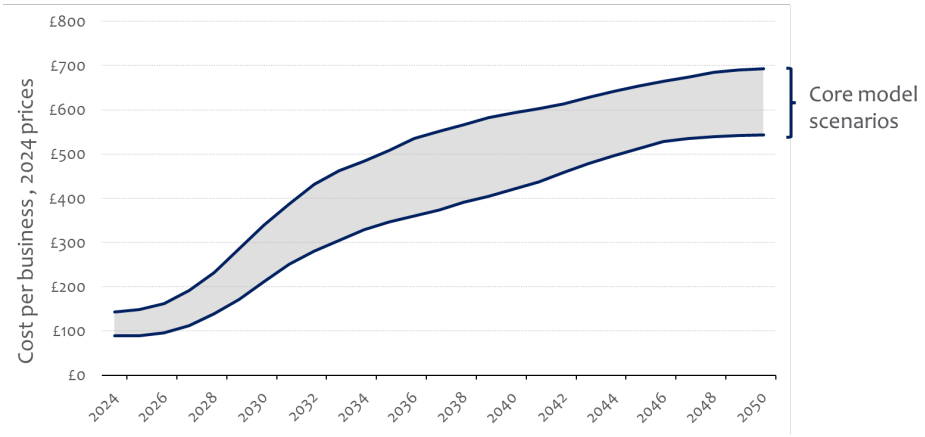
intensive industrial businesses, such as steel works, so the average cost per business will not reflect this variation. It is therefore difficult to assess how this additional cost will affect each individual business. Wider trends on other parts of the bill will still determine the overall bill impact.

Figure 6: The additional network cost per household is expected to be relatively small

6a: Average additional network cost per household 2024-2050, core model scenarios



6b: Average additional network cost per business 2024-2050, core model scenarios



Source: Commission analysis using Regen and EA Technology's modelling and data from the Department for Energy Security and Net Zero, distribution network operators, Ofgem and Electricity System Operator. Smoothed 5-year rolling averages.

Sensitivity analysis

Investing to meet the peak of winter demand in the 'winter stress test' scenario could lead to the average additional costs ranging from £10-40 each year per household and from £275-1,070 each year per business between now to 2050. This scenario is not a probabilistic assessment based on a defined cold spell. It is based solely on the maximum representative winter peak demand day for electric heating technologies received from any of the network operators, combined with low levels of flexibility. The scenario is therefore deliberately cautious in outlook, and it would not be sensible to invest to this level. Rather, it would be preferable to focus on maximising flexibility, in order to reduce the size of the peak and minimise the amount of additional investment required. That said, the overall conclusions in this report do not change in this scenario.

Sensitivity analysis has also been carried out for the regulatory financing assumptions (**Table 3**). The capitalisation rate and the asset life both play a large part in determining whether costs are

recouped in the short- or long-term. At the start of the previous price control period (2015-2023), Ofgem increased the regulatory asset life of the distribution network from 20 years to 45 years. A longer asset life means a lower depreciation rate, which leads to the Regulatory Asset Value decreasing at a slower rate, therefore increasing costs for future bill payers – as shown in **Figure 7**.

Figure 7: The Regulatory Asset Value is sensitive to asset life

Regulatory Asset Value for load related expenditure, core scenario with high heat pump uptake and high flexibility

Source: Commission analysis using Regen and EA Technology's modelling and data from Ofgem, distribution network operators and the Electricity System Operator.

Note: This excludes non-load related expenditure. Load related expenditure forecasts have been uplifted for 132 kV using Department for Energy Security and Net Zero forecasts and for low voltage service cables using Ofgem data.

Costs to the public sector

Table 6 shows the average annual day-to-day ('resource') expenditure by the public sector from 2024 to 2049, over and above baseline expenditure from current planned activity. Recommendation 4 in the Study will likely mean local government incurs additional resource expenditure to support engagement with Regional Energy Strategic Plans, which includes building capability and capacity. None of the Commission's other recommendations from this Study are expected to increase day-to-day public spending over and above baseline resource expenditure.

Additional local government resource expenditure is estimated to be approximately £5-45 million each year (to the nearest £5 million). The lowest end of this range is based on three full-time equivalent roles in 33 potential strategic planning areas across England.[25] The higher end of this range would require both higher salaries and two full-time equivalent roles for all councils in England (including district councils). The salaries are based on Office for National

[25] Bellona Advisors (2025), NOW! That's what I call Planning Reform Volume 267

Statistics earnings data and have been uplifted for non-wage costs using Department for Transport estimates.[26]

Table 6: Average annual expenditure by the public sector (£ million)

Category	2025-29	2030-34	2035-39	2040-44	2045-49
Local government resource expenditure	£5 - £45	£5 - £45	£5 - £45	£5 - £45	£5 - £45

Note: Rounded to the nearest £5 million, in 2024 prices. FTE assumed to be constant but may vary.

[26] Office for National Statistics (2024), Annual Survey of Hours and Earnings, Occupation by four-digit SOC, Table 14, SOC 245; Department for Transport (2022), Transport Analysis Guidance Unit A4.1 - Social-impact-appraisal

Section 5: Distributional impacts

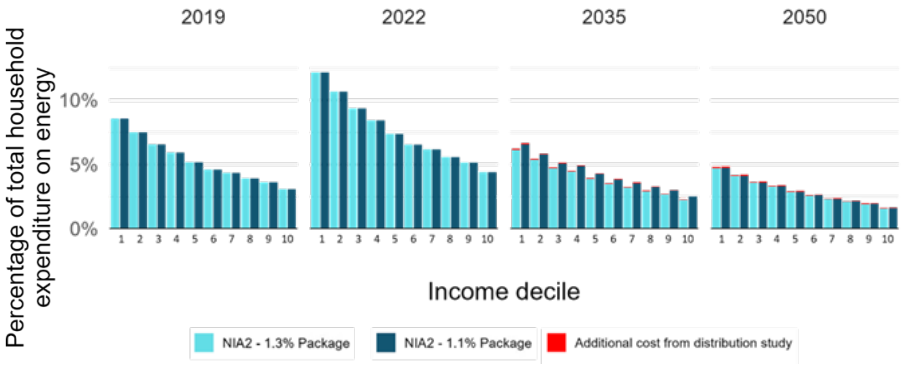
This section assesses the distributional impacts of the Commission's energy recommendations to 2050 across three dimensions: income groups, protected and vulnerable groups, and geography.

The Commission's distributional analysis from our recommendations during the second *National Infrastructure Assessment* concluded that, overall, average household bills should fall across all income deciles, and the recommendations should not disproportionately affect low-income households. The Commission recommended support for lower-income households in the second Assessment, such as covering the full cost of heat pumps for these households, where recommendations might otherwise have a disproportionate impact. These recommendations are used as a baseline for the electricity distribution study.

When considering the additional network costs from the *Electricity Distribution Networks* study, we find that the conclusions from the second Assessment remain valid as these additional costs are small relative to household spending on other energy infrastructure. Bills are still expected to fall across all income deciles, with the additional costs from the study's recommendations making up only an additional 0.03-0.12 per cent of total household expenditure (**Figure 8**). Spending on energy infrastructure is also expected to fall across all regions and protected characteristic groups, as concluded in the second Assessment (**Figure 9**). Further details can be found in the technical annex on distribution analysis for the second Assessment.[27]

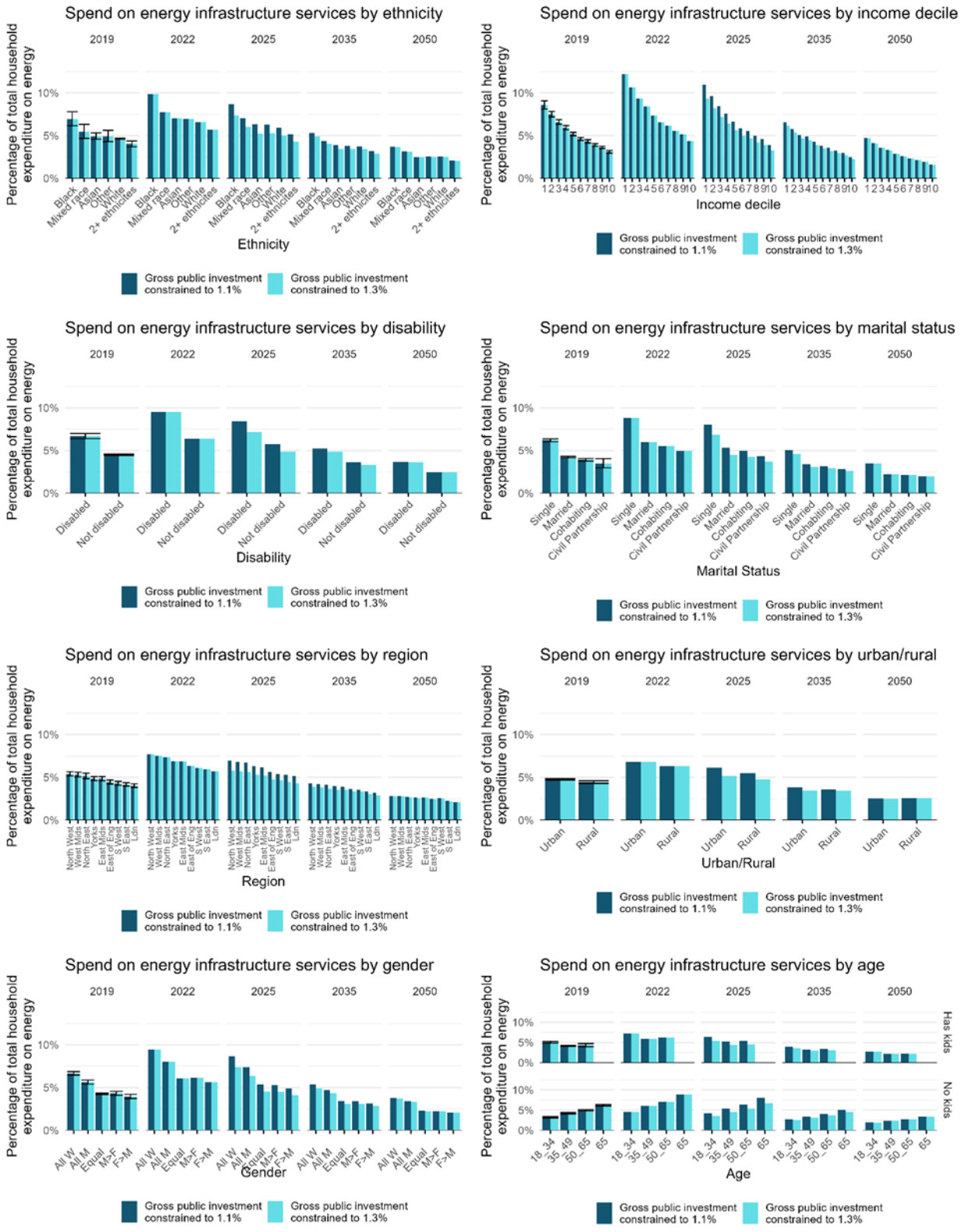
Furthermore, the Commission has qualitatively assessed the impacts on protected groups. Digital exclusion correlates with age, disability and households with high energy use/lower income, which again correlates with some protected characteristics. This was identified as an issue around the recommendation which includes an increase of the use of demand side flexibility. Digital systems will be needed to enable flexible technology, which has the potential to reduce individual consumer bills. Therefore, the Study explicitly states that this needs both automation and support from suppliers so that the digitally excluded can benefit.

Figure 8: Spend on energy infrastructure services by income decile



[27] National Infrastructure Commission (2023), Technical annex - Distributional analysis

Figure 9: Energy bill spend as a percentage of total household spend



Source: Commission analysis using Regen and EA Technology's modelling and data from the Department for Energy Security and Net Zero, distribution network operators, Ofgem and Electricity System Operator.

Section 6: Environmental impacts

This section focusses on the quantitative assessment of environmental impacts of the *Electricity Distribution Networks* study's recommendations across three environmental domains: air pollution, biodiversity and water quality. These are three of the themes in the Environmental Improvement Plan relevant to the Commission's recommendations.[28] The wider natural capital benefits of the electricity distribution network enabling net zero is qualitatively assessed. This is expected to outweigh the quantified natural capital direct costs.

The quantitative tool, which the Commission developed for the second *National Infrastructure Assessment*, covers a wide range of economic infrastructure sectors and natural capital impacts. The direct natural capital impacts on air quality, biodiversity and water quality during construction of the distribution network are quantified. The distribution network is a relatively small component of the tool, focussed on the construction of overhead lines. The biodiversity impacts of constructing other network assets, such as substations and underground cables, have therefore been quantified separately using the same assessment framework.

The inputs for the quantitative analysis focus on conventional assets for network construction, such as transformers and new circuit infrastructure, from Regen and EA Technology's modelling. The air and water quality estimates assume the construction of between 151,000-306,000 km of new overhead lines across the core model runs, compared to over 800,000 km of underground cable and overhead lines today.[12] The biodiversity estimates assume the construction of between 1,050-7,300 new substations across the core model runs.

However, the modelling inputs are not based on the volume of specific interventions as *Transform* is a representation of the distribution network across Great Britain. Instead, the number of "solutions" is multiplied by the average size and length of interventions, based on documentation from *Transform*.[29] In addition, the modelling inputs do not distinguish between new and replaced assets, so in reality the environmental impacts will be lower as existing assets are replaced. Load related (new) expenditure represents a small but growing proportion of total electricity distribution network expenditure, increasing from 10 to 16 per cent from the previous to the current price control period, whereas non-load related asset replacement represents around 28 per cent of total expenditure in the current price control period.[10] Therefore, the quantitative estimates presented in this section are an overestimate of the environmental impacts.

The quantitative tool takes the change in the size and length of each type of infrastructure and applies a series of intensity factors to that increase or decrease. The intensity factors effectively transform the scale data (for instance the operating capacity of new plants) into estimates of emissions of key pollutants. The intensity factors are 'per unit' measures (for example, per megawatt, kilometre, meter cubed), which can be multiplied by the size of the asset to provide an estimate of the potential environmental impact.

For biodiversity impacts, the quantitative tool uses representative hectares of land for Great Britain to allow impacts to be quantified. These representative hectares are based on regional scale values from the National Environment Valuation tool for Wales, South West, South East, London, East Midlands, North West, Yorkshire and Humber, North East and West Midlands.[30]

Table 7 shows the quantified impacts on air quality, biodiversity and water quality. The air quality impact estimates range from £6.5-£14.2 billion in net present value terms across the

[28] Department for Environment, Food and Rural Affairs (2023), 25 Year Environment Plan
[29] Smarter Grid Solutions for Ofgem (2013), Review of Enablers, Solutions and Top-down Modelling in Transform
[30] Land cover mapping is not provided for Scotland

core model runs. This is relatively large compared to the air quality impacts of the second *National Infrastructure Assessment* recommendations because the inputs to the model (length of overhead lines) do not allow for a split between new and replaced assets. It is likely that some of the conventional assets will require the replacement or renewal of existing assets rather than the construction of new assets. Furthermore, these costs are likely to be very low when compared to the air quality benefits of decarbonising the economy, including electrifying heating and transport, which investment in the electricity distribution network will support. Domestic transport was responsible for 28 per cent of total UK domestic emissions in 2022 or 113.2 million tonnes of carbon dioxide equivalent (MtCO2e), 89 per cent of which was from road transport.[31]

For water quality, the range of impacts is £0.9-£2.0 billion in net present value terms across the core model runs. This is relatively large compared to the £4.6 billion water quality impacts from our energy sector recommendations in the second *National Infrastructure Assessment*, for the same reasons as the air quality estimates. In the second *National Infrastructure Assessment,* the water quality impacts were estimated to be £2 million for the transport sector and £12 million for the waste sector.

For biodiversity, the impact is between 340-2,430 habitat units across the model runs. This includes the construction of new network assets, including substations and underground cables, and assumes that replacing assets does not require any additional land. To put this into context, one 'average' hectare of agricultural land is considered to be worth 2.9 habitat units, whilst one hectare of semi-natural grassland is worth 12 habitat units on average. One hectare of urban land is worth 3.6 habitat units, while water reservoirs/ponds are worth 10.9 habitat units and woodlands 11.2 units on average.[32]

There are wider environmental and natural capital benefits associated with enabling net zero which are not captured in the quantitative assessment. These wider benefits, including decarbonising electricity generation, heating and transport, are considered qualitatively in Table 8.

Table 7: Summary of the impacts on air quality, biodiversity and water quality

Environmental impact	£m, 2024 prices	Change in habitat units
Air quality	-6,500 to -14,200	N/A
Biodiversity	N/A	-340 to -2,430
Water quality	-900 to -2,000	N/A

[31] Department for Transport (2023), Greenhouse gas emissions from transport in 2022
[32] Natural England (2023), The Biodiversity Metric

Table 8: Environmental assessment of the electricity distribution study recommendations

Environmental impact	Contribution to net gain
Air quality	Construction of new distribution network assets, along with maintenance and renewal of existing assets, will generate emissions during construction, although these are likely to reduce over time with a switch to zero emission vehicles and plant. However, wider benefits from a reliable network enabling net zero, such as decarbonising electricity generation, heating and transport, will lead to beneficial outcomes for air quality, with reductions in emissions of nitrogen oxides and particulate matter expected from a significant reduction in the use of unabated gas for electricity generation, heating buildings, surface transport and in powering industry.
Biodiversity	A significant increase is expected in overall investment in energy infrastructure, including the distribution network, meaning the greater construction volumes will need to be offset to compensate for any biodiversity loss and ensure losses of natural capital are avoided, minimised and mitigated. Changes permitted under the Town and Country Planning Act are required to deliver biodiversity net gain, and from 2025, new nationally significant energy infrastructure connecting to the network will be legally required to achieve biodiversity net gain.[33] For distribution infrastructure, in particular, much of the new infrastructure will be underground cables, so the land above will be able to be restored once construction has completed and there are only minor restrictions to land use above underground cables. There are few restrictions to using land underneath overhead lines.
Water quality	Construction of new distribution network assets, along with the maintenance and renewal of existing assets, may lead to some water quality impacts during construction, but these should be mitigated to a reasonable extent once built. However, efficient network investment through maximising the use of flexibility should reduce the overall level of generation capacity. The wider benefits from a reliable network enabling net zero should indirectly increase renewable generation and reduce the amount of water required for electricity generation.[34] The majority of this water is also returned to the environment.[35]

[33] Department for Environment, Food and Rural Affairs (2023), Consultation on Biodiversity Net Gain regulations and implementation: Government response and summary of responses
[34] Water is abstracted for cooling at 82 per cent of thermoelectric power stations in the UK. Byers, Hall and Amezaga (2014), Electricity generation and cooling water use: UK pathways to 2050, p. 18; Aurora Energy Research (2023), The impact of decarbonizing heating on the power system (C)
[35] Environment Agency (2012), Water use and electricity generation

Section 7: Uncertainty

This section presents how robust the Commission's recommendations are to different possible future states of the world and to changes in assumptions.

It is highly likely that energy demand on the network will increase between now and 2050, but there is uncertainty about when and where as this will depend on the rollout of electric vehicles and heat pumps, as well as other sources of demand such as data centres. This means that proactive investment in the network comes with underutilisation risk in the short term, rather than the risk of stranded assets. Moving to a proactive approach and delivering this level of investment will require adopting a greater short term risk appetite, as it will not be possible to fully resolve all uncertainty before investment decisions need to be taken. But with demand expected to grow rapidly – particularly in the 2030s – there is now greater risk from falling behind need.

There are some clear no regrets options for the network such as off gas grid homes in rural areas that will need to replace oil with heat pumps. There are also households that need to have their interconnected (looped) service cables separated, something that will usually be necessary for houses that want a heat pump and electric vehicle and so would be no regret actions, though there is some uncertainty in some regions over the number and location of these looped supplies (see No regrets case study below).

While the Commission has modelled the cost of upgrading the network under different scenarios, the study does not recommend a specific level or pathway for investment, but instead makes recommendations about how the system can best take an adaptive approach to investment to manage uncertainty.

The Commission's recommendations look to manage uncertainty through the use of

- Improved monitoring of the network to ensure decisions on investment are based on high quality information
- Regional energy strategic plans that can enable an adaptive planning approach to the network, enabling and de-risking proactive investment in the network as well as reducing uncertainty
- Price controls that more explicitly balance priorities for the system beyond short term cost, using adaptive mechanisms such as volume drivers to ensure that funding can be made available when it is needed

Different types of investment will have different levels of uncertainty. Some types of investment are highly likely to be low regrets, such as the unlooping of domestic properties, and the Commission has recommended accelerating those types of investment.

Other types of investment will have greater levels of uncertainty, such as investments to enable industrial decarbonisation and new housing. A stronger role for strategic planning will help to mitigate and manage the uncertainty around the need for investment.

Modelling uncertainty

The Commission has modelled the investment needs of the network under a number of different scenarios. The technology uptake scenarios were based on data from Electricity System Operator's *Future Energy Scenarios 2023 Consumer Transformation* scenario and load profile data from distribution network operators, with variations to the heat technology mix and levels of flexibility tested via sensitivity analysis.

This net zero scenario was chosen because it aligns with the Commission's recommendations from the second *National Infrastructure Assessment*, and reflects rapid and high levels of heat and transport electrification needed to achieve interim carbon budgets and net zero. The *Future Energy Scenarios 2023 Consumer Transformation* scenario was compared to the most recent energy scenarios and it was found that this scenario would be suitable based on the uptake of low-carbon technologies with sensitivities designed to quantify key uncertainties. Further details can be found in the scenario development report.[36]

No regrets case study: Unlooping low voltage service cables

Tables 9 shows the total cost of unlooping low voltage service cables for properties across the distribution network that are currently interconnected. Recommendation 9 in the Study will mean distribution networks need to unloop interconnected properties by a date set by Government. However, there is considerable uncertainty about the scale of these costs due to poor quality data. Therefore, the Commission has estimated a high-level range of the potential costs using sensitivity analysis for the percentage of properties that need unlooping and two different methodologies.

Table 9: Total volume and cost of unlooping properties across Great Britain

Variable	Low	Central	High
Total number of domestic properties (million)	29.6	29.6	29.6
Percentage of properties currently looped	10%	12%	13%
Number of properties to unloop (million)	3.0	3.5	3.9
Properties unlooped in FY 2023/24	19,606	19,606	19,606
Cost in FY 2023/24 (£ million, 2024 prices)	£62.62	£62.62	£62.62
Inferred unit cost (£, 2024 prices)	£3,190	£3,190	£3,190
Total cost (£ billion, 2024 prices)	**£9.6**	**£11.0**	**£12.4**
Weighted average unit cost (£, 2024 prices)	£1,840	£1,840	£1,840
Total cost (£ billion, 2024 prices)	**£5.5**	**£6.3**	**£7.1**

The total number of domestic properties today and the percentage of properties currently looped is from distribution networks customer connections and survey data for both methodologies.[37] The unit cost in the first methodology is inferred from the total costs and volume of properties unlooped in the first year of the current price control period, representing an average cost per property. The unit cost in the second methodology is a weighted average of underground and overhead line low voltage services unit costs, based on Ofgem's final determinations for the current price control period assuming one unit per property (1:1 ratio), and the percentage of the low voltage network that is underground (83%) and overhead (17%) from Electricity Networks Association data.[38] The costs have been uplifted to 2024 prices.

This illustrates the estimated cost could range from £5.5-12.4 billion depending on the methodology and assumptions used. This one-off cost will be recovered through bills. Despite the high estimate being large, it is expected to be more than offset by lower costs of electrified heating and transport in the long run.

[36] Regen and EA Technology (2025), Scenario Development Report
[37] Distribution Connection and Use of System Agreement (2024), Annual Review Packs and Cost Information
[38] Ofgem (2022), RIIO-ED2 Final Determinations Core Methodology Document