A photograph of a utility pole with power lines and a wind turbine in the background under a blue sky. The utility pole is made of wood and has several power lines attached to it. The wind turbine is white and is located on the left side of the image. The sky is blue with some light clouds. The overall scene is a mix of natural and man-made elements, representing energy infrastructure.

# Electricity distribution networks:

Creating capacity  
for the future

NATIONAL  
INFRASTRUCTURE  
COMMISSION

Better infrastructure for all

February 2025

## Our remit

The Commission provides government with impartial, expert advice on major long term infrastructure challenges.

The Commission's objectives are to:

- support sustainable economic growth across all regions of the UK
- improve competitiveness
- improve quality of life
- support climate resilience and the transition to net zero carbon emissions by 2050.

In fulfilling our purpose and objectives, we:

- **set a long term agenda** – identifying the UK's major economic infrastructure needs, and the pathways to address them
- **develop fresh approaches and ideas** – basing our independent policy recommendations on rigorous analysis
- **focus on driving change** – building consensus on our policy recommendations, and monitoring government progress on their delivery.

A fuller description of the Commission's remit can be found on our website at [nic.org.uk/about/what-we-do/](https://nic.org.uk/about/what-we-do/). This includes a table of devolved administration responsibilities by infrastructure sector.

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# Foreword

Modern life is built on electricity. We rely on it to light our homes and businesses, wash our clothes, and access online services or entertainment. This reliance will increase as we electrify the country's heating, transport and much of our industry over the coming decades.

Most of us only notice the systems that deliver electricity to the socket when we read the monthly bill or watch the smart meter move from green to amber as we turn on the kettle.

That meter is the visible end of a complex network of over 838,000 km of wires, and hundreds of thousands of substations and transformers, distributing the power which underpins our prosperity.

But while the revolution in electricity generation and transmission is a notable part of the public discourse on energy, the future of our distribution networks rarely is. We need to change that.

Distribution networks are how all homes and most businesses receive electricity. They are a vital component for successfully decarbonising the economy, so we need a concrete plan to ensure they are fit for the future.

They must be flexible to cope with the greater demands we will place on them – not least the new sources of generation which will plug straight in, and the power-hungry data centres integral to our future, data-driven economy.

They need to be smart and ready to handle the varied sources of generation and storage – such as stored electric vehicle battery power, which will be increasingly important features of our electricity system.

And they must be resilient, able to cope with not just increased demand but more extreme hot and cold spells and higher average temperatures.

The risk is that if we don't have a plan in place before demand shifts up a gear, we end up with an overloaded and under-capacity system lacking the resilience customers need and expect.

For householders contemplating buying a heat pump, or an electric vehicle, any likelihood the system won't work as it should risks them putting these changes on hold, right when we need people to make the switch.

And if business can't connect to the network promptly they will delay investment decisions or, worse, make those investments elsewhere, undermining the government's growth mission.

We must learn the lessons of the UK's transmission infrastructure, where a failure to invest ahead of demand means we're playing catchup. Encouraging proactive investment requires a new system of managing, regulating and upgrading our distribution networks.



This has already started with the move towards more strategic planning of the energy system, but there's much more to do. Ofgem, the new National Energy System Operator and the government now need to work together to ensure that investment flows where and when it is needed.

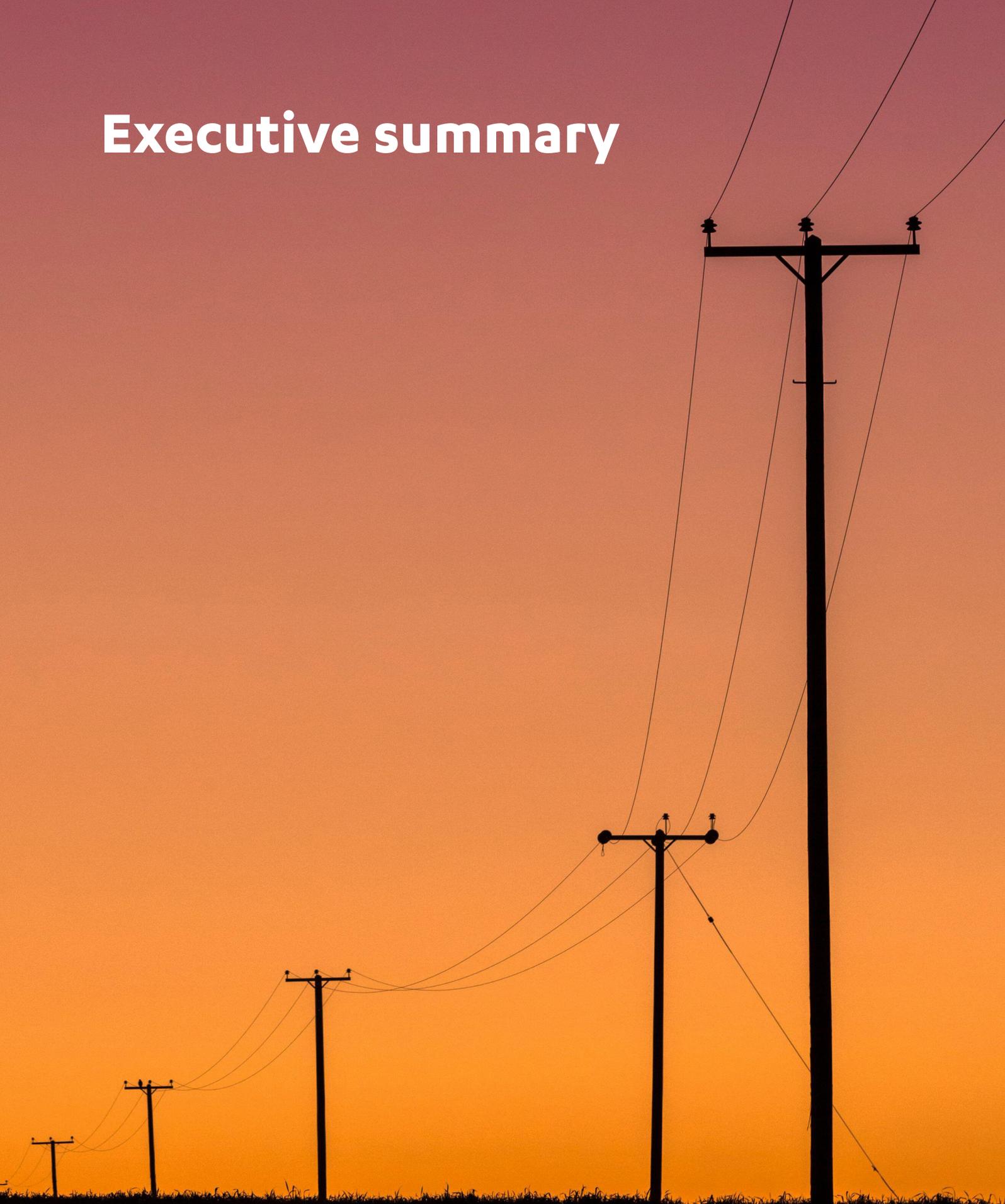
The good news is that if we act early, not only will we improve the resilience of the overall system but we can help the country reap the benefits of a fully electric economy sooner, not just in bills but in cleaner air, a more efficient energy system, and being able to build new developments – including housing – where and when they are needed.

The public's concern about the cost of electricity remains high, but it's precisely by higher investment that we enable lower electricity bills. But if we don't grasp the nettle and make that further network investment, we risk short changing the country over the long term.

**Sir John Armitt**

**Chair, National Infrastructure Commission**

# Executive summary



**The energy transition means Great Britain’s electricity distribution network is becoming increasingly important. As the country makes progress towards its net zero target, the distribution network will be a key enabler of electrifying heat and transport, and will support the decarbonisation of the power sector by connecting new sources of generation. This will fundamentally change the role of the network. Continuing a steady state approach will not be sufficient to meet future demand or deliver benefits, such as enabling economic growth and development.**

**To deliver these social and economic benefits, there must be a step change in the approach to the distribution network. This will require investing proactively in the network through greater strategic planning and simplified price controls that take account of a wider range of objectives. This should deliver greater benefits to consumers – and see them realised earlier – as well as helping to manage the transition to electrification more efficiently over time. Reforms will also be required to enable faster deployment of network infrastructure, as well as better customer service for households and businesses looking to connect to the grid.**

Demand for electricity is set to increase as heating, transport and industry increasingly turn to electricity to decarbonise. The National Infrastructure Commission’s analysis for the second *National Infrastructure Assessment* projected demand for electricity would increase by around 50 per cent by 2035 and double by 2050.

All households, and the vast majority of businesses, connect to the distribution network. And around a third of generation is connected to the distribution network – a proportion which is growing as more solar and onshore wind is deployed. Not all this power will need to be used locally. Distribution networks will also need to be able to export some power to other parts of the country via the transmission network. Significant value will also be created from consumers responding to price signals to use their electricity when clean power is plentiful.

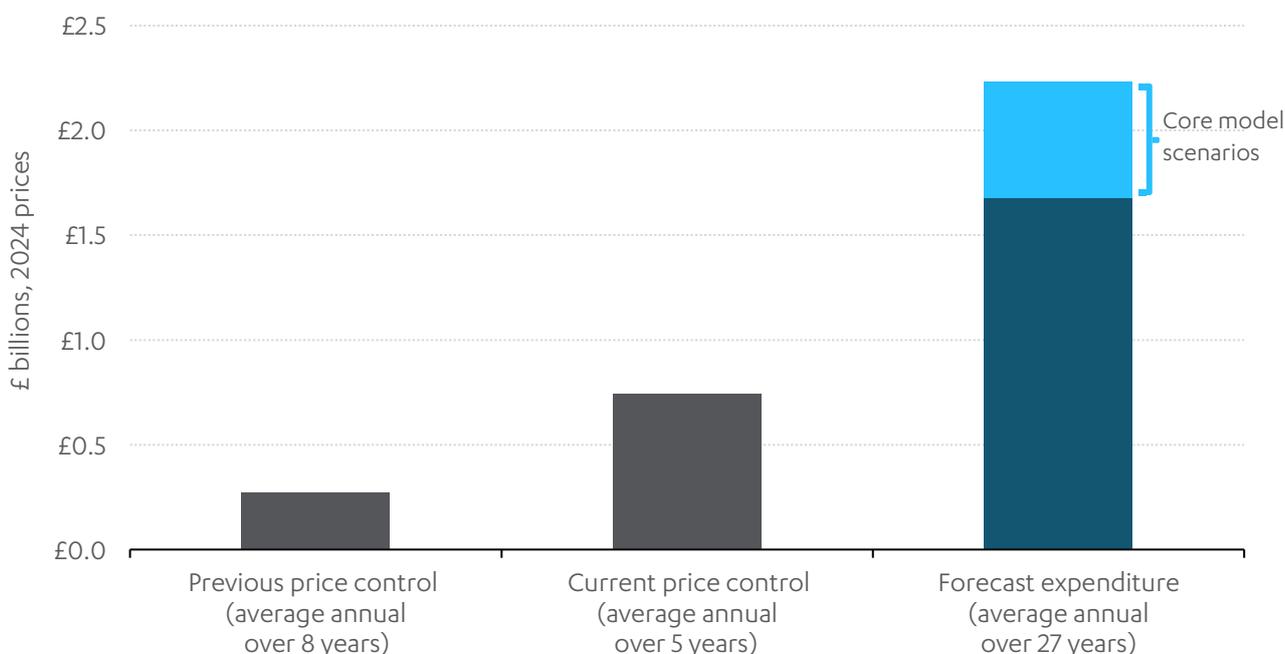
It will be critical that the network is able to meet the expected level of future demand and maintain a reliable electricity supply to all consumers. As reliance on electricity increases, networks must be resilient to climate change and security of supply must be maintained.

Inevitably, there is uncertainty around exactly where and when new sources of demand will connect to the network. However, the objectives of achieving net zero emissions, expanding house building and growing the economy create confidence that increased network capacity will be needed in the medium to long term – especially as electrification is the best option for decarbonising an increasingly large proportion of the economy. Waiting for demand to materialise risks investing too late, creating bottlenecks and delays. Proactive investment in the network will ensure that capacity is available when it is needed to support decarbonisation and the wider economy.

Nationally, £37-50 billion of investment in the distribution network could be needed to support additional demand and generation between today and 2050. This represents at least a doubling of current annual allowances for load related expenditure, on top of business as usual investment, such as end of life asset replacement (see Figure 1).

### Figure 1: A step change in electricity distribution network investment is needed

Average annual load related expenditure from 2015 to 2050



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

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

Consumer led flexibility, such as rewarding consumers for charging electric vehicles at times of lower demand, will be an important part of the future energy system and bring significant potential benefits for households. Flexibility is expected to be key to meeting the government’s mission to deliver clean power by 2030 and its ambition to meet net zero by 2050. Maximising consumer led flexibility could reduce the amount of investment required in the distribution network by around 15 per cent and even greater savings could be made from avoiding the need to build generation and transmission network capacity beyond that required. Changes to network management processes, increased digitalisation of the distribution grid, better designed price signals to customers and smart technology in homes and businesses are all required urgently to allow the value of flexibility to be delivered.

Significant changes in how networks are planned and regulated will be needed to deliver the required level of proactive investment efficiently and effectively. This includes strategic planning of energy supply and demand to provide more certainty on the needs case for investment. Ofgem’s proposed Regional Energy Strategic Plans should provide this.

However, they must be implemented in a way that provides certainty over investment for the next price control period and beyond. They also need to be set up in a way that delivers clear accountability, strong engagement with local stakeholders and integrates national and local objectives.

Price controls will need to be reformed to enable proactive investment. The current regulatory process is too complex and focused on the short term cost of network investment, rather than the wider goals of economic growth and decarbonisation. Continuing the current approach risks delaying investment and putting significantly more pressure on networks and supply chains in future, as well as on the bills of future consumers. Ofgem should rebalance the price control around a broader set of long term objectives. These should include enabling economic growth, accelerating progress towards net zero, strengthening network resilience and delivering high quality customer service.

To deliver the increasing number of new and modified distribution connections required, improvements to the connections process and customer experience will be needed. Reforms aimed at tackling the connections queue and significantly reducing connection times are ongoing. This process should provide benefits for distribution network customers, but the general process of connecting to the network also needs to be improved. All network customers should receive a high quality of customer service, supported by a clear process and consistent good practice. Stronger incentives encouraging networks to deliver the major connections needed to support economic growth will also be required.

Ambiguities and outdated regulations in the planning system can act as a blocker on the maintenance and expansion of the distribution network. A small number of targeted changes to the planning and consenting regime for distribution infrastructure would speed up delivery and reduce uncertainty for both planners and network operators.

Supply chains and workforce capacity need to be more actively managed to speed up project delivery. There are increasing pressures from inflation, stronger global competition and longer lead times, as well as competition for skills across the energy sector and wider economy. Strategic planning and price control reform can help manage these challenges by offering greater certainty around the need for forthcoming network investment. But proactive interventions to meet current and future skills gaps are urgently needed. This must include measures to attract, recruit and retain the large workforce needed to deliver the energy transition.

To achieve this, the Commission recommends eight system-wide reforms:

- **Going further and faster on digitalising the network and deploying flexibility in a way that maximises national benefits for the electricity system and for consumers**
- **Reviewing security of supply standards so that networks are designed appropriately for future loads**
- **Developing more effective strategic planning to enable and de-risk proactive investment, including Regional Energy Strategic Plans that align stakeholders around a clear trajectory for the future needs of the network**

- **Reforming and simplifying price controls by:**
  - rebalancing them around long term objectives that deliver wider social and economic benefits, as well as efficient delivery
  - reorientating funding mechanisms to focus on allowances set before the price control begins, using re-opener mechanisms only where there is genuine long term uncertainty
  - accelerating ‘no regrets’ activities such as unlooping and off-gas grid reinforcement.
- **Government adjusting its relationship with Ofgem to provide the necessary steers and vision to enable proactive investment, including by strengthening the strategy and policy statement**
- **Improving the connections process through the introduction of minimum service standards and stronger incentives for major connections, to ensure high quality customer service and timely connections for all network customers throughout the full connections process**
- **Making targeted reforms to the planning and consenting system to speed up the delivery of distribution infrastructure and reduce uncertainty for operators**
- **Government should urgently identify the skills challenges and actions required to ready the workforce to deliver the energy transition.**

## A changing role for distribution networks

### The distribution network is critical for meeting net zero and enabling economic growth

The distribution network is an essential component of our electricity system. It is how all households, and the vast majority of businesses connect to the network, as well as around a third of generation - a proportion which is growing as more solar and onshore wind is deployed. Sufficient capacity on the distribution network is a critical enabler of economic activity. Timely connections allow businesses to set up and expand where they want to. The network must also remain reliable and resilient, maintaining security of supply as demand grows, while also adapting to a changing climate.

The distribution network is also critical to decarbonisation and reaching net zero. Having sufficient network capacity is essential to the electrification of heat and transport. It will also be key to meeting the ambitious levels of flexibility required to balance supply and demand – such as through smart electric vehicle charging – required by government’s clean power by 2030 mission. New types of economic activity, such as data centres and advanced manufacturing, need significant and reliable electricity supplies. Existing industrial activity will increasingly join them in electrifying. The government’s ambitious housing targets will also require access to reliable and timely electricity connections if they are to be delivered.

## **It is certain that network demand will increase, but not certain where and when change will happen**

Electricity demand on the distribution network has been static or declining for many years – domestic electricity consumption in the UK fell by 26 per cent from its peak in 2005 to 2023.<sup>1</sup> However, the transition to net zero will make the energy system increasingly dependent on electricity, with demand for electricity expected to increase by around 50 per cent by 2035 and to double by 2050.

The projected growth in embedded generation – generation which connects at distribution – will also require network growth. The National Energy System Operator estimates that the volume of distribution-connected generation will increase from around 30 GW to between 80 and 140 GW in 2050. Consequently, the ability of the distribution network to link supply and demand – including where power needs to be exported to other parts of the country via the transmission network – will be increasingly important.

The decisions of individual households and businesses will determine when demand increases in specific locations. But we can be confident in aggregate future demand rising in the long term because it will be required to meet the legally binding target of decarbonising the economy. Increased confidence in the electrification of heating and surface transport means there is greater certainty about the level of future demand than there was at the start of the current price control period.

## **From steady state to proactive investment**

### **Taking a more proactive approach to investment**

While the system has been in a steady state, there have been strong arguments for focusing on efficient management of the distribution network and minimising the risk of over-investment. However, as the network begins a period of significant change and expansion, an approach focused on minimising network costs will not work. It risks consumers missing out on wider social and economic benefits – like meeting decarbonisation targets and enabling economic growth. It may also fail to deliver the investment needed to maintain reliability and sufficient resilience to the impacts of climate change. The current ‘just in time’ approach to investment also does not do enough to ensure the efficient transition to net zero over time and across subsequent price controls.

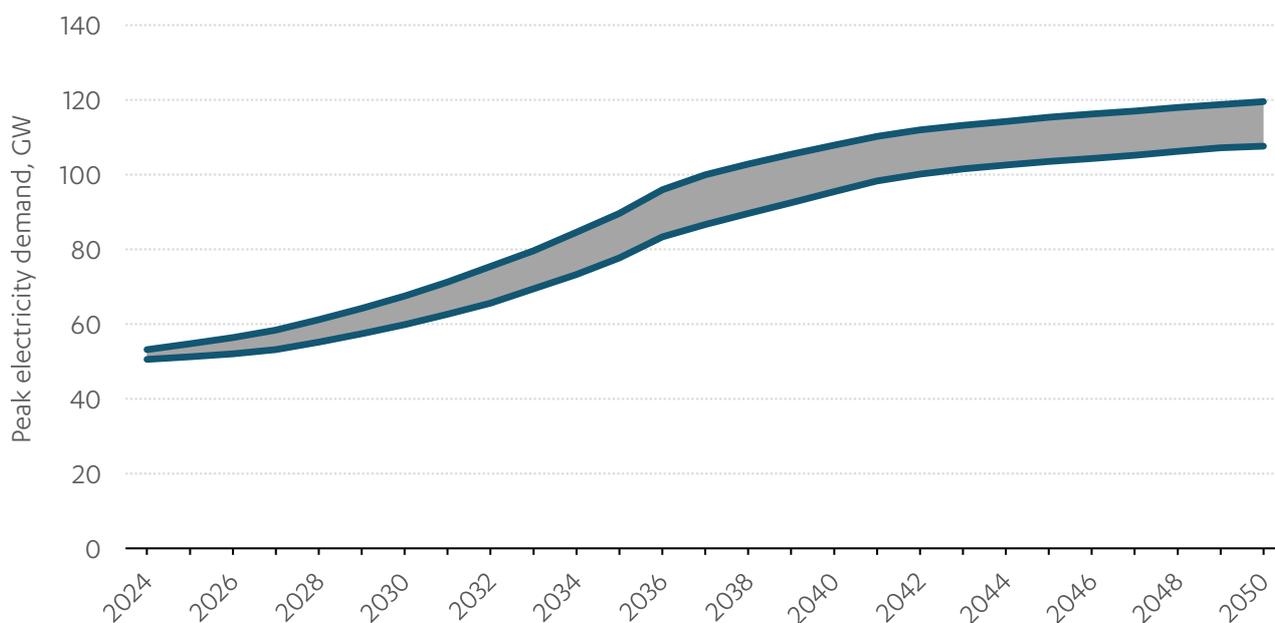
While the current price control has seen an increase in load related expenditure, a step change is now required. The Commission’s analysis shows that to meet increasing demand between today and 2050, around £37-£50 billion of investment in the distribution network is required. This is at least a doubling on current annual rates, with investment needing to accelerate most steeply in the next five to ten years.

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. As demand on the distribution network grows,

the nature of the risks around proactive investment will change. With steady demand, the challenge is to avoid investing too heavily ahead of need, resulting in stranded or underutilised assets. But with demand expected to grow rapidly – particularly in the 2030s – there is now greater risk from falling behind need (see Figure 2). The risk of assets not being required is limited and any underutilisation should be temporary.

## Figure 2: Electricity demand is expected to accelerate through the 2030s

Peak electricity demand from 2024 to 2050, core model scenarios



Sources: Regen and EA Technology’s analysis for the Commission, using Electricity System Operator’s *Future Energy Scenarios 2023* and the second *National Infrastructure Assessment* in combination with distribution network operators’ data.

A step change in investment will require short term risks to be taken, but remaining reactive rather than proactive will worsen the challenges around connecting to the network when it needs to become easier for generators, new housing and growth industries to connect. A reactive approach also risks slowing the pace of decarbonisation if network capacity is not there when consumers need it.

A proactive approach can better balance risks over the medium and long term up to 2050. It can also support a more programmatic approach to investment, rather than looking at specific projects and needs cases on an individual basis. This will ease the supply chain and skills challenges for network operators by providing the market with certainty that sustained, increasing demand for parts and workers will materialise. A programmatic approach will also enable distribution network operators to build strategic partnerships with suppliers and contractors to deliver more efficiently over time.

While significant network investment will be required in the next price control period, plans must remain flexible and adaptive over subsequent price controls. This will allow lessons to be learned and the benefits of innovation to be captured, as well as adjust the investment pathway as certainty grows over time.

The consequences of failing to meet changing patterns of supply and demand have become clear at transmission 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. 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. Failing to meet changing patterns of supply and demand must not happen on the distribution network as well.

## **Flexibility is crucial for Great Britain’s energy system but ‘flex first’ is not**

Flexibility is the ability for something connected to the electricity system to adjust when electricity is used or produced – either in time or location. Flexibility broadly takes two forms: national flexibility, used to reduce the size of peak demand and balance supply with demand, and local flexibility, which is used to manage pinch points in networks by moving demand in parts of the network close to capacity to lower demand periods where grid flows are faster.

Maximising the use of flexibility across the electricity system will enable more efficient system management. Deploying flexibility further and faster will also reduce the costs to consumers by reducing the amount of generation and network infrastructure that needs to be built to meet increased demand. The government’s Smart Systems and Flexibility Plan estimated that increased flexibility could reduce total system costs by £6-10 billion per year in the run up to 2050. The modelling in this report shows that consumer led flexibility could reduce required distribution network investment by around 15 per cent.

The government’s 2030 Clean Power Plan requires 10-12 GW of consumer led flexibility as well as additional battery storage. To support this, the planned Low Carbon Flexibility Roadmap must focus on maximising flexibility where it is the best system wide solution. This should include the implementation of digital systems needed to support this and allowing all consumers to benefit from facilitating it, including market wide half hourly settlement, which Elexon is programme managing.

Government and Ofgem will also need to ensure that the distribution network is designed to support this increase in flexibility. Currently, distribution network operators follow a ‘flex first’ approach, deferring or avoiding investment where it is lower cost than building new infrastructure. While the ‘flex first’ approach could be justified while electricity demand has been relatively stable, it is not appropriate in a world of rapidly increasing demand.

Continuing to use flexibility while deferring investment could result in a bottleneck for network reinforcement while demand growth is accelerating rapidly. There is also a risk that local flexibility could come into conflict with national flexibility if demand is shifted to suit local network needs when a different investment or action is more valuable or efficient for the system overall.

While further analysis may be required to fully understand these dynamics, investment in the distribution network will be required to ensure that it is possible to realise the full benefits that national flexibility can offer. Flexibility to deal with local network challenges will remain useful where it can provide an enduring solution or time to plan and coordinate investments more strategically. Prioritising national flexibility should provide even greater benefits.

**Recommendation 1 – Government should introduce measures to maximise the use of flexibility across the electricity system, working with the National Energy System Operator and Ofgem to deliver the Low Carbon Flexibility Roadmap by the end of 2025. This should cover the role of flexibility and digitalisation across all parts of the electricity system, including:**

- **working with Ofgem to update the smart meter rollout plan by the end of 2025, including measures to fix smart meters not currently operating in smart mode**
- **implementing the smart appliance mandate for heat pumps in 2026**
- **working with Ofgem and Elexon to deliver market-wide half hourly settlement by 2027 without further delay**
- **supporting industry to improve flexible asset registration.**

## **Maintaining the reliability of the network**

Great Britain’s electricity distribution network is very reliable. Reliability has increased significantly since the 2010s and power cuts are rare events for most consumers. As demand on the network increases – especially as heat demand transfers from gas to electricity – government and Ofgem will need to work together to ensure that a high level of reliability is maintained in an economic manner, with security of supply standards updated to reflect this.

Commission analysis for the study included a ‘winter stress test’ scenario which combined high future heating demand with low levels of flexibility. This scenario suggests that investing to the full peak of future demand in accordance with current security standards could add over £25 billion to the amount of distribution network investment required between now and 2050. While this scenario illustrates the importance of managing peak demand and deploying flexibility, investing to this level would not be prudent. Instead, the focus should be on maximising flexibility to avoid the need for this level of investment.

This scenario also demonstrates the need to consider whether security of supply standards for the network need updating. Current security of supply standards assume low levels of flexibility and low diversity of demand, as well as low levels of digital network capability and smart device integration. Sensible investment and modelling of these new features should lessen the amount of network build required to maintain a high level of security of supply. Therefore, the role of flexibility and ‘smarter’ solutions will be important to consider, alongside additional investment in maintaining security of supply.

There will also need to be a strong focus on wider network resilience and its capacity to anticipate and respond to shocks and stresses such as extreme heat, storms and flooding. In a changing climate, the network must be designed for the conditions it will face in 2050 and beyond. Much of this can be delivered through clearer objectives and incentives in the price control process. But network operators will also need to develop and cost adaptation plans, as the Commission recommended in the second *National Infrastructure Assessment*. Alongside this, Ofgem should incorporate climate risk into its asset risk metric as the Commission set out in its *Developing resilience standards in UK infrastructure* report.

**Recommendation 2 – Government and Ofgem should review security of supply standards for distribution networks to ensure that they are designed for future loads and vulnerable customers are protected.**

**As part of business planning for the next price control:**

- **Ofgem should require distribution network operators to identify ‘no regrets’ activities that would improve security of supply**
- **government and Ofgem should work with distribution network operators to agree the detailed work required to review security of supply standards and how this will be undertaken.**

**The full review of security of supply standards should then be completed by the end of 2028.**

## Reforms to support proactive investment

### Strategic planning

To enable the proactive investment required to deliver a distribution network fit for net zero, there should be a step change in the way that the network is planned. A more strategic approach is needed to support the maintenance and upgrades that must be delivered to achieve government’s decarbonisation targets.

The governance of the UK’s energy system is undergoing significant change to move it in this direction. The recent launch of the independent National Energy System Operator – formerly the Electricity System Operator – represents a new approach to the running of the network and a wider move toward increased strategic planning. Reflecting the need for regional considerations, Ofgem has confirmed that the National Energy System Operator will introduce new Regional Energy Strategic Plans. The Commission welcomes this decision, having supported their introduction in the second *National Infrastructure Assessment*. These plans are intended to support coordinated development of the system and enable long term investment to be made with confidence and ahead of need. They will also look beyond the distribution network, aligning electricity and gas, with scope to potentially include heat, hydrogen and other vectors.

These changes to the governance of the energy system should help clarify the roles and responsibilities for organisations across the system, which will be critical to achieving clean power by 2030 and net zero by 2050. If network operators produce investment plans that are consistent with the Regional Energy Strategic Plans, Ofgem’s role can become more focused on assuring timely and efficient delivery of network investment. It is important that the shift toward strategic planning streamlines the governance system rather than adding complexity. It should also provide better data that can support more effective and innovative planning across the sector and wider economy.

It is critical that the roles and responsibilities of all parties involved in the development of Regional Energy Strategic Plans are clear and resourced appropriately. In particular, local authorities must be able to input into their development meaningfully so that regional plans take appropriate account of local plans and priorities. Support will need to be given to local authorities with relatively lower capacity and capability to ensure regional plans have democratic accountability. Their involvement can help prioritise what is most important and ensure credible local priorities are supported.

**Recommendation 3 – Ofgem and the National Energy System Operator should set out a clear statement of accountability for the Regional Energy Strategic Plans. This should include the decisions that the system operator will be empowered to take in developing the plan, how they will assess network investment plans in a proportionate way, and the stages at which different actors will have the ability to input and challenge.**

**Recommendation 4 – Ofgem and the National Energy System Operator should develop structured ways for local authorities and other local stakeholders to input into the Regional Energy Strategic Plans.**

- **The National Energy System Operator should proceed with plans to make tools and advice available to local stakeholders to support their planning role. Government should also assess what additional capacity and capability is required for local authorities to engage meaningfully with the process and provide the necessary financial support for them to do so.**
- **Local authorities must have structured mechanisms to input meaningfully into Regional Energy Strategic Plans, even if they are not on the strategic board or have not completed a formal local energy plan.**
- **Local decarbonisation targets and strategies should be enabled as far as reasonably possible, where projects are underpinned by credible plans for delivery.**

**Recommendation 5 – Ofgem and the National Energy System Operator should use the Regional Energy Strategic Plans as a vehicle to improve planning and data in the sector. As part of the process, the National Energy System Operator should:**

- **develop a register of projects ‘in development’ that have not yet had connection applications submitted**

- **publish the plans in both an open data format, and through a publication that is accessible and understandable to all energy system actors, including local government.**

**Recommendation 6 – Ofgem and the National Energy System Operator should set out a proportionate transitional plan for the Regional Energy Strategic Plans to inform the next electricity distribution price control. This should be delivered far enough ahead of decisions about the price control to enable network business planning. It should give network operators confidence in the investment pathway for the whole price control period as well as an indication of the longer term trajectory of investment.**

## Price control reform

Price controls set the amount of money that network companies can recover from consumers over the price control period. Ofgem, as the regulator, sets price controls for the companies that operate Great Britain’s gas and electricity networks at both distribution and transmission level. Distribution network operators submit business plans to Ofgem outlining their estimated costs for operating and building their networks during each price control period. Ofgem then assesses these costs and sets baseline revenue allowances. Distribution network operators then maintain and operate the electricity distribution network and recover their revenue through charges in consumer energy bills.

Ofgem designs the framework with mechanisms and targets to drive efficient performance and incentivise distribution network operators to deliver outcomes that benefit consumers.

The current electricity distribution price control period runs from 2023 to 2028. Early indications are that network operators have not yet significantly increased load related expenditure to prepare for higher future peak demand, despite a rise in allowances from the previous price control. A slow start at the beginning of a price control period is not unusual and there have been persistent underspends in the early years of past price controls. This is due to a range of uncertainties, such as the take up and impact of low carbon technologies, as well as supply chain challenges and natural turbulence around the start and end points. To meet the demands of the transition to net zero and government’s goal for economic growth, it is important that proactive investment begins to be delivered during the current price control period. Beyond this, price controls will need to be reformed to enable the further proactive investment required.

While the fundamental principles of the price control framework – using incentives and innovation to drive outcomes – should be maintained, the process is too complex and too focused on minimising short-term costs at the expense of wider consumer value. Future price controls need to be orientated around a clear set of rebalanced objectives, including enabling decarbonisation and economic growth and improving customer service as well as maintaining the reliability and resilience of the network. Investing ahead of need should also mean that the growing number of consumers seeking to install heat pumps and electric vehicle charging points in their homes can do so at the time of their choosing.

Minimising consumer costs through appropriately incentivising efficient delivery will remain important. However, solely focusing on minimising the amount of investment will not represent value to consumers and could come at the expense of a more cost efficient transition to net zero over the long term.

Funding mechanisms also need to be reformed to achieve these outcomes. Under the current framework, uncertainty mechanisms are used to scale up network investment during the price control period where Ofgem judges there is not sufficient certainty to commit to it at the start. Ofgem's approach to the uncertainty around low carbon technology uptake has been to introduce a larger volume of uncertainty mechanisms, with the number of 're-openers' common to all network operators doubling from the previous price control from eight to sixteen.

Continuing the current price control model will limit investment certainty and carry a high administrative burden for companies and Ofgem, slowing decision-making. Instead, Ofgem should allow more upfront funding, with re-openers used only where there is genuine and material long-term uncertainty. More clarity and certainty over long term investment should help build confidence and provide visibility for the supply chain. Network operators can then secure the supply chain and workforce requirements needed to enable proactive build and stay ahead of need. Higher allowances will need to come with additional mechanisms to ensure distribution network operators actually invest in new infrastructure and that value for consumers is maintained.

As part of ongoing maintenance and renewals, network operators should be funded to take a 'touch the network once' approach by installing assets that are future proofed for future higher levels of demand. This approach is already starting to be embedded and extending it further should minimise costs and disruption over the long term by avoiding the need for assets to be replaced multiple times. Wider 'no regrets' investment activities also need to be accelerated. Proactive unlooping of domestic properties will remove a barrier to the installation of low carbon technologies, where households would otherwise have to wait an extended period to install a heat pump if their boiler breaks down.

**Recommendation 7 – Ofgem should base future price controls around a rebalanced set of objectives focused on long term requirements for the distribution network that deliver wider consumer value, alongside consumer costs. These objectives should include Ofgem's net zero and growth duties, as well as strengthening network resilience and delivering high quality customer service, including connection outcomes. Funding mechanisms and incentives should be designed to deliver these objectives.**

**Recommendation 8 – Ofgem should orientate the next price control around allowances set before the price control begins. Funding mechanisms should be set at a sufficient level to enable proactive investment. This should include:**

- **using re-opener mechanisms only where there is genuine long term uncertainty and the process and objectives for re-openers is proportionate to the investment being considered**

- **setting allowances to enable a 'touch-the-network-once to 2050' approach as standard, to build resilience and minimise the overall costs of investment to deliver net zero.**

**Recommendation 9 – Ofgem should accelerate no regrets activities such as proactive unlooping and off-gas grid reinforcement. Government should also set a date for the elimination of looped supplies to inform Ofgem's approach to delivery and enable distribution network operators to develop a programme for completing the work across multiple price controls.**

## Government and Ofgem

To successfully transition to a model of greater proactive investment – and deliver the reforms to strategic planning and price controls which enable this – it is important that the relationship between government and Ofgem is appropriately adjusted. Ofgem's role in the governance of the network has become more complicated. It has new duties to support meeting net zero in 2050 and promote sustainable economic growth, which it did not have at the start of the current price control.

With an expanded and more complex role, Ofgem needs a clear sense of which objectives it should prioritise. But government currently lacks the powers to provide Ofgem with a suitable strategic vision. The most recent strategy and policy statement set out 15 strategic priorities and 32 policy outcomes which government wished to achieve.

Government should adjust its relationship with Ofgem so that it can provide the necessary steers to enable proactive investment. Government should do this by strengthening the strategy and policy statement to provide a clearer strategic vision, as well as considering whether the current legal framework gives government sufficient ability to direct Ofgem on strategic matters. Any changes should be limited to strategic steers, not individual regulatory decisions, so that Ofgem's independence is maintained.

**Recommendation 10 – By the end of 2025, government should provide a stronger strategic vision to Ofgem through an updated strategy and policy statement. This should include clarity on a more focused set of priorities and outcomes for the energy sector, that better reflects government's objectives and the trade-offs between them. The revised strategy and policy statement should include the importance of proactive investment in the distribution network.**

# Removing barriers to an expanding network

## Connections

The projected rapid increase in demand for electricity will require an increased number of new and enlarged network connections. All demand customers should be able to easily connect to the network when they need to and priority generation customers must also be able to connect in line with government targets. Otherwise, there is a risk that it will not be possible to connect the right mix of renewables needed to decarbonise electricity supply, to build the new developments required to meet housing targets or deliver economic growth, nor for domestic customers to install low carbon technologies, like heat pumps and electric vehicle chargers.

Moving to proactive investment can ease the connections process by keeping capacity ahead of demand. This will be particularly critical for ensuring the simplest connections are quick and easy – for example, so that distribution networks do not create frictions for domestic consumers fitting a heat pump, or other low carbon technologies, when they want to. However, just maintaining sufficient capacity on the network is not sufficient and the connections process itself also needs to be improved.

At present, the connections queue is too long and some projects applying for a connection today cannot expect to connect to the network for over a decade. This is usually where projects require transmission reinforcement, as capacity issues are more acute on the transmission network. Significant work is currently being undertaken by the National Energy System Operator to reform the connections queue by prioritising those projects which are ready to connect and align with the needs of the future energy system. It will be critical that this work continues at pace.

In contrast, distribution network operators estimate that new projects can typically expect to take between six months and four years to connect to the network, depending on voltage level and requirements for third party consents and/or distribution reinforcement. This variation in connection reflects the different characteristics of projects and the variation in capacity across the network as well as different customer priorities. Not all projects require the fastest possible connection as, for example, developers do not want to pay for a connection years before their project is complete. What is important is that connections are delivered to a timescale that suits the customer and that the process works effectively and predictably.

While many connections processes run smoothly and networks' customer satisfaction scores are generally high, it is not uncommon for customers to face delays and wider issues with the connections process. Delays to connections can be driven by customer choices and factors outside the control of network operators, but the Commission has heard a number of common issues with the process that are within networks' control. Network customers of differing sizes, across demand and generation, have repeatedly pointed to poor customer service, misaligned connection incentives, disparities between distribution network operators, and a lack of data as key issues with the connections process. These issues were also highlighted in Ofgem's end-to-end review of connections.

While distribution connection times (excluding those where transmission reinforcement is needed) are far shorter than the ones currently being experienced on the transmission network, there has been a steady increase in average connection times since the start of the previous control period. It is essential that common challenges are addressed now, before demand increases over the coming years, to avoid the distribution connections process constraining decarbonisation and economic growth.

To simplify the process and ensure all customers have access to high quality, timely service, Ofgem should introduce new minimum service standards, applicable to all distribution network operators. These standards should raise the level of service across all distribution network operators while still providing scope for operators to go above and beyond by tailoring their service for specific customers.

More specific reforms are needed to deliver distribution network major connections, such as housing developments, factories and data centres, as well as distribution connected generation. Given the centrality of these projects to the objectives of the network – and the likelihood that the number of such projects will increase significantly – distribution network operators should be better incentivised to deliver them. It is important that incentives cover the full connections process, including pre-application engagement and the post-offer ‘negotiation’ phase, where customers and distribution network operators finalise their connection agreement. Performance should also be measured robustly and transparently, with appropriate rewards that are proportionate to the ease and timeliness of connections and the quality of service provided.

**Recommendation 11 – As part of the next price control, Ofgem should introduce minimum standards for distribution network operators. These standards should include:**

- **agreed connections guidance for all customer types and all distribution network operators, including indicative pricing and connection timescales**
- **enabling all domestic customers to apply for the installation of more than one low carbon technology through a single application, regardless of where they live**
- **developing common digitised connection documentation to be used across all network operators.**

**Recommendation 12 – Ofgem should strengthen the incentives for delivering major connections in the next price control, with a view to sustaining this approach in future price controls. The reformed incentives should:**

- **appropriately incentivise performance across each part of the major connections process, including ‘pre-application’ engagement and post-offer ‘negotiation’ phases, through financial rewards and penalties based on clearer performance expectations**

- **measure distribution network operator performance robustly, with requirements to publish connections performance data, including timeliness of connection offers and actual connections delivery**
- **offer appropriate rewards for high performance, as well as penalties for poor performance.**

## Planning and consenting

To meet government’s decarbonisation targets, barriers to the delivery of network upgrades must be addressed. The Commission has previously identified challenges with the infrastructure planning system, including in delivering the transition to net zero, for Nationally Significant Infrastructure Projects. Overcoming these challenges should help speed up delivery of distribution network infrastructure.

However, much of the distribution network does not fall within the Nationally Significant Infrastructure Project regime. The Commission has identified a small number of targeted changes to wider planning and consenting which could help speed up investment in the distribution network. Some of these changes may require primary legislation, but should remove unnecessary bureaucracy and save time for network operators, land owners and local and national government. These changes include clarifying and widening eligibility for permitted development and aligning access rules with those for other utilities.

**Recommendation 13 – Government should reform the planning system by the end of 2025 to enable new connections and network upgrades to be made more quickly. Changes should include:**

- **amending the Overhead Lines (Exemption) (England & Wales) Regulations 2009 and the process for seeking consent under section 37 of the Electricity Act 1989 to allow a wider set of alterations to overhead lines to be made without the need for planning permission**
- **addressing the ambiguity in the process for acquiring rights in private streets under Section 10 and Schedule 4, Paragraph 1 of the Electricity Act 1989**
- **amending Schedule 6 Paragraph 9 of the Electricity Act 1989 to extend access for operators conducting maintenance activities on third party land, so that they can cross as much land as is necessary, when that route is the most efficient**
- **amending the Town and Country Planning (General Permitted Development) (England) Order 1995 to increase the volume threshold for substations to be built with permitted development rights from 29 cubic metres to 45 cubic metres.**

## Supply chain and skills

Like many other sectors, the distribution network faces supply chain and skills pressures. As demand on the distribution network grows and investment increases, these pressures are likely to grow. As well as the challenges common to other sectors, there is increased global competition within the international energy market. While supply chain pressures currently pose a more significant problem for the transmission network – where global competition is most acute – some of this equipment is also common to distribution networks. Global competition is also likely to move to distribution network equipment as transmission investment is completed.

Taking a longer term, proactive approach to network investment can help manage these pressures and support manufacturers and their supply chains to plan for volume increases. A more strategic approach to procurement, informed by a longer term view of distribution network investment plans, could enable network operators to make stronger commitments to their supply chains who, in turn, can plan for the increased volume of parts needed. Government and Ofgem should also consider whether new mechanisms that have been developed to manage the transmission supply chain could also be applied or adapted for distribution networks.

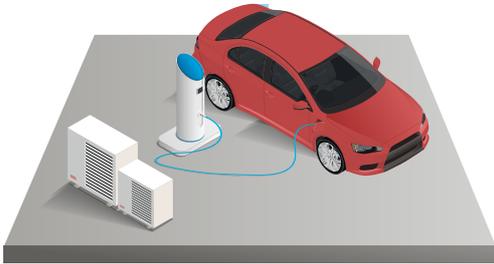
Skills shortages impact the whole of the energy sector and pose a significant challenge for the deliverability of the energy transition. For distribution, the most significant concern is a shortage of craft skills, particularly cable jointers and overhead line workers. There are also concerns that general engineering skills and growing requirements, such as digital and data, will not be met. There is strong competition for these skills within the energy sector, with other infrastructure sectors and across the broader economy, which makes it difficult to solve issues specifically within the distribution sector.

Given the time it takes to develop these skills, urgent action must be taken to ready the workforce for the energy transition and to meet net zero. Short and medium term solutions – such as retraining and recruiting skilled workers from other countries – can help, but they will not be sufficient to manage the long term workforce challenge. Government needs to review the issues and identify the actions required to address skills challenges. This should inform a wider net zero skills strategy that sets out how the workforce will be developed and maintained over time.

**Recommendation 14 – Government should identify the skills gaps and actions required to attract, recruit and retain the large workforce needed to deliver the energy transition. This should form the basis of a net zero skills and workforce strategy, published by the end of 2025.**

# The challenge

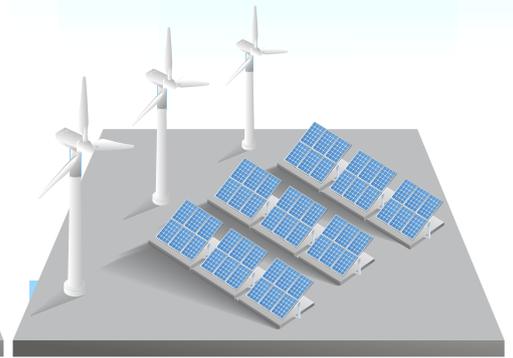
Distribution networks are going to change as the economy electrifies.



**24 million** heat pumps and **35 million** electric vehicles by 2050



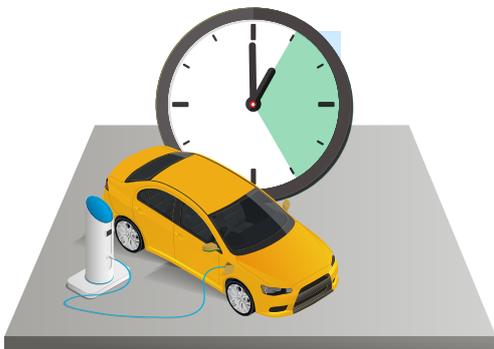
Peak electricity demand growing from **44 GW** to **108-120 GW** by 2050



Additional **13 GW** onshore wind and **30 GW** solar by 2030

# Meeting the challenge

Actions are needed so distribution networks can enable economic growth and support the country's net zero goals.



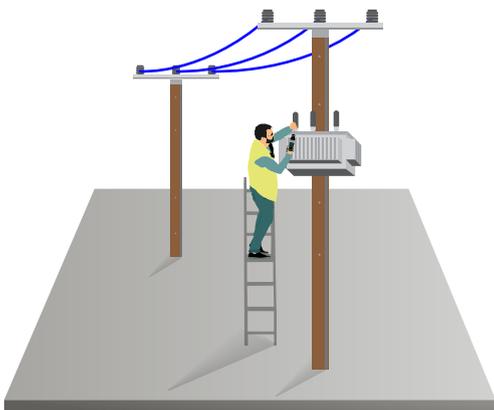
**15%** reduction in distribution network spend from using flexibility



**50,000 - 130,000** additional workers by 2050 across electricity networks



**11** regional strategic plans to accelerate strategic investment



Reforming planning to enable network upgrades

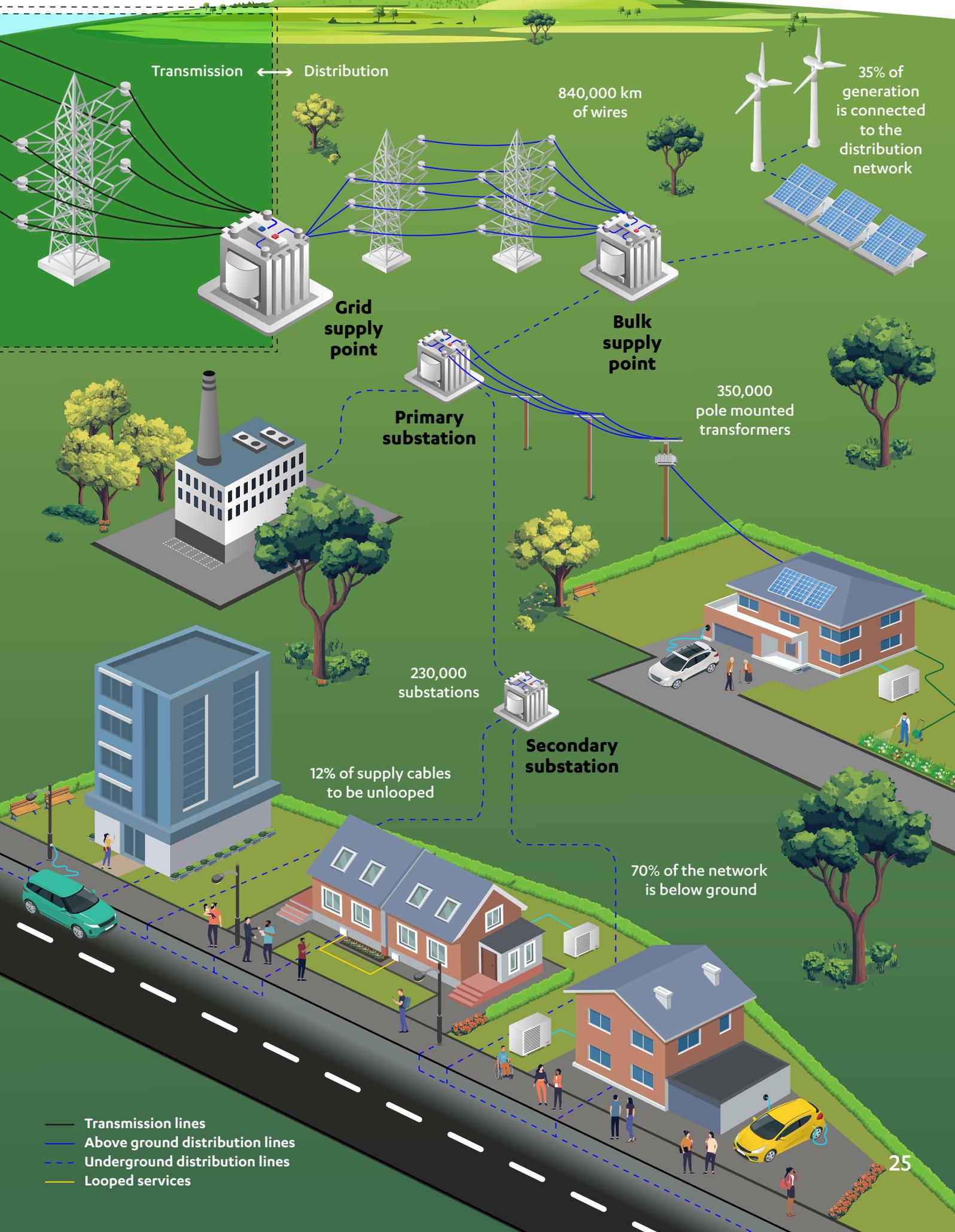


Timely customer friendly connections process



Simpler network business plans to drive proactive investment

# Key elements of the distribution network



# 1. Distribution networks today and how they are changing



The distribution network connects all households and the vast majority of businesses to the electricity system, as well as around a third of generation. While the network has been run on a steady state basis for some time, changing patterns of supply and demand will see the role of the network change. The distribution network will play a critical role in enabling the decarbonisation of the power sector, heat and transport, as well as supporting economic growth across all regions of the country.

These changes in supply and demand will have consequences for the level of investment that needs to be made in the distribution network. This has already prompted changes in investment delivered through the price control process, but as heating and transport increasingly electrify, and new sources of demand arise, the pace of investment will need to increase. Investment patterns will also need to reflect fundamental changes in how networks are governed and regulated, as the energy sector as a whole moves to a more strategically planned approach.

In parallel, the network will need to change how it operates, becoming more flexible and digitally capable to help meet future demand effectively and efficiently. And it will need to do all of this while remaining reliable and resilient to a changing climate.

## Study scope

In the 2023 Autumn Statement, the government asked the National Infrastructure Commission to provide recommendations on the policy decisions required to make the electricity distribution network fit for net zero.<sup>2</sup> In making its recommendations, the government asked the Commission to consider:

- how use of the distribution network will change as new sources of demand, storage and generation are deployed
- whether the regulatory model, including already proposed future changes, is fit for purpose for identifying and enabling anticipatory investment in the distribution network at the scale required to facilitate the connection of new sources of supply and demand, and how it may need to evolve to deliver this investment at pace
- the role of network and non-network solutions in delivering the capacity needed at lowest cost, and the policy, regulatory and governance changes that could be needed to unlock these solutions
- the role of data and technology in managing the network efficiently
- the role of different parties, including distribution network operators, the Future System Operator and Regional Energy Strategic Planners, in the process of connecting new sources of generation to the network, as well as new sources of demand, including low carbon technologies such as heat pumps and electric vehicle chargers. This includes the scope for standardisation across distribution network operators
- the interaction with available capacity on the transmission network and how this may be impacting connections to the distribution network, and how these interactions could be best managed

- whether any changes to the planning system in England could support faster delivery of needed distribution network infrastructure.

The terms of reference specify that the Commission may recommend that government works with Ofgem to take action on particular issues, but that the current distribution price control will not be reopened. The Commission was also asked not to make a specific assessment of the overall level of investment required.

## The distribution network

The electricity network can be divided into two parts: transmission and distribution. The transmission network moves electricity around the country via high voltage wires, from generation sources to areas of demand. Distribution networks are regional, operating at lower voltages and connecting all households and most businesses to the electricity system. Distribution networks connect to the transmission network through grid supply points.

The distribution network in Great Britain is split into 14 licence areas, shown in Figure 1.1. These are operated and run by monopoly distribution network operators, which are currently owned by six companies.<sup>3</sup> They are responsible for operating and maintaining the electricity infrastructure in their network, including wires and substations. Independent Distribution Network Operators own and operate some smaller sections of network, such as networks for new housing developments, and connect into the distribution network.

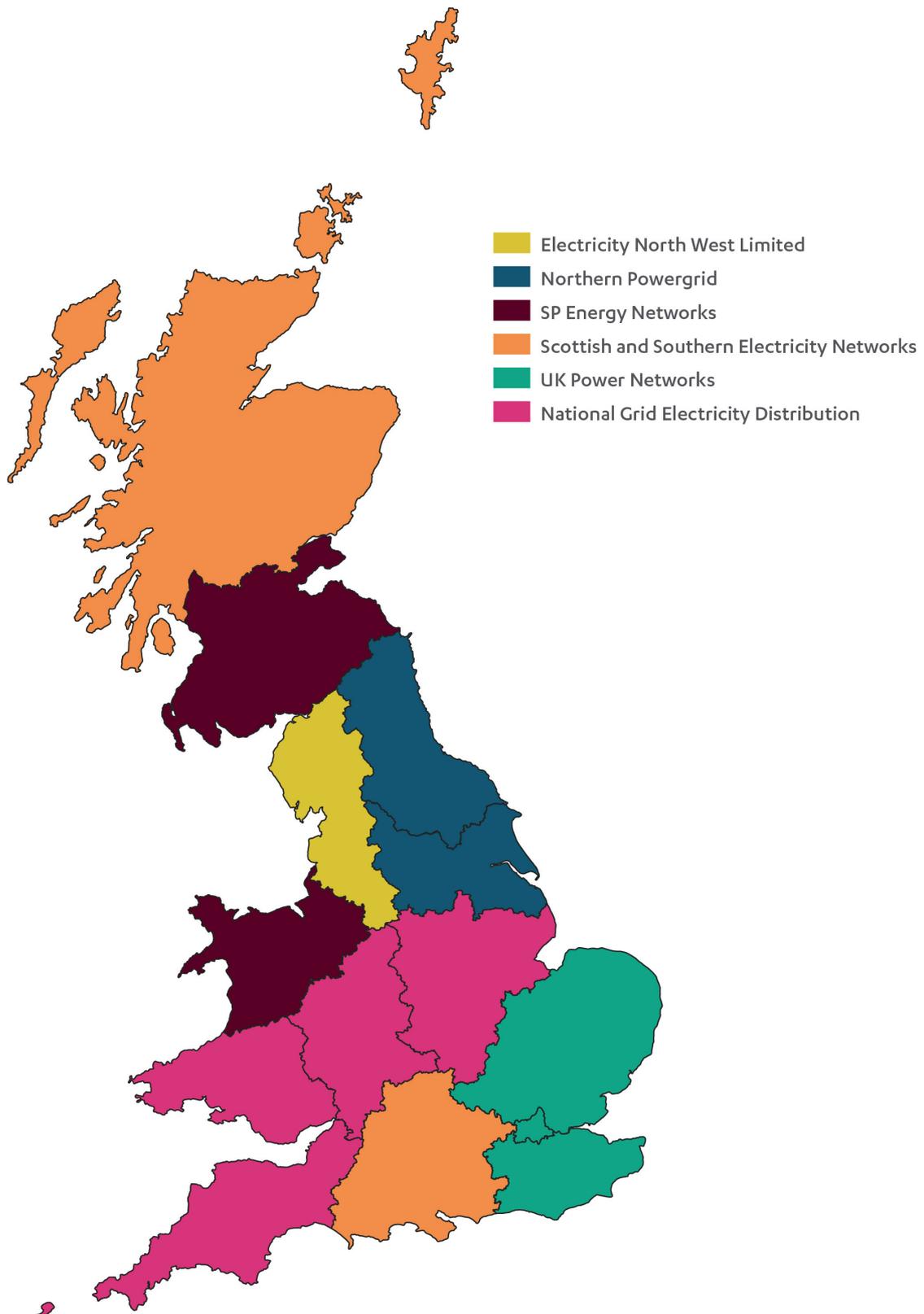
In the past, power moved from large, centralised generation sites on the transmission network down to distribution level at grid supply points. The location of generation is changing with the move to a highly renewable system, as renewable technologies and battery storage tend to be more dispersed. They are also more likely to be connected to the distribution network. Currently 35 per cent of generation is distribution connected (also known as embedded generation), up from 15 per cent in 2011, and this will continue to increase as more renewables are deployed.<sup>4</sup> This means that in some areas, power is now flowing from distribution networks up into the transmission network.

The network operates across multiple levels at different voltages. The distribution network starts at the 132 kV level in England and Wales and below that in Scotland, and drops down over multiple stages to 230 V to domestic users. Higher voltages move larger volumes of power around longer distances and lower voltages supply power directly to consumers at safer voltages. Between each voltage level is a substation – a facility which includes a transformer to reduce the voltage and enable the network to branch out to multiple destinations.

Most of these different voltage levels are included in the primary distribution network. The final tier of network that distributes power to small commercial and domestic users, is known as the secondary distribution network or low voltage network and makes up 45 per cent of the total network by length. This distributes power to small commercial and domestic users.<sup>5</sup> The final stage of the distribution network is the service cable into a property and the cutout. Non-domestic users connect at different voltage levels of the network, depending on the amount of power they need.

**Figure 1.1: The distribution network in Great Britain is owned and operated by six companies across 14 licence areas**

*Distribution network licence areas by owner*



Source: Commission analysis using data from National Energy System Operator.

The distribution network is expansive, comprised of over 838,000 km of wires, more than 230,000 substations and 348,000 pole mounted transformers.<sup>6</sup> 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.<sup>7</sup>

In some license areas, over 20 per cent of electricity service cables from the main network are shared with neighbouring properties.<sup>8</sup> These are known as ‘looped’ supplies. In most cases, these will need to be replaced before low carbon technologies can be fitted, as looped supplies have lower limits on the amount of electricity the properties can use. This involves removing the looped connection and installing individual service cables to each property – ‘unlooping’ – which can take some time to organise and carry out.<sup>9</sup>

## Polymaking and regulation

A fundamental shift in how the energy sector is governed and regulated is underway. Reflecting how the sector will continue to change as demand for electricity increases significantly and rapidly, there is a need to shift from the market-led approach which has characterised the sector for decades. To meet increasing demand, achieve government’s decarbonisation targets and unlock economic growth across all regions of the country, the sector is taking a more strategically planned approach. Policy and regulation for the distribution network is shared between government, Ofgem and the National Energy System Operator. The current regulatory system has generated investment and improved performance. But the system was not set up to provide strategic direction for investment to tackle issues such as achieving net zero greenhouse gas emissions by 2050.<sup>10</sup> As governance and regulation moves from reactive to a proactive, more strategically planned approach, the roles and responsibilities of all three bodies must shift too.

Most energy policy in Great Britain, including the generation and supply of electricity, is reserved to the UK government, but there are some exceptions, such as energy efficiency. Planning policy is also devolved in both Wales and Scotland. The Department for Energy Security and Net Zero is therefore responsible for the overall policy framework for the sector in Great Britain, set through legislation, National Policy Statements, strategy and policy statements, and guidance. The department also plays a role in the planning and consenting regime – such as the ‘section 37’ consenting regime for overhead lines, permission for which must be granted by the Secretary of State in England and Wales. In Scotland, all overhead lines are consented by the Scottish Government.<sup>11</sup>

The Department for Energy Security and Net Zero is also the sponsor department for Ofgem and for the National Energy System Operator. The government has powers under the 2013 Energy Act to issue a strategy and policy statement, which sets out the strategic priorities for the energy sector. Ofgem must “have regard to” these priorities when carrying out its functions and must do so in the way it considers is best calculated to further the delivery of the policy outcomes, subject to its principal duty.<sup>12</sup>

To support government's ambition to achieve clean power by 2030, a new unit has been established in the Department for Energy Security and Net Zero: Mission Control. The new body will look to break down siloes in government and bring together public officials and industry experts to facilitate the decarbonisation of the grid.

Ofgem is the independent economic regulator of gas and electricity markets in England, Scotland and Wales. Ofgem's principal objective is to protect the interests of existing and future consumers in relation to the energy system. It was recently given two new duties. Firstly, the net zero duty which requires it to consider consumers' interests in meeting the 2050 net zero target and other associated targets, like carbon budgets. The second is the growth duty, which requires Ofgem to have regard to the promotion of sustainable economic growth through its regulatory activities.<sup>13</sup>

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.<sup>14</sup> At the time price control decisions were set in 2022, Ofgem estimated that the costs of the distribution network comprised around £100 per billpayer within an average electricity bill of around £1,200 per year.<sup>15</sup>

The National Energy System Operator is the independent system operator, responsible for balancing the supply and demand for energy in real time. It is also responsible for strategic planning of networks, taking a whole system approach across natural gas, electricity and other forms of energy. The new body was launched in October 2024 after government acquired the Electricity System Operator from National Grid, bringing it into public ownership. It has already provided government with advice on how the UK can meet its goal to deliver clean power by 2030 and it has also been commissioned to develop a Strategic Spatial Energy Plan, which will be used to help plan the future of the energy system.<sup>16</sup>

The relaunched National Wealth Fund (previously the UK Infrastructure Bank) will play a role in enabling investment into clean energy industries.<sup>17</sup> Great British Energy has also been launched as a publicly owned energy company, focusing on less mature technologies and supporting the supply chains required to develop a decarbonised power system. Great British Energy will invest directly in small scale renewable projects as part of the Local Power Plan, in partnership with local government and community energy groups.<sup>18</sup>

# How the network is changing

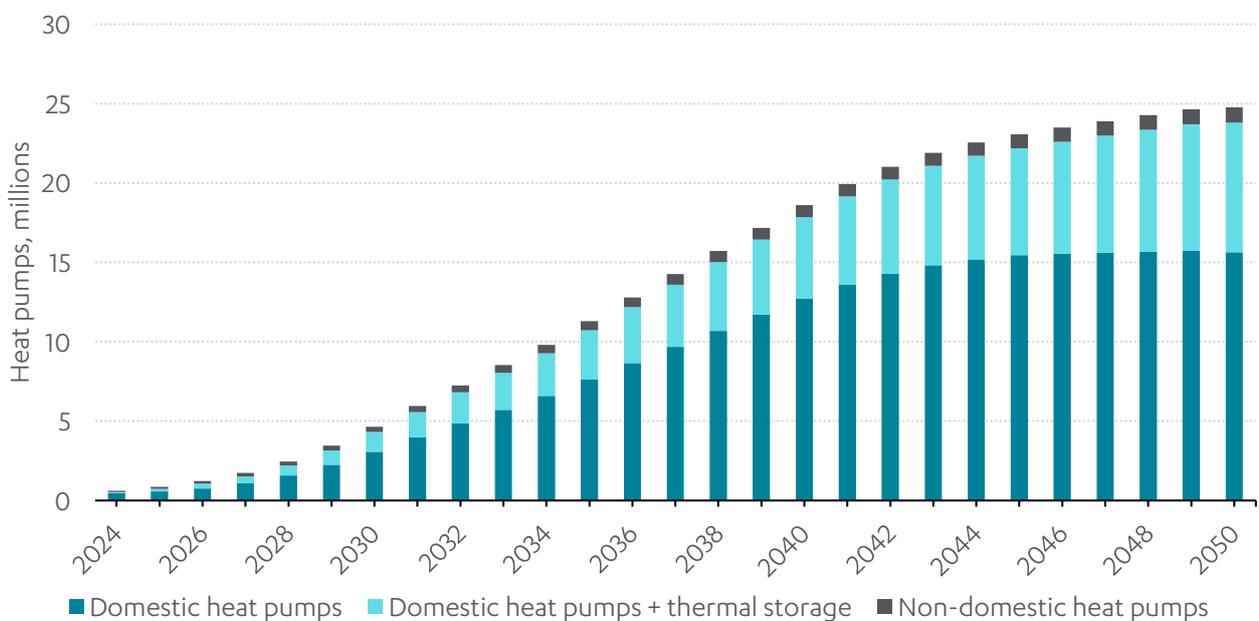
## Demand

For many years, distribution networks have been run on a steady state basis, taking a ‘just in time’ approach to network build and only investing ahead of certain short term need. The primary goal in managing the network has therefore been to maintain the network efficiently. This approach was appropriate while overall demand levels were relatively flat or declining – in 2023, domestic electricity consumption fell to the lowest levels since 1990 at 92.6 TWh, with industrial and commercial consumption also down.<sup>19</sup> The need to decarbonise society and the economy changes this dynamic, but significant uncertainty about technological choices and the pace of the energy transition has made future demand hard to predict.

Ofgem’s approach to setting the electricity distribution price control reflected this. For the current price control, Ofgem asked distribution network operators to submit their own future energy scenarios as part of their business plans. However, ultimately, Ofgem chose to base their cost assessments on the most conservative low carbon technology uptake scenario from the system operator’s Future Energy Scenarios report – ‘system transformation’. This was designed to avoid excessive costs and make sure consumers did not speculatively fund investment that turned out not to be required.<sup>20</sup> Despite its somewhat conservative approach, the current price control period should see an increase in investment. However, the pace of investment will need to increase again to stay ahead of projected demand – see Figure 1.2.

**Figure 1.2: The roll out of electrified heating systems is challenging but achievable**

*Cumulative heat pumps installed from 2024 to 2050, Consumer Transformation scenario*



Source: Regen analysis using Electricity System Operator’s *Future Energy Scenarios 2023*.

Helpfully, uncertainty is starting to reduce and there is now a much clearer direction of travel on the pathway to net zero. Most critically for distribution networks, it is increasingly clear that electrification will be the route to decarbonising heat and that an increasingly large proportion of the economy is likely to electrify. The Commission's analysis for the second *National Infrastructure Assessment* estimated that demand for electricity will increase by 50 per cent by 2035 and double by 2050.<sup>21</sup> While there is still some remaining uncertainty, overall the requirements for distribution networks are becoming much clearer.

The electrification of heating and transport is expected to have the biggest impact on demand. Modelling by Regen and EA Technology for the Commission estimated that in 2050, heat electrification would account for 40-47 GW of peak demand in 2050 and electric vehicle charging demand would account for 22-28 GW.<sup>22</sup> Because of this analysis undertaken for the study shows that there will be need for the greatest number of interventions and the largest investment in the low voltage levels of the network.

Industrial electrification is also likely to impact demand. Analysis undertaken by Element Energy for the Climate Change Committee found that additional electricity consumption from industry resulted in an average increase in electricity consumption of 1.7 TWh per annum between 2020 and 2050.<sup>23</sup> There is a risk that this electrification will impact network capacity, with one estimate showing that 65 per cent of industrial sites may be constrained by 2040.<sup>24</sup> While this assessment did not consider the impact of electrification of industrial processes on peak demand, it is assumed that industry will be relatively responsive to the price signals which enable flexibility, as they use technologies such as thermal storage, and will therefore have limited impact on peak demand. The role of flexibility is discussed in more detail in the subsequent sections of this report.

New industrial processes required as part of the transition to net zero will also impact demand, primarily hydrogen electrolysis – the process by which electricity splits water into hydrogen and oxygen. This will provide the 'green' hydrogen needed to help decarbonise industry and the power sector. Aurora's modelling for the second *National Infrastructure Assessment* suggested that in 2050, electrolysis could account for 2-8 GW of peak demand.<sup>25</sup> But if used flexibly, these processes could also provide additional capacity at peak time.

In addition, policies to encourage economic growth will impact the networks. There is likely to be increased industrial demand from an industrial strategy. The increase in new homes built as a result of revised house building targets will also add new demand to the networks.

The increased digitalisation of the economy and associated need for data centres will also see demand for electricity increase. These high demand facilities are now designated alongside energy and water systems as 'critical national infrastructure' and, unlike other key technologies, this demand is unlikely to be flexible. Currently, data centres account for 0.8 GW of peak demand.<sup>26</sup> But with growing data processing requirements, demand for data centres could increase rapidly – modelling done by the National Energy System Operator assumes a fivefold increase in data centre electricity demand from today to 2030.<sup>27</sup>

Water supply, telecoms connectivity and skills shortages present other spatial and strategic barriers to the investment potential that data centres bring to the economy while waste heat provides an opportunity. There is a need for government to further develop policy and guidance to steer future data centre growth towards suitable locations informed by a strategic assessment of the impact on energy supply and demand. The government has already proposed to consent large data centres under the Nationally Significant Infrastructure Projects regime.<sup>28</sup> The cross-sector impacts of data centre growth should be addressed as part of the 10 Year Infrastructure Strategy. Government's recently announced Artificial Intelligence Energy Council will need to consider this as it explores potential solutions, including innovation in energy and water efficiency, to meet the increasing resource demands of artificial intelligence.<sup>29</sup>

Although it is certain that there will be an increase in electricity demand overall, there is uncertainty as to how this demand will spread across the network, and precisely when demand will increase over the coming years. This is because the growth in demand will be driven by the decisions of millions of individual households and businesses. However, the objectives of achieving net zero emissions, expanding house building and growing the economy create confidence that extra network capacity will be needed in the medium to long term – especially as electrification looks like the best option for decarbonisation of a large proportion of the economy. Waiting for demand to materialise would mean investing too late, creating bottlenecks and delays. A step change towards proactive investment in the network can ensure that the capacity is available when it is needed to support decarbonisation and the wider economy.

## Network capacity

Government estimates suggest there is currently adequate spare capacity on the distribution network, with around 60 per cent spare capacity on average.<sup>30</sup> This is the difference between the amount of power the network is designed to deliver and the actual demand on the network. This will vary by area. Spare capacity on the network can be beneficial because it allows demand for electricity to increase, but only if the location of spare capacity is aligned to the location of growing demand.

Capacity challenges on the distribution network are already emerging. For example, in West London, network constraints brought about by the installation of data centres have already led to connection issues, causing connection delays for other large demand projects such as housing developments and commercial customers.<sup>31</sup>

Without available capacity, new sources of supply and demand will not be able to connect. This will mean that households will not be able to install low carbon technologies, like heat pumps or electric vehicle charge points, and industrial customers will not be able to switch to electricity as a cleaner, more secure source of power.

### **Box 1: Transmission interactions**

There are two types of electricity network in Great Britain: transmission, and distribution. The transmission network operates at high voltages (275-400 kV) moving large amounts of electricity across the country.

The distribution network takes electricity from the transmission network and delivers it to homes and businesses. It operates at a wide range of voltages: from 230 V to 132 kV (in Scotland the 132 kV is included in transmission). The distribution network is comprised of a lot of small assets, with over 230,000 substations<sup>32</sup> and over 838,000 km of distribution network wires. The majority of distribution, by length, is underground.<sup>33</sup>

In the past, electricity flowed from large power stations on the transmission network into the distribution networks and on to customers. With the increase in renewable generation, this is changing. Renewables are often connected to the distribution network (known as embedded generation), which means that in some parts of the distribution network, electricity flows back to transmission, depending on the demand and the weather.

Often the capacity of the transmission network can dictate the volume of electricity that a section of the distribution network can take or produce, and so projects connecting to the distribution network can be impacted by the capacity of the transmission network to support them.

The increasing proportion of generation connecting at the distribution network will also impact on network capacity. Currently around a third of generation is connected to the distribution network, but this is expected to increase as more solar and onshore wind is deployed. The proportion of network customers who are net exporters of electricity, rather than net importers, is therefore likely to increase. And while growth in distribution connected generation may provide power closer to growing demand, network capacity will still be required to move it.

To meet current demand on the distribution network while minimising investment in network expansion, distribution network operators use flexibility – the ability to shift energy consumption, either in time or location. Some technologies, which are expected to be increasingly deployed, can also provide additional flexible capacity to the network. In the Clean Power Plan, government estimates that 23-27 GW of electricity storage is expected to connect into the system by 2030, and modelling undertaken by Regen for the Commission suggests that distribution connected storage could range between 7.4-11.5 GW in 2030.<sup>34</sup>

The forthcoming increase in demand can be met partially through increased use of flexibility, which will need to be planned for. And flexibility will also play an important role in managing the electricity system. The Commission's recommended approach to maximising flexibility is set out in the next chapter.

## Resilience

As dependency on electricity grows, there must also be a commensurate focus on network resilience – the network’s ability to anticipate and respond to shocks and stresses, like extreme heat, storms and flooding. The importance of maintaining and improving security of supply – so that networks can provide a reliable supply of electricity even with increased future demand loads – will also be critical.

Like all infrastructure, the distribution network will need to be prepared and adapt to a changing climate. The impacts of climate change are already being felt by the distribution network and, as impacts intensify, the risks that they present are likely to increase.<sup>35</sup> Extreme heat and storms are likely the two key challenges.

Extreme heat can impact the distribution network in multiple ways. Prolonged exposure to high temperatures significantly reduces the performance of insulation on the network, which can reduce the lifespan of equipment like transformers. Extreme heat can also reduce the capacity of the distribution network. High temperatures cause overhead power lines to sag due to expansion of material, which reduces the wires’ electrical performance, reducing the amount of electricity which can flow through them.<sup>36</sup> In July 2022, when Great Britain first recorded a 40 degree Celsius temperature, network faults developed across at least two licence areas.<sup>37</sup> The Climate Change Committee estimates that by 2050, the heatwave summer of 2018 will be a typical summer, likely to occur every other year.<sup>38</sup>

Storms also create challenges for the distribution network. Strong winds can bring down trees and branches, damaging overhead power lines and other electrical installations. Lightning strikes can cause power surges, leading to equipment damage. In November 2021, Storm Arwen saw wind speeds of up to 98 miles per hour, knocking trees and branches onto power lines and damaging them. This left 40,000 consumers without electricity for over three days – 4,000 of whom did not have their power restored for over a week.<sup>39</sup> The impacts of Storm Arwen drew significant attention to the resilience of the distribution network, leading to Ofgem creating a new uncertainty mechanism for the current price control to fund further resilience activity. The impacts of Storm Arwen were particularly severe, but subsequent named storms have also had significant impacts on the distribution network, including Storm Eowyn in January 2025. There is some evidence to suggest that climate change could lead to a slight increase in the number of storms and to more severe storms.<sup>40</sup> It is, however, uncertain whether maximum windspeed is likely to increase.<sup>41</sup>

While these changing risks will affect most regions, some will be more vulnerable to particular risks than others. For example, southern England – particularly the South East – is set to experience a greater increase in maximum summer temperature and is therefore more exposed to the risk of extreme heat than other regions.<sup>42</sup> Even within licence areas, different parts of the network are more exposed to risks and can face more detrimental impacts. The impact of power loss may be more acute in remote rural locations where physical access can be limited and there is less redundancy built into the network.

It will also be increasingly important that the distribution network is resilient to cyber threats. Growing digitalisation of the network can provide significant benefits, including potential resilience benefits. However, at the same time cyber resilience is a growing concern.

The National Cyber Security Centre has noted an upward trend in targeted cyber attacks, including an increasing number against operational technology that can control critical infrastructure.<sup>43</sup> As the network becomes more digitally enabled it will be increasingly important to understand interactions between technology and associated areas of vulnerability.

The Commission has previously looked at the importance of resilient infrastructure, calling for government to publish a full set of resilience standards every five years, for increased stress testing of infrastructure and for operators to develop and maintain long term resilience strategies.<sup>44</sup> Growing interdependencies between electricity and other utilities, such as digital and telecommunications infrastructure, make resilience even more critical. As the Commission recommended in the second *National Infrastructure Assessment*, a system should be put in place for cross sector stress tests to address interdependencies and the risk of cascade failures.<sup>45</sup> Ofgem has a role to play in developing stress tests which effectively address vulnerabilities and will need to work with government and regulators in relevant sectors to coordinate action.<sup>46</sup>

## 2. Moving to proactive investment



## Limits of the current approach

Society has seen the consequences of failing to meet changing patterns of supply and demand at transmission level. Over half of generation customers in the transmission queue today are waiting for a connection date at least five years in the future, and over ten per cent are due to wait ten years or more.<sup>47</sup> In 2023, energy bill payers paid £1.4 billion in network constraint costs because the electricity transmission network did not have the capacity to transmit all the energy generated by renewables.<sup>48</sup> The National Energy System Operator outlines that for transmission, twice as much will need to be built in the next five years as was built over the last decade to achieve clean power by 2030.<sup>49</sup> The challenges on the transmission network should serve as a warning for the distribution network.

Without action, distribution networks are at risk of becoming a similar blocker to the energy transition and a constraint to growth. Therefore, taking a ‘just in time’ approach to network build is no longer fit for purpose. To meet carbon budgets and net zero, uptake rates of heat pumps and electric vehicle chargers will need to increase rapidly in the 2030s. There will be a good level of certainty associated with short to medium term investments where demand is rising or where development is occurring. Given the projected scale of electrification by 2050, the risk of stranded assets and unnecessary investment is extremely low – though there may be some underutilisation risk that needs to be managed in the short term. Fundamentally, the challenge is that the risks of falling behind demand now outweigh the potential downsides of building ahead of need.

There are a range of estimates for the rate at which network capacity will be used up, with one estimate suggesting the capacity on the low voltage networks will, on average, be used up by 2035, while another shows less than 25 per cent of secondary substations will be at capacity by 2035.<sup>50</sup> This requires a step change in the pace and scale of network investment from today, with greater acceleration needed from the start of the next electricity distribution price control. A proactive approach to network investment would smooth and likely reduce overall consumer costs over the longer term due to increased cross programme efficiencies and strategic partnerships with the supply chain. Greater investment is needed now to set the system on the long term trajectory to hit the Sixth Carbon Budget and meet net zero, as well as enable economic growth.

## Proactive investment can drive economic growth and deliver wider consumer value

The start of the current electricity distribution price control coincided with an increase in energy prices following Russia’s illegal invasion of Ukraine. Consequently, Ofgem designed a price control framework and set distribution network operators’ allowances at a level which would prioritise keeping bills down. There is now a need to move to a wider conception of value for consumers, the economy and society, which goes beyond just the immediate costs of investment.

Sufficient capacity on the distribution network is a critical enabler of economic activity and the drive to net zero. Facilitating quick connections enables businesses to set up and expand, which underpins economic growth. It is also fundamental to the government's clean power by 2030 mission. Enabling the deployment of more homegrown generation will futureproof society against potential resource scarcity and price shocks from imported energy.

Proactive investment in the distribution network will also bring wider system benefits to society and the environment. Major government priorities, such as housebuilding, are dependent on the effective growth of the distribution network, with the government setting a target of building and connecting 1.5 million new homes over the next five years. Improving air quality and reducing risks of respiratory and cardiovascular diseases caused by pollutants from fossil fuel use can only be achieved by the deployment of low carbon technologies, which depend on the distribution network. Better strategic planning of investment will also allow more opportunities to manage and mitigate environmental impacts from new infrastructure. The additional costs associated with preparing the distribution network must therefore be viewed in light of these wider consumer, societal and system benefits.

It is also 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.<sup>51</sup> Further analysis on the cost to consumers of distribution investment is set out later in this chapter.

## Ofgem's growth and net zero duties

The government has made a start at sending signals to the industry, but more needs to be done to galvanise this transition. In 2023, the government gave Ofgem a new statutory 'net zero' duty. The duty states that Ofgem's principal objective is to protect the interests of existing and future energy consumers while supporting the government to meet its legal obligation to get to net zero by 2050. In 2024, the government amended the statutory growth duty to include utilities' regulators, including Ofgem, who are now required to have regard to how their decision making promotes economic growth.

These measures provide the starting point for Ofgem to develop the wider conception of consumer value required to ensure that distribution networks remain an enabler and not a blocker to growth and development, or to net zero. The government and Ofgem need to set a clear direction that puts distribution networks on the path to achieving these long term objectives through proactive investment.

## Potential requirement for distribution network investment

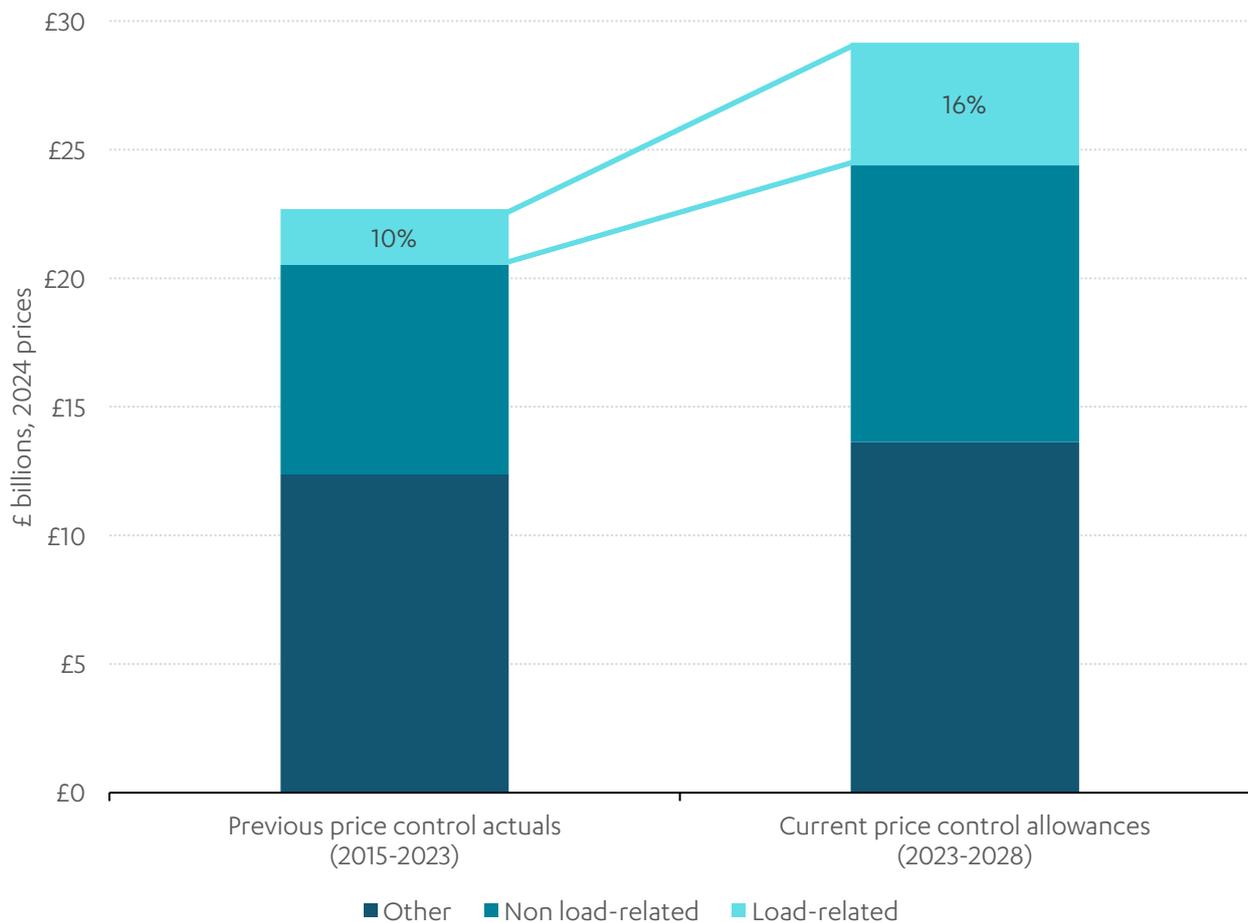
To support the study, the Commission procured modelling and analysis from Regen and EA Technology to understand the level of distribution network investment that could be required. This covered two types of modelling:

- **National analysis** – using EA Technology’s ‘Transform’ Model to assess the potential load related expenditure that could be required across Great Britain in different scenarios.<sup>52</sup>
- **Low voltage network case studies** – considering how load growth could affect different parts of the network in different ways.<sup>53</sup>

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.<sup>54</sup> Load related expenditure is a small but growing proportion of total expenditure, as shown in Figure 2.1. Further details on the methodology can be found in the published reports from Regen and EA Technology.<sup>55</sup>

**Figure 2.1: Load related expenditure is a small but growing proportion of total expenditure**

*Total expenditure for the current (2023-2028) and previous (2015-2023) price control periods*



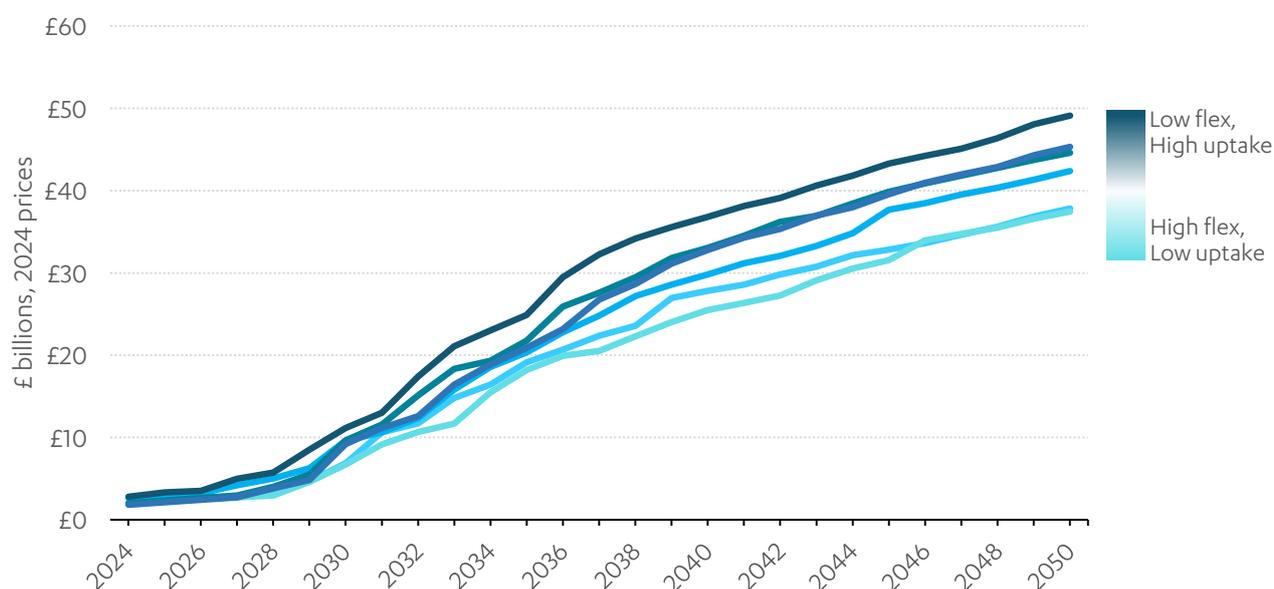
Source: Commission analysis using data from Ofgem.

Note: Other costs include high value projects, network operating costs, closely associated incidentals, and business support.

Figure 2.2 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. 60-70 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 by wire length and 97 per cent of substations – drives this high share of investment.<sup>56</sup>

### Figure 2.2: 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.

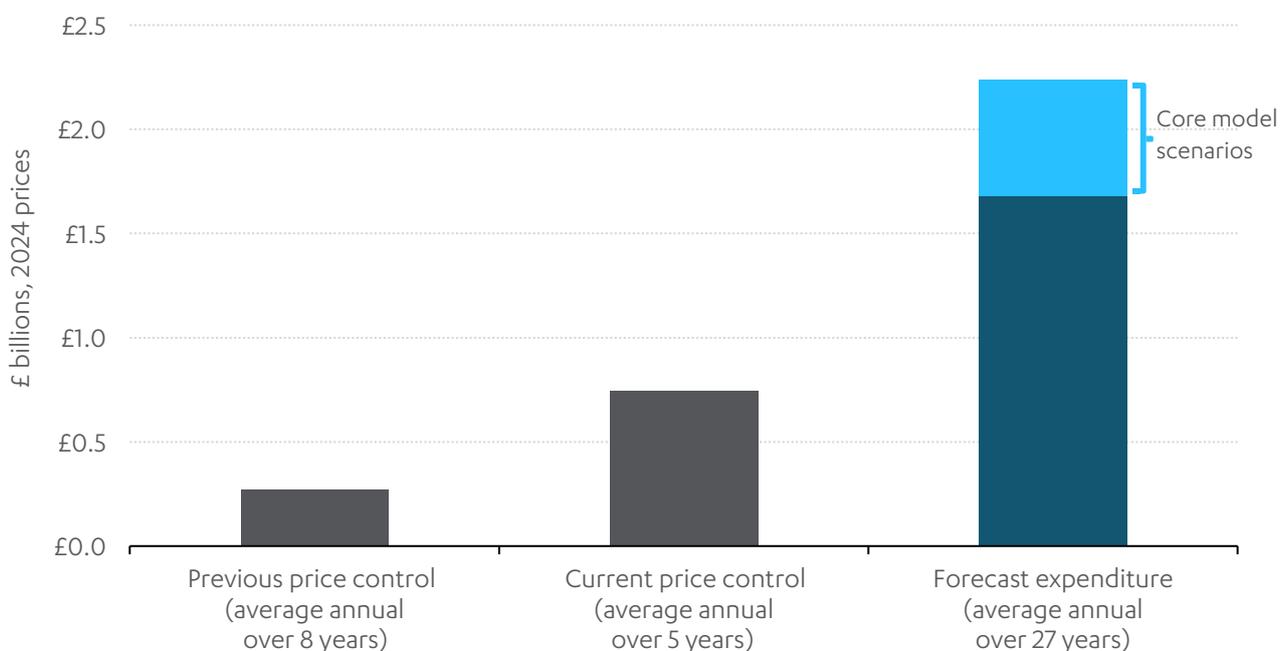
Note: This excludes non-load related expenditure and load related expenditure for 132 kV and low voltage service cables.

Figure 2.2 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.<sup>57</sup> 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, though a significant amount of investment is still needed even with high levels of 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, though they would only have a small impact on bills overall.<sup>58</sup> The previous electricity distribution price control period (2015 to 2023) delivered an annual average of £270 million of load related expenditure and the forecast average for the current price control (2023 to 2028) 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 2.3. 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 the 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.

### Figure 2.3: A step change in electricity distribution network investment is needed

*Average annual load related expenditure from 2015 to 2050*



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

To complement this national level modelling, Regen and EA Technology also examined the impacts of the deployment of low carbon technologies through a series of network case studies. These examined seven different network locations across different urban, suburban and rural network configurations, based on network data from Northern Powergrid and National Grid Electricity Distribution. The location of low carbon technology uptake was varied across each network to test how this affected the impacts on each network, including the type and timing of interventions required.

Each network case study was affected differently by both the expected uptake and varying locations of low carbon technologies. While there are several common themes that can be drawn out, the case studies show how varied the local impacts of increased electricity demand could be. The suburban terraced street case study had no need for intervention, even by 2050, though it demonstrated the impact of peak electricity demand shifting to different times.<sup>59</sup> Four of the case studies required transformer upgrades, including all three rural case studies.<sup>60</sup> The two urban case studies required larger feeder cables, but did not see transformer capacity issues.<sup>61</sup> Where an upgrade was required, 2035 was the most common intervention year due to the coincidence of increased uptake rates for both electric vehicles and heat pumps.

While separate to the national modelling, the case studies demonstrate that even where investment is ultimately required, local use of flexibility could delay when intervention is needed. This has benefits for long term network planning as it provides additional time to identify the optimal network solution. Increased network monitoring will give a better understanding of changing levels of demand, including the impact of low carbon technology uptake and consumer behaviour changes – for example, in response to supplier tariffs.

## **Risk of getting behind need outweighs risk of getting ahead of need**

The modelling results show that a step change in investment in distribution networks is required, with annual load related expenditure needing to at least double. While there has been an overall uplift, Ofgem's approach to load related expenditure in the current price control remains mostly responsive, using uncertainty mechanisms to trigger reinforcement when demand materialises. There were understandable reasons to take this approach – particularly the uncertainty around heat decarbonisation – but the balance of risk has changed. The risk of getting ahead of need is now outweighed by the risk of falling behind need and this requires a different approach and risk appetite. The next electricity distribution price control, which starts in 2028, must facilitate the rapid acceleration of investment required in the early 2030s shown in Figure 2.2.

A more proactive approach can look at how to balance risks over the longer term more effectively. It will mean planning for future changes over time and taking a more programmatic approach to proactive network planning rather than looking at specific projects and needs cases on an individual basis. This should speed up delivery and help provide the supply chain with a clearer direction of travel and a smoother profile of investment. A programmatic approach should also enable distribution network operators to build strategic partnerships with suppliers and contractors to deliver more efficiently over time.

A step change towards proactive investment will not be risk free, but remaining reactive would risk worsening the challenges around connecting to the network, with negative implications for growth and development. Heat pump installations in existing properties need to grow by an average of 35 per cent each year to switch seven million existing fossil fuel heating systems to heat pumps or heat networks by 2035, as recommended in the second *National Infrastructure Assessment*.<sup>62</sup> Decarbonising the economy will become a major challenge if those who want

to decarbonise – whether domestic customers or large industrial users who want to electrify – cannot connect to the network in a timely manner. As more of the economy electrifies, confidence in the reliability of electricity supply will be even more critical.

While assets may be underutilised in the short term, the risk of them being stranded is very low given expected demand growth in the 2030s. Optimising the timing of all interventions is not possible given the complexity of the system. It will take too long to devise an optimal strategy and not acting now will only serve to store up a bigger challenge for the future. A proactive approach is needed for networks to plan ahead with confidence and provide the right signals and commitments to supply chains.

Ofgem will need to allow more investment before uncertainty is fully resolved, supporting the installation of assets that are big enough to meet the demands of a much larger future system. At the same time, no regrets actions should be taken to prepare homes for the transition to low carbon technologies, so that consumers can install a heat pump or other domestic low carbon technologies when they want to – see part three.

## Managing the cost of investment for consumers

The step change in investment will require a modest increase in distribution network costs for consumers. Distribution network charges represent a relatively small proportion of energy bills – currently five to ten per cent.<sup>63</sup> The cost of the additional load related expenditure across the core scenarios developed for this study would amount to around £5-25 extra per household, per year from now to 2050.

Any increase in consumer costs should not be dismissed – particularly given the current high levels of energy debt – and government and Ofgem will need to spread costs to consumers appropriately over time. While delaying investment could reduce short term costs to consumers, the burden on future consumers also needs to be considered. Even with rising network investment, average bills should still fall below 2019 levels by the mid 2030s if government takes active decisions to put the right wider policy measures in place. This aligns with analysis of energy bills, based on the recommendations in the second *National Infrastructure Assessment*.<sup>64</sup> Underinvestment in the short term also risks increasing the overall cost of investment.

A proactive approach to network investment can help smooth consumer costs over time. Taking a proactive approach could also reduce the impact of investment on consumers by enabling cross programme efficiencies and allow networks to build strategic partnerships with the supply chain, as well as avoiding investment bottlenecks. Increased network investment should also be happening alongside falling wholesale costs. Indeed, it can be an enabler of this as network investment will be a critical prerequisite to connect more low marginal cost renewable generation to the system.

## Flexibility will become more important

One key way of keeping the cost of investment down is through maximising the role of flexibility in the electricity system. Flexibility is the ability for something connected to the electricity system to adjust when electricity is used or produced – either in time or location – and is one of the most important aspects of operating the future electricity system. Flexibility is crucial for meeting our net zero goals and reducing the costs of doing so. Consumer led flexibility is expected to play a key role in meeting government’s Clean Power 2030 target, with 10-12 GW of flexibility capability from consumers required by 2030.<sup>65</sup> Embedding flexibility will be key in supporting industry to decarbonise and should be included in an industrial strategy.

Consumer led flexibility has multiple advantages and takes broadly two forms:

- **National** – by reducing the size of peak demand, the amount of generation needed and size of the network to deliver that power to end users is also reduced. As electricity generation becomes increasingly renewables based, flexibility can enable an increase in energy usage during sunny or windy periods and reduce it during lulls.
- **Local** – flexibility can be used by distribution system operators to manage pinch points in networks by moving demand in parts of the network that are close to capacity to lower demand periods.

There are multiple ways consumers can provide flexibility. For example, an electric car can shift when it charges. Electric vehicles using smart charging could provide up to around 70 GW of flexibility.<sup>66</sup> Private electric vehicles chargers already need to be installed with the capability to charge flexibly.<sup>67</sup> Vehicle to grid technology allows cars to transfer electricity back to the network during periods of peak demand as well as providing flexible benefits to users – as set out in box 2.

### Box 2: Vehicle to grid

Electric vehicles have large batteries which store electricity. While this adds extra demand when charging up, it also provides opportunities for flexible usage. Through smart charging, the demand a car has on the electricity network can be shifted to times when more electricity is available or there is less demand on the network.

Vehicle to grid technology goes beyond this by enabling the car to sell electricity back to the network during periods of high demand, and then recharge later when power is cheaper. A similar application of this technology (vehicle to home) can be used to reduce a home’s electricity demand during peak hours by using the electricity within a house. Several trials of vehicle to grid technology have shown that it can deliver significant benefits that it can deliver significant benefits, with the potential to provide up to 35 GW of capacity to the network in 2035.<sup>68</sup>

To enable vehicle to grid technology, either the car or the charge point needs additional equipment installed. It is currently not clear which one of these options will become standard. There is also an increased cost for this, with vehicle to grid chargers forecast to cost an additional £650 – £1,000 in 2030.<sup>69</sup>

Heat pumps will be one of the largest sources of demand on the future electricity network, with the analysis for this study showing that domestic heat pumps will add 23-34 GW to the peak load by 2050 across the core model scenarios. Their impact could be reduced through the use of smart heat pumps – which can automatically preheat a house then turn off or reduce load for a period – or through the installation of thermal storage to reduce their operation at peak times.<sup>70</sup> Heat pumps will also be used in heat networks, which are expected to play a key part in meeting future demand. Thermal storage in heat networks will also be crucial.<sup>71</sup>

The government has consulted on making more appliances ‘smart’, with a key focus on heat pumps. Government should implement this by 2026, so that the heat pumps installed in Great Britain will be smart capable and able to move demand away from peak hours.<sup>72</sup> Heat pumps will not be the only form of heating in the future, and other forms of domestic and commercial heating such as heat batteries and storage heaters should also be included over time. Heat pumps and electric chargers must have a level of automation and support from suppliers which means even those who are digitally excluded can access the benefits from these technologies.

Batteries can be used to store excess energy and discharge it back to the network, either when it is needed to help meet increased national demand, or within part of a network to increase supply on the other side of a capacity constraint. Energy efficiency measures can also help buildings reduce peak demand and may play a role in enabling flexibility. Continuing to progress and push for greater improvements on home insulation is therefore still an important goal. The energy efficiency actions that the Commission recommended in the second *National Infrastructure Assessment* – including delivering £5.1 billion of capital spending on energy efficiency improvements between 2024 and 2030 – remain the right focus.<sup>73</sup>

Distribution networks themselves can also provide flexibility, such as with the Customer Load Active System Services system used by Electricity North West Limited, which can adjust the voltage on parts of the network and so adjust energy consumption.<sup>74</sup> Impacts could be increased by rolling this system out further and/or reviewing permitted voltage ranges.

## **Flexibility is crucial for the UK’s energy system, but ‘flex first’ is not**

Maximising the use of flexibility across the electricity system will enable more efficient system management. Deploying flexibility further and faster will also reduce the costs to consumers by minimising the amount of generation and network infrastructure that needs to be built to meet increased demand. Analysis for the government has suggested that flexibility can reduce annual electricity system costs by around £6-10 billion per year.<sup>75</sup> Most of this saving comes from building less generation than would otherwise be required. Modelling for this study shows that flexibility could reduce the cost of distribution network investment by around 15 per cent – a cumulative saving of £6.7-7.9 billion by 2050. Most of this saving is driven by enabling national flexibility, but this is not how flexibility is currently approached in distribution networks.

For the current price control, Ofgem embedded a ‘flex first’ approach. This allows distribution system operators to procure flexibility to defer upgrades where procuring flexibility is cheaper than the cost of reinforcement in the short term.

This makes sense if the network will not need upgrading in the future and flexibility can provide the enduring solution. For example, one of the local case studies showed the potential for some areas to avoid the need for upgrades between now and 2050 by procuring flexibility.<sup>76</sup>

Local flexibility will therefore continue to play an important role in the management of a robust and adaptive system where it can provide this type of enduring solution, or where it can create additional time for strategically planning longer term interventions. However, short term deferral of investment could result in a bottleneck for network reinforcement while demand growth is accelerating rapidly in the next ten years. There is also a risk that local flexibility could come into conflict with the bigger prize of national flexibility.

Deployment of flexibility will usually align with both local network constraints and national demands on generation, such as by flattening peaks, but this may not always be the case. For example, a solar farm may be able to generate more power but be constrained by the local network and so curtail its production. Where the priorities of the local and national networks conflict, it is preferable to use flexibility to manage national demand peaks rather than local constraints, as the benefits should be greater – see also box 3. To avoid the use of local flexibility curtailing the use of national flexibility, Ofgem will need to move away from the ‘flex first’ principle and instead encourage the utilisation of flexibility where it represents the best system solution (or part of it) over the long term. Further work to better understand the trade-offs between local and national demand flexibility – and how they can be managed – may also help identify where investment is needed or where flexibility can be utilised.

There is also the additional challenge that flexibility is currently procured in multiple markets – by the National Energy System Operator and then also separately by individual distribution system operators. The Flexibility Market Facilitator role will improve standardisation and coordination across markets, including by making sure contracts do not overlap through ‘primacy rules’ which govern who comes first within contracts.<sup>77</sup>

A Low Carbon Flexibility Roadmap has been announced as part of the Clean Power 2030 Action Plan.<sup>78</sup> This roadmap will be crucial to increasing the rollout of flexibility. It should bring together digitalisation and flexibility across the electricity system to increase the use of flexibility, focusing on reducing peak demand and managing the variability of renewables. It must also provide direction for digitalisation activities to enable this. This must include a route to market for the owners of distributed assets such as smart chargers and heat pumps.

## **Digitalisation will be key to enabling ‘smarter’ networks**

Digitalisation of the network will be key to enabling flexibility, including that required for Clean Power 2030. A smart energy system will be able to respond to real time communications. With greater digital capability and more monitoring of the networks’ condition, system operators can understand and plan their systems more accurately. They should also be able to respond more quickly to changes in network conditions or signals from the wider electricity system – in some cases automatically. Enhancing networks’ digital capability will therefore be a key part of the distribution system operators’ role.

Network monitoring has already been rolled out across the high voltage parts of the distribution network. In the past, demand on the low voltage parts of the network was predictable and monitoring was not needed. The increased deployment of low carbon technologies will change this. The use of flexibility and distribution connected generation, such as onshore wind, also means that consumer electricity demand profiles are becoming more dynamic and less predictable.

More detailed, (close to) real time information about network demand will therefore be needed for the effective upgrading and running of the network. Low voltage network monitoring is being rolled out in the current price control. The effectiveness of this increased monitoring should be assessed, and the rollout continued in the next price control. The variation in rural and urban network between licence areas makes a 'one size fits all' approach to modelling network capacity challenging, as demonstrated by the low voltage network local case studies. Increased monitoring will enable networks to have a better understanding of network capacity in different localities and mitigate potential constraints.

As part of this network monitoring there will be an increase in the number of assets in remote locations that will need to be connected. The ability to communicate with assets in remote locations will provide operational improvements, such as being able to spot network problems in advance or adjust the network remotely. In the second *National Infrastructure Assessment* the Commission stated there should be clear policy responsibilities within government for delivering telecoms strategies for different infrastructure sectors. This should include assessing the need for spectrum allocation to utilities to enable necessary connectivity, and responsibilities for securing spectrum if needed.<sup>79</sup> Making a decision on this will be key.

In addition to network monitoring, smart meter data can be used by system operators to understand how demand on the network is changing. They can then identify where network constraints are emerging. Smart meters are needed to enable flexibility as they record when electricity is used as well as the amount. Consumers with a traditional electricity meter are charged based on the amount of energy used between readings. Smart meters enable suppliers to set tariffs which are more reflective of the wholesale price, which should encourage the use of flexible technologies.

The government is targeting 75 per cent of homes and nearly 69 per cent of small businesses to have a smart meter by the end of 2025.<sup>80</sup> Currently, 66 per cent of domestic users have an electricity smart meter, but the rate of smart meter installation is falling, and so the target is unlikely to be met.<sup>81</sup> In addition, 1.4 million smart meters are not operating properly in 'smart' mode and the upcoming 2G switch off in 2033 means that many more may not operate as they should.<sup>82</sup> The previous government introduced a four-year framework for smart meter rollout in 2022.<sup>83</sup> This should be updated, and sufficient progress driven forward to avoid smart meter rollout becoming a blocker to greater system flexibility.

Generators and suppliers trade electricity in the wholesale market in half hourly periods. Currently, all medium and large businesses are settled on their half hourly energy consumption, but it is not a requirement for domestic customers.<sup>84</sup> Extending this to all customers, whether domestic or commercial, should act as an enabler for new low carbon products and services to encourage flexible use of heating and car charging to shift demand away from peak periods.

Ofgem estimates benefits to consumers of £1.6-£4.5 billion over the period 2021-2045, with these benefits most likely to accrue to consumers who can be most flexible on their energy usage.<sup>85</sup> While Ofgem announced their decision to approve market wide half hourly settlement in April 2021, progress has been delayed. Despite an expected four and a half year implementation period the current implementation date is expected to be between July and December 2027. Ofgem have appointed Elexon as the programme manager for the roll out of market wide half hourly settlement.

Suppliers, such as Octopus, Centrica, and OVO, are already conducting half hourly settlement for some domestic customers and offering smart tariffs so that electricity is cheaper for customers at periods of lower demand. Benefits from the increased digitalisation of the network and development of smart tariffs must be made available to a wide range of customers. There must also be adequate protections in place for vulnerable customers that may not be able to move their energy usage, for example those on pre-payment meters and the digitally excluded. Equally, there must be consumer protection from sustained high prices for vulnerable users with energy needs that cannot be flexed.

### **Box 3: National price signal impact on the low voltage network in Finland**

In Finland, 29 per cent of households have electricity contracts where the amount they pay for hourly consumption is based on the national market price. Consumers are incentivised to minimise consumption when that price is high in favour of periods with a lower price.<sup>86</sup>

On 24 November 2023, a submission error caused the national market price to plummet over a ten hour period to minus €500 per MWh. After distribution fees and taxes were added end users were paid €0.4 for every kWh of electricity they consumed. Total consumption nationally increased by nearly ten per cent, driven predominantly by the reaction of household consumers.<sup>87</sup>

The increased demand had a significant impact on the distribution network. One distribution network operator experienced increased consumption of 500 MWh.<sup>88</sup> Three fuses within the distribution network melted and information collected from smart meters indicated that 120 household fuses melted within customer protection devices.<sup>89</sup>

Flexible asset registration has an important role to play. This ensures that electric vehicle charge points and heat pumps are known to the distribution system operators so they can assess where flexibility is available in the system. Network companies also benefit from increased registration of small assets because it improves their granular visibility of the networks and aids decision making on planning and infrastructure reinforcement. This in turn reduces costs for network companies and consumers. Government is currently working on its Automatic Asset Registration programme to test solutions for automatically registering small scale energy assets and an accompanying Central Asset Register.<sup>90</sup> Ofgem is also consulting on this with its Flexibility Market Asset Registration consultation.<sup>91</sup> Work on asset registration must progress so that flexible asset registration can be implemented throughout the industry.

To enable a smart, efficient energy system, all these aspects of flexibility and digitalisation must be brought together. The Low Carbon Flexibility Roadmap must aim to enable digital infrastructure to communicate across the energy system from the assets in people's homes to the National Energy System Operator balancing the grid on a national level in order to get the most value and efficiency out of the energy system. Alongside distribution system operators, Ofgem needs to ensure that the digitalisation strategies are outcome focused for both consumers and across the electricity system with an emphasis on both transparency and security.

**Recommendation 1 – Government should introduce measures to maximise the use of flexibility across the electricity system, working with the National Energy System Operator and Ofgem to deliver the Low Carbon Flexibility Roadmap by the end of 2025. This should cover the role of flexibility and digitalisation across all parts of the electricity system, including:**

- **working with Ofgem to updating the smart meter rollout plan by the end of 2025, including measures to fix smart meters not currently operating in smart mode**
- **implementing the smart appliance mandate for heat pumps in 2026**
- **working with Ofgem and Elexon to deliver market-wide half hourly settlement by 2027 without further delay**
- **supporting industry to improve flexible asset registration.**

## **Maintaining security of supply will remain a key objective**

Maintaining security of supply and keeping electricity flowing to consumers in the face of shocks and stresses is a key objective for the network and for the electricity system overall. Consumers today experience a largely reliable supply of electricity from the distribution network with power cuts being rare events for most consumers. During the previous electricity distribution price control, the number of supply interruptions fell by 23 per cent.<sup>92</sup> The importance of a reliable network will only grow as the economy and society becomes increasingly dependent on electricity.

The security of supply standard for distribution networks is set out in Engineering Recommendation P2/8.<sup>93</sup> This sets out the level of redundancy required for different sized groups of demand. The standard is based on a series of principles which inform how network operators plan and invest. This standard has been periodically reviewed and updated and it should be reviewed again now. In one of the low voltage network case studies the appropriate solution for how to meet increased demand was influenced significantly by security of supply standards.<sup>94</sup> Although an illustrative example, this demonstrates that security of supply standards significantly impact network planning.

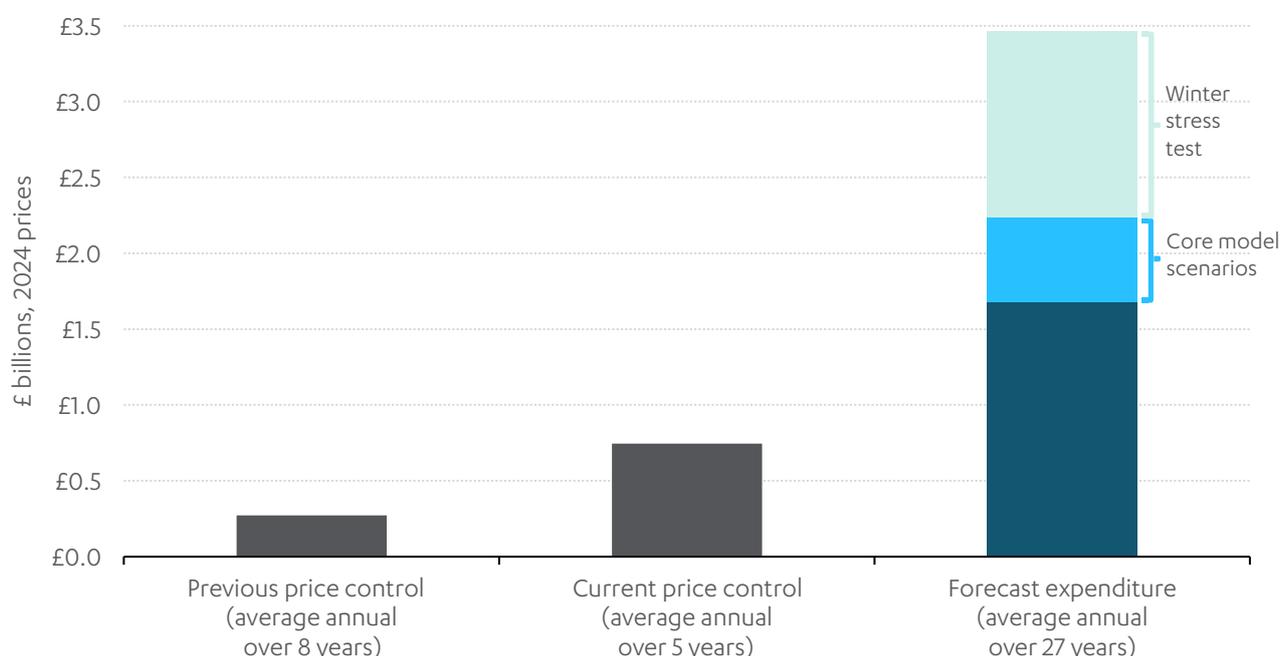
The 'winter stress test' scenario included in Regen and EA Technology's modelling for the Commission looked at the impact of combining high future heating demand with low levels of flexibility. This scenario suggests that investing to meet peak of winter peak demand could

add over £25 billion to the amount of distribution investment required between now and 2050 compared to other scenarios – see Figure 2.4. This increased investment is driven by the need to build additional assets to increase network capacity, particularly at low voltages.

The scenario is not a probabilistic assessment based on a defined cold spell and 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.

### Figure 2.4: Network design needs to consider the evolving security of supply challenge

Average annual load related expenditure from 2015 to 2050



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

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

When considering security of supply standards, it is also important to consider how demand varies over time, as well as its overall peak. Demand which is clustered together at the same time is a greater challenge for the network than demand which is ‘diverse’ – more spread out over time. Current security of supply standards assume relatively low diversity of demand, but this could change.

In addition, better monitoring, greater digital network capability and smart device integration all have the potential to help manage the network and efficiently maintain security of supply. By managing the network more effectively, existing network infrastructure can be more efficiently utilised, reducing the need for further investment. For example, network automation will

enable networks to reconfigure to prevent or manage an issue. This potential has only partly been integrated into the current security of supply standard. Previous assessments of the security of supply standard have suggested that significant savings could be made from better incorporating this additional network capability.<sup>95</sup>

However, it will be critical that flexibility and network management tools can be sufficiently relied on so that they do not weaken the outcome for consumers. That means there must be a high degree of confidence in access to flexibility markets and the capability of network operators to actively manage their network. Automation will need to play an increasingly key role here to increase the reliability of flexibility, particularly consumer led flexibility. Changes in the scale and diversity of demand from large numbers of consumers responding to the same price signals will also need to be considered. However, sensible investment and modelling of these features should lessen the amount of investment required to maintain a high level of security of supply.

Reviewing security of supply is not an immediate challenge, but it would be sensible to do this ahead of the acceleration of demand expected in the 2030s. The Commission has previously set out the importance of regularly reviewing resilience standards and iterating them over time.<sup>96</sup> While detailed work for the review is identified and undertaken, sensible activity which can improve reliability – for example, in parts of the network where reliability is known to be lower – should still be progressed. As part of business planning for the next price control, distribution network operators should identify ‘no regrets’ activities to improve network reliability which can be progressed before the review is completed.

While security of supply is set through a technical engineering standard, setting any resilience standard involves trading off social and economic impacts, which is a role for government. Government will therefore need to work with Ofgem and key stakeholders within the system – including the distribution network operators – to agree an approach for reviewing security of supply standards, develop the evidence base and assess different options.

As part of reviewing security of supply standards, vulnerable customers must remain appropriately protected. Network operators have an obligation to produce a priority services register and have piloted programmes delivering batteries and using vans with onboard energy storage systems to serve customers who need electricity for medical equipment during outages.<sup>97</sup> Solutions like these could be rolled out across the network, but there is also potential to look at policies to provide greater support to vulnerable customers. This could include installing batteries alongside heat pumps or incorporating emerging technology where electric vehicle batteries provide power to the grid or home during disruption. Such solutions are likely to be significantly less expensive than building a much bigger network, but no less reliable at protecting vulnerable customers.

Maintaining overall security of supply for the electricity system will also require considering the interdependencies with the transmission network and with generation. While there is likely to be some overlap, the standards and challenges are different, so different approaches and actions will be required.

The Commission has previously considered aspects of this, including recommendations in the second *National Infrastructure Assessment* on the need for persistent, low carbon gas generation to meet shortfalls in renewable generation as unabated gas comes off the system.<sup>98</sup>

**Recommendation 2 – Government and Ofgem should review security of supply standards for distribution networks to ensure that they are designed for future loads and vulnerable customers are protected.**

**As part of business planning for the next price control:**

- **Ofgem should require distribution network operators to identify ‘no regrets’ activities that would improve security of supply**
- **government and Ofgem should work with distribution network operators to agree the detailed work required to review security of supply standards and how this will be undertaken.**

**The full review of security of supply standards should then be completed by the end of 2028.**

### **3. Reforms to facilitate proactive investment**

**To deliver the proactive investment required to meet the future needs of the network, a different approach to network planning and regulation will be needed. There is too much uncertainty over future demand to optimise investment exactly when it is needed.**

**Some of this uncertainty is inherent, but aligning around a single understanding of how the future energy system might evolve through strategic planning can give more confidence in where and when network investment is needed. This can help to identify investments of particular complexity or value which require a different approach from network operators and regulators. And this can then support a simpler approach to price control regulation which is refocused on a broader set of objectives to deliver greater value for consumers.**

## Strategic Planning

There is currently no effective system of strategic planning for energy networks at local or regional level. Gas and electricity network operators plan their investments independently from each other. Assumptions around the future trajectory of supply and demand are negotiated individually with Ofgem – though some parameters for the current price control were set based on the electricity system operator’s Future Energy Scenarios.<sup>99</sup>

Distribution network operators engage closely with local government, but there is no formal method for incorporating local priorities or the outputs of local plans. Some areas have formalised Local Area Energy Plans, and the Scottish and Welsh governments have mandated and funded energy plans for their constituent local authorities. Distribution network operators take these into account, but local authority engagement is inconsistent and highly dependent on resource.

There is an opportunity to improve this process, creating whole system strategic plans that stakeholders can align around. In turn, these can inform pathways for network investment which are better at managing and anticipating the future needs of the system.

This is not the same as attempting to plan the network or the energy system centrally. Instead, this represents an opportunity to align stakeholders around a single view of the future and accelerate decarbonisation by delivering infrastructure at the pace required to meet decarbonisation goals. This is the vision set out by government, Ofgem and the National Energy System Operator, which now needs to be turned into reality.

## Principles for strategic planning

If implemented effectively, strategic planning has the potential to bring many benefits to the energy system. It can provide additional confidence in the future needs of the system, provide better alignment across vectors and help drive proactive investment by establishing an agreed needs case for investment. However, badly managed strategic planning could create additional bureaucracy without any of these benefits being realised. As the framework of strategic planning takes shape, it must be underpinned by the following principles.

## **Strategic planning should remain strategic**

The main purpose of strategic planning is to coordinate and align stakeholders around an agreed view of the future energy system, rather than imposing a top-down view of the energy system on stakeholders. The responsibility for network planning should remain with distribution network operators, and the responsibility for local spatial planning should remain with local government.

## **Strategic planning should incorporate the best possible data and information to mitigate uncertainty**

Some uncertainty over the future needs of the energy system is inherent to energy planning, but using the best possible data and information can help mitigate this problem. Networks have made significant improvements in monitoring their capacity. This should continue, and the data should be used to inform the strategic plan, as well as individual network plans.

Inputs from local and devolved governments such as Local Area Energy Plans should be fully utilised. Forecasts of energy supply and demand should be regularly developed and improved. This should incorporate real world demand data from heat pumps and electric vehicles to refine the estimates of how much capacity will be needed, as well as data on other sectors such as industrial demand and flexibility. This is not just about which projects and technologies will be connected to the network, but also about understanding the effect they will have on the system and ensuring the assumptions are transparent.

Inputs from local and devolved governments, such as Local Area Energy Plans and Local Heat and Energy Efficiency Strategies and Delivery Plans, should also inform strategic planning. And this should include non-energy specific inputs, such as Local Growth Plans.

## **Strategic planning should collate and reconcile views to a single vision**

A key role of strategic planning is to identify how supply and demand is most likely to evolve. This will help articulate a single agreed trajectory for the development of the energy sector in the short term, creating greater confidence in the needs case for investment. This does not mean ignoring the uncertainty over how the sector will develop, particularly in the longer term, where it will be appropriate to develop multiple scenarios reflecting multiple possible futures of the energy system. Longer term forecasts should also be used to make sure new investments are sized to support the full range of potential futures.

Strategic planning can also help manage trade-offs between competing priorities, and facilitate agreement on which priorities are most urgent or important.

## **Strategic planning should genuinely accelerate investment**

Strategic planning must be used to facilitate the move away from a steady state approach towards more proactive investment based on long term assumptions about supply and demand. The pathway developed through strategic planning should be used to inform network

investment plans and identify areas where strategic investment is particularly valuable, either due to the network requirements being complex or the potential effects of the investment being particularly significant.

Ofgem's regulatory approach will need to change to accommodate this. Strategic planning must minimise regulatory burdens on both Ofgem and the network operators rather than add to them. Outputs from the strategic planning process should act as the agreed needs case for investment, which can streamline scrutiny in the price control process. Ofgem can then focus its efforts on assuring the proposed solutions and their efficient delivery, as well as ensuring appropriate funding mechanisms are available.

### **Strategic plans should be iterative**

Strategic planning will need to be an ongoing process. An adaptive planning approach will facilitate the process of managing and minimising uncertainty and give confidence to stakeholders that new projects can be accommodated as their development becomes more certain.

A transparent methodology and regular data updates should minimise the likelihood of large shifts in the plan between iterations. Starting from scratch each time would be unhelpful, so the strategic planner will need to develop a careful balance between adjusting the plan to new developments, while giving distribution networks and other stakeholders enough certainty to plan and deliver investment.

## **Regional Energy Strategic Plans**

In 2023, Ofgem confirmed the introduction of a new regional strategic planning function delivered by the National Energy System Operator. The purpose of the 11 Regional Energy Strategic Plans is to align stakeholders around a coordinated vision for the energy system across vectors. The plans will produce a cross-vector pathway that can then inform network investment plans. Distribution network operators will need to align their investment plans to this pathway, but will retain responsibility for planning and delivering network investment.

The National Energy System Operator will publish a transitional Regional Energy Strategic Plan in early 2026. This will inform the next electricity distribution price control, which begins in 2028. Plans will then be produced every three years beginning in 2027/28. The regional plans will be informed by the system operator's Strategic Spatial Energy Plan, and will in turn feed into future iterations of the national plan.

### **Using regional plans to inform strategic investment**

Regional Energy Strategic Plans will aid investment planning in different ways. Firstly, the plans will help to define how investments should be sized – including asset replacement – based on an agreed demand pathway. The pathway can inform the volume of load related expenditure needed to keep ahead of demand. It will also support efficient and effective delivery across multiple price controls.

The Regional Energy Strategic Plans can also deliver benefits by proactively identifying strategic investment opportunities. These are investments with the highest level of network complexity, or where significant value could be added to either the energy system or the economy. Strategic network investments could include investments to support decarbonisation in industrial clusters, significant new housing developments (including new towns), and infrastructure to support motorway electric vehicle charging.

The development at Biggleswade, described in box 4, is an example of a project with both high economic value and strategic complexity. More proactive strategic planning could potentially have streamlined the process of delivering this project.

#### **Box 4: Biggleswade**

National Grid and UK Power Networks partnered to deliver a new substation in Biggleswade, enabling an additional 80 MW of power capacity to support new housing in the area. National Grid and UKPN concluded that incremental upgrades to existing infrastructure could not meet the future demands of the region, and that a more strategic upgrade was required.<sup>100</sup>

The network companies were not able to invest in this upgrade proactively as it did not relate to an identified project which had applied to connect. Any developer seeking to build housing in Central Bedfordshire would have been liable for the full costs of the upgrade to the grid, which would have been a prohibitively high cost for any single project.

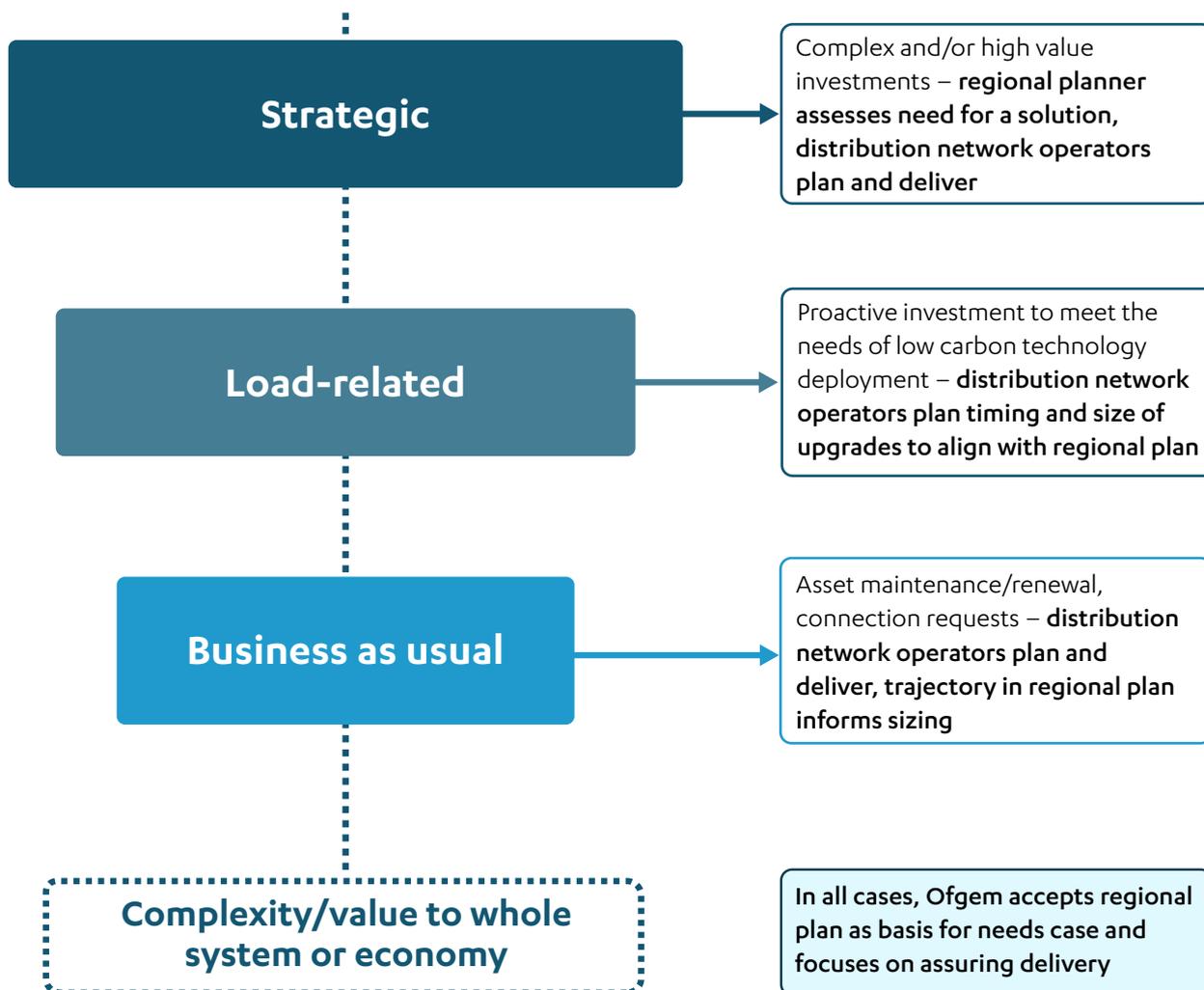
As a result, Homes England stepped in to provide £70m of upfront funding for the substation and other projects in the area, to be recouped through contributions from developers as projects were built.<sup>101</sup> The capacity will support Central Bedfordshire Council's plans for 3,000 homes to the east of Biggleswade, as well as future developments.<sup>102</sup>

As demand increases across the network, there will be more sites like these where large individual investments could unlock capacity to support multiple projects. The Regional Energy Strategic Plans should identify areas where this could be beneficial in partnership with distribution network operators, and Ofgem should agree an appropriate funding mechanism to fund these projects.

The Regional Energy Strategic Plans should engage with stakeholders and distribution network operators, and utilise network data to identify strategic investment opportunities. This way, investments related to regional or national priorities can be identified, as well as through cross vector planning. This will particularly be the case where a single larger intervention could meet consumer needs more effectively or cheaply than if projects were considered individually.

Distribution network operators should continue to plan the specific investments required, but the regional planner should help to identify the needs case for investment and support networks with optioneering. Figure 3.1 sets out how different types of investment should be managed under a new strategic planning system.

**Figure 3.1 Defining strategic investment**



## Making the new architecture work

The introduction of Regional Energy Strategic Plans is welcome, but policy is still in development and decisions about how they will operate in practice are yet to be taken. The following paragraphs set out the Commission’s view of how key outstanding issues should be taken forward.

### Clear accountability

It must be clear to all stakeholders how Regional Energy Strategic Plans will fit into the architecture of the energy system. This requires a clear statement of responsibilities and accountability from the National Energy System Operator. This should set out which decisions

the regional plans will make, when different stakeholders will have the ability to input and challenge, and which responsibilities will remain with other stakeholders, such as distribution network operators. One key area for Ofgem and the National Energy System Operator to clarify is the role and responsibilities of the strategic board and working groups in each region, including whether they will approve the plan or merely advise or set strategic priorities for it.

As part of this process, the regional planner will need to assess which projects are likely to be built, as they will also make the final decision on which projects are included in the plan. Ofgem and the National Energy System Operator need to produce a clear methodology for how these decisions will be made and set out clearly whether, and how, stakeholders can challenge and scrutinise them. Projects not included in the plan should receive feedback as to what evidence could justify their inclusion in future iterations of the plan.

While network planning should remain the responsibility of distribution network operators, they will need to demonstrate that their investment plans align with the broader plan for the energy system. Assessment of network investment plans by the Regional Energy Strategic Planner should help achieve this, but it must be proportionate and serve to streamline the system. There should be some room for divergence from the regional plan where this can be robustly justified – for example where distribution network operators feel this is critical to meeting their licence conditions. In turn, Ofgem will need to accept the final regional plan as the agreed needs case to underpin new investment and avoid re-scrutinising this. Ofgem should provide more clarity on how the plans will interact with the price control process.

## Meaningful input from local stakeholders

Local authorities and devolved governments are leading key aspects of the net zero transition for their respective areas, and they play a key role in public engagement. This means it is important that local authorities and devolved governments provide democratic input to shape the energy system in their areas, including through Regional Energy Strategic Plans.

Ofgem is still in the process of developing proposals for the strategic board. In order to create a reasonably sized board, it is likely that only some local councils, as well as the devolved governments, will be able to participate in most regions. It is likely that the National Energy System Operator will focus its engagement on strategic authorities (in England) and devolved governments (in Scotland and Wales). This approach sensibly limits the size of the board, but broader engagement will be needed for Regional Energy Strategic Plans to be effective and build consensus around the needs case. The National Energy System Operator will therefore need to create opportunities to gather data and views from the full range of combined, unitary, county and district authorities (while they exist). This should be proportionate and ensure there is the right level of engagement, with the right bodies.

The balance of engagement is likely to shift towards combined and unitary authorities as the devolution settlements in England change in line with the government's recent English Devolution White Paper.<sup>103</sup> In Scotland and Wales, more engagement with individual councils will be needed to reflect the different local government arrangements across Great Britain.

## Engaging with energy planning

There is a range of levels of engagement with energy planning among local authorities. Some areas – particularly the combined authorities in England – have developed Local Area Energy Plans and have the resource and capability to engage closely with the regional planning process, as well as with wider energy policy developments, including connections reform. The Scottish and Welsh governments have each mandated energy plans, which are already funded. Local Heat and Energy Efficiency Strategies and Delivery Plans are in place for all local authorities in Scotland, and full Local Area Energy Plans have been developed for all local authorities in Wales.

Many local areas have also set ambitious targets to reach net zero ahead of the UK-wide 2050 target and the Scottish government has set a target in legislation for Scotland to reach net zero emissions by 2045.<sup>104</sup> Local authorities and the devolved governments have levers which are critical to delivering decarbonisation in local areas, such as planning requirements on heating systems in new homes. These will need to be used if local and national net zero targets are to be delivered.

Local statutory plans therefore need to be incorporated into the Regional Energy Strategic Plans – in line with the accountabilities set out above – to ensure they reflect the social and economic priorities of the region. This can also provide a feedback loop back to local policy decisions, such as on developing the skills policy required to ensure a sustainable local workforce, and take account of wider local priorities, such as local nature recovery strategies.

However, not all local authorities – particularly in England – are engaged with energy planning to the same degree, and funding constraints mean that this is often not their highest priority. The government will therefore need to provide further funding to local authorities in England to build capability and to resource engagement with energy planning.<sup>105</sup> This will likely need to focus on strategic authorities, as they are likely to be the main level of local government interacting with Regional Energy Strategic Plans.

Subject to a final decision from Ofgem, the National Energy System Operator already intends to provide support for local government, including technical advice and training, working groups, example projects and common digital tools and data. It will also need to adopt a flexible approach to allow local areas to input even where they have not developed their own formal local energy plans.

The objective of building capacity and capability should not be that all English local authorities complete a Local Area Energy Plan. Creating these plans is resource intensive and would represent a significant burden for local authorities who are not already engaged with energy planning. The priority should be to ensure that they can engage with strategic energy planning over time and funding a one-off plan is unlikely to be the best way to do this.

Engagement will need to go beyond local government – businesses and community groups will also have an interest and should have opportunities to input data and views. Local developers will often have important insight on where supply and demand projects are most likely (or most wish) to locate.

## Maximising the benefit to the wider energy sector

The outputs from Regional Energy Strategic Plans must be usable by stakeholders to inform and improve their own planning. The plan must be iterative and evolve with the energy sector rather than starting from scratch every three years. This will give greater confidence to investors over the future pathway of both network investment and wider sector investment. The National Energy System Operator will need to develop methods to incorporate changes to both local energy plans and other local planning processes. They will also need methods to track and account for projects that are not yet in the planning system or the network connections process, and should develop an ‘in development’ register that fulfils this need. In producing this register, the National Energy System Operator will need to consider how best to balance the commercial sensitivity of investment plans with the need to develop complete data.

The Regional Energy Strategic Plans will need to be useful to those who would benefit from technical data, but also to stakeholders with limited energy expertise who wish to understand what is likely to be built in their area. That means the final outputs will need to be published in multiple formats, including an open data publication, as well as documents that are accessible to local government and the broader public.

## Coordinating with the next electricity distribution price control

The timescales proposed for the introduction of Regional Energy Strategic Plans must coordinate effectively with the start of the next distribution network price control. Ofgem has set out that the National Energy System Operator will consult on transitional plans in September 2025 and publish final transitional plans in January 2026.<sup>106</sup> This is already late in the process to inform network business planning and cannot be delayed further. Ofgem and the National Energy System Operator should consider whether there are ways to accelerate parts of the process which are more critical to networks developing effective business plans, such as identifying underlying energy system assumptions.

The full Regional Energy Strategic Plans are expected to be delivered in 2027/28, after price control business plans have been completed. Ofgem is considering how this will be incorporated into the price control. The process of transitioning to the final Regional Energy Strategic Plan output must not result in an investment hiatus. It is vital that the transitional process gives distribution network operators and Ofgem sufficient confidence to plan investment. The price control should not be substantially reopened once the full Regional Energy Strategic Plan is delivered, and Ofgem should give clarity on how they will be incorporated as early as possible.

**Recommendation 3 – Ofgem and the National Energy System Operator should set out a clear statement of accountability for the Regional Energy Strategic Plans. This should include the decisions that the system operator will be empowered to take in developing the plan, how they will assess network investment plans in a proportionate way, and the stages at which different actors will have the ability to input and challenge.**

**Recommendation 4 – Ofgem and the National Energy System Operator should develop structured ways for local authorities and other local stakeholders to input into Regional Energy Strategic Plans.**

- The National Energy System Operator should proceed with plans to make tools and advice available to local stakeholders to support their planning role. Government should also assess what additional capacity and capability is required for local authorities to engage meaningfully with the process and provide the necessary financial support for them to do so.
- Local authorities must have structured mechanisms to input meaningfully into Regional Energy Strategic Plans, even if they are not on the strategic board or have not completed a formal local energy plan.
- Local decarbonisation targets and strategies should be enabled as far as reasonably possible, where projects are underpinned by credible plans for delivery.

**Recommendation 5 – Ofgem and the National Energy System Operator should use the Regional Energy Strategic Plans as a vehicle to improve planning and data in the sector. As part of the process, the National Energy System Operator should:**

- develop a register of projects ‘in development’ that have not yet had connection applications submitted
- publish the plans in both an open data format, and through a publication that is accessible and understandable to all energy system actors, including local government.

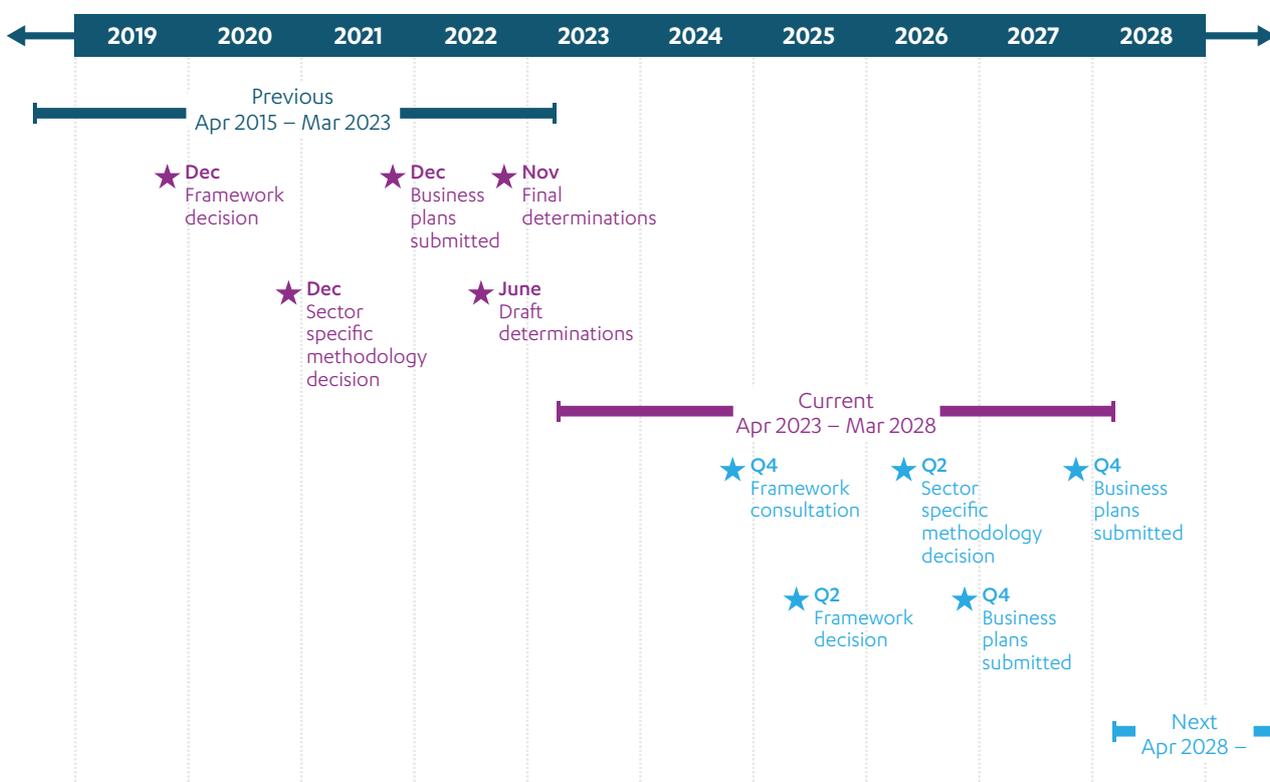
**Recommendation 6 – Ofgem and the National Energy System Operator should set out a proportionate transitional plan for the Regional Energy Strategic Plans to inform the next electricity distribution price control. This should be delivered far enough ahead of decisions about the price control to enable network business planning and give network operators confidence in the investment pathway for the whole price control period.**

## **Price control reform**

## Price controls in the energy system

Price controls set the amount of money that network companies can recover from consumers over the price control period. Ofgem, as the regulator, sets price controls for the companies that operate Great Britain’s gas and electricity networks at both distribution and transmission level. Distribution network operators submit business plans to Ofgem outlining their estimated costs for operating and building their networks during each price control period. Ofgem then assesses these costs and sets baseline revenue allowances. Distribution network operators then maintain and operate the electricity distribution network and recover their revenue through charges in consumer energy bills. The aim of the price control is to enable operators to gain a fair return, while regulating the end cost to consumers.

**Figure 3.2: Previous price control dates, milestones in the lead up to next price control**



## Historic investment

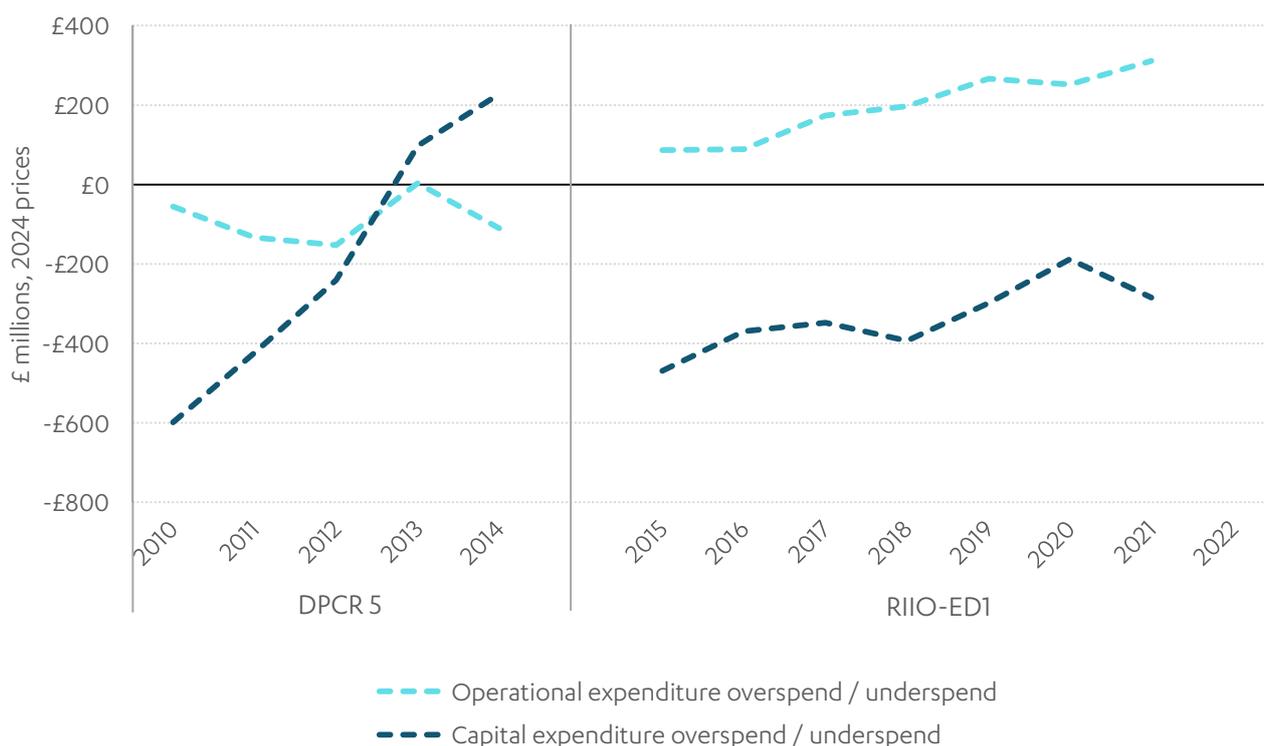
For the current electricity distribution price control, Ofgem decided to set baseline allowances to meet a relatively conservative decarbonisation scenario, a move seen by some stakeholders as constraining the pace of decarbonisation. However, it is also important to note that distribution network operators have consistently underspent their capital expenditure allowances across multiple price control periods since privatisation. This can be seen in Figure 3.3.

During the previous price control alone, the total capital underspend was around £2.4 billion (up to March 2022 – the latest data available).<sup>107</sup> Expenditure on network reinforcement was on average 34 per cent less than allowances and operators underspent on replacing and

refurbishing non load related equipment by an average of 19 per cent.<sup>108</sup> Ofgem’s recent electricity distribution network price control framework consultations show that actual load related expenditure for distribution network operators over the previous electricity price control period was £2.2 billion, an underspend of 27 per cent.<sup>109</sup> This pattern has continued in the first year of the current price control, with distribution network operators underspending on their load related allowances by 45 per cent.<sup>110</sup>

### Figure 3.3: Networks have historically underspent their capital allowances

Capital and operational expenditure vs allowances across distribution networks from 2010 to 2022



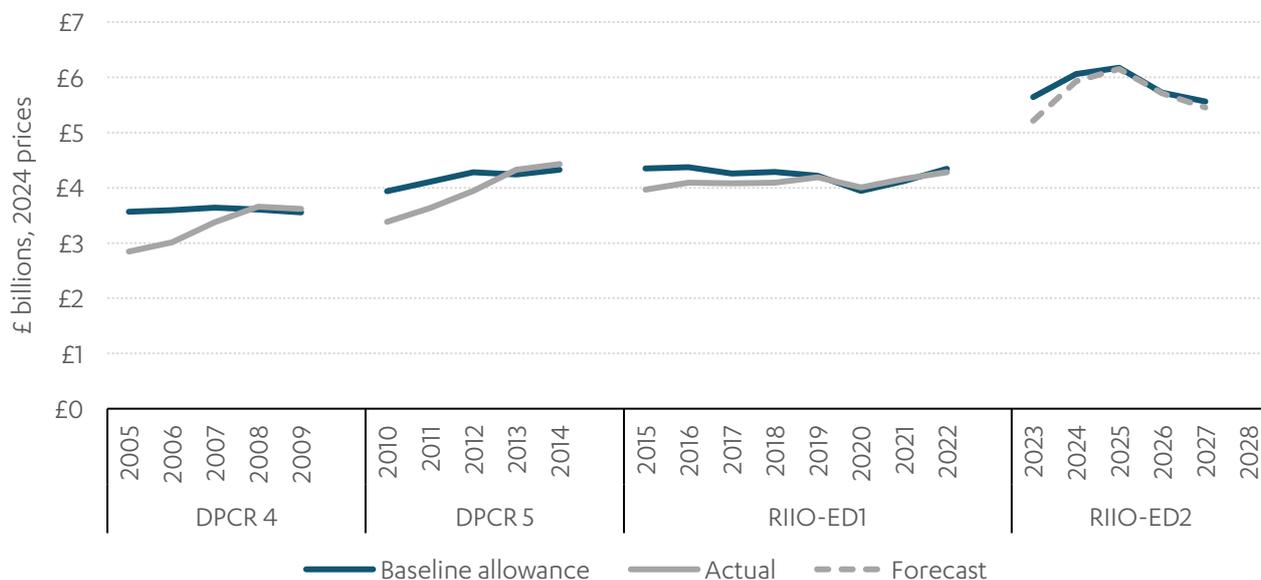
Source: Commission analysis using data from Ofgem.

Note: Data for the final year of RIIO-ED1 is not published. DPCR = Distribution Price Control Review. RIIO: Revenue = Incentives + Innovation + Outputs. ED = Electricity Distribution.

Ofgem considers there to be several drivers for underspend during the previous electricity price control (2015-2023). These include economic conditions creating uncertainty in demand for electricity, schemes that have been deferred or cancelled in response to consumers requirements, and network operators using innovative solutions or increasing energy efficiency measures. Several stakeholders, including equipment suppliers have also raised the challenge of mobilising investment in the early years of price controls, with uncertainty about allowances and late decisions leading to delays in delivery. This trend in delayed investment at the start of the price control can be seen in Figure 3.4.

**Figure 3.4: Investment delays at the start of each price control period**

Total actual/forecast vs allowed expenditure across distribution networks from 2005 to 2028



Source: Commission analysis using data from Ofgem.

Note: DPCR = Distribution Price Control Review. RIIO: Revenue = Incentives + Innovation + Outputs. ED = Electricity Distribution.

## The price control regime – developments in the current and previous price controls

Ofgem changed its framework for regulating the energy networks to incentivise companies to drive innovation, drive efficiency and deliver better outcomes for consumers. The new framework was named ‘RIIO’: Revenue = Incentives + Innovation + Outputs. Under this framework, which began in 2015, distribution network operators’ revenues can be adjusted during the price control through uncertainty mechanisms. Financial incentives reward operators for going beyond business as usual performance and are set for outcomes like customer service and network reliability. The current price control is the second under this approach.

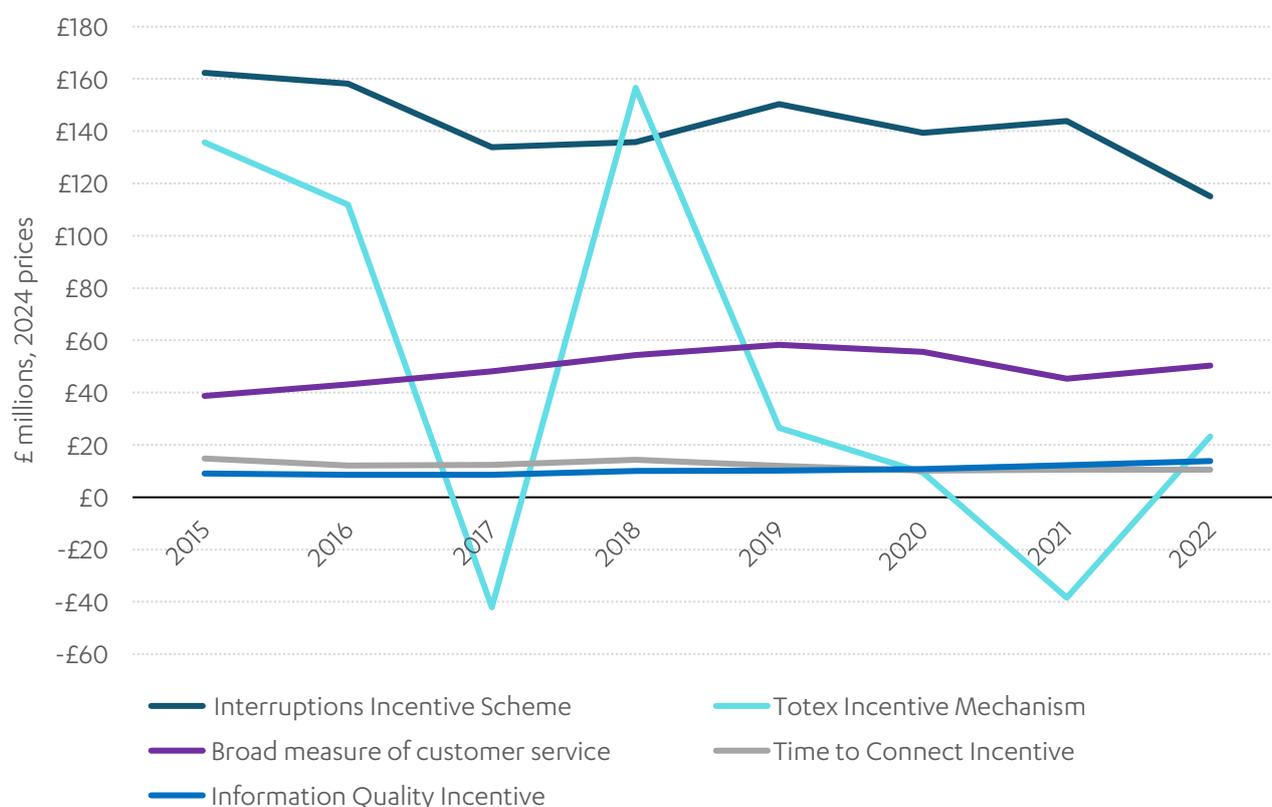
### Distribution network operators’ performance, incentives and financial returns

Some incentives have worked well to drive improvements for consumers. For example, since the introduction of the Interruptions Incentive Scheme in the previous price control, electricity supply interruptions have fallen by 23 per cent.<sup>111</sup> However, reputational incentives, such as for major connections annual reports and environmental reports, add complexity, but with limited value or accountability. Overall, the incentives package has been diluted in the current price control.

The package of financial incentives in the previous price control was stronger, in terms of potential reward, than in the current price control. This led to distribution network operators making high returns particularly through the Interruptions Incentive Scheme (in return for the improved reliability noted above) and the TOTEX (Total Expenditure) Incentive Mechanism. The latter is in place to promote efficiency and fair returns, with savings from underspend or costs from overspend split between the operator and its customers. Distribution network operators' returns came to a total of £2.4 billion in the first price control, with £1.8 billion of this from incentives (up to March 2022 – the latest data available). Figure 3.5 shows how this breaks down between different incentives.

**Figure 3.5: The strength of incentives matters in setting priorities for the distribution network operators**

*Return by incentive mechanism for the previous price control period from 2015 to 2023*



Source: Commission analysis using Ofgem data.

## Funding mechanisms

The funding package for the previous and current price controls includes uncertainty mechanisms, which allow investment to scale up to meet demand within certain parameters. Automated uncertainty mechanisms such as volume drivers are working well to scale funding up to a defined cap. Out of the £29.2 billion allowed total expenditure for the current price

control period, distribution network operators received over £4.8 billion of load related expenditure through fixed allowances, with an additional 40 per cent subject to volume drivers.<sup>112</sup>

The wider uncertainty mechanism package provides operators with the opportunity to apply for additional allowances during the price control period, though most of these ‘re-openers’ are yet to be tested. ‘Use it or lose it’ mechanisms are not widely applied and have had mixed success.

The use of uncertainty mechanisms has grown as Ofgem has attempted to manage the uncertainty associated with low carbon technology uptake and the pace of the energy transition. This may also reflect a reaction to Ofgem being accused of awarding operators higher capital investment allowances than were needed in the previous price control. The number of re-openers common to all operators has doubled in the current price control, from eight to 16, and the total number of uncertainty mechanisms has risen to 37.

## Ofgem scrutiny and timing of funding decisions

The complex and bureaucratic nature of the price control process – especially re-openers – means it can take a long time for funding to be agreed. In the previous price control, re-opener funding was subject to an automatic reward if Ofgem did not process the applications and decide outcomes within six months. This has been removed in the current price control and operators are already facing delays on funding decisions. As set out in box 5, decisions on the Storm Arwen re-opener – the first of the current price control – took longer than the previous six month limit. There are also challenges around the timing of re-openers, with many scheduled for mid-period, which limits the window for investment compared to baseline allowances.

Re-openers can be very prescriptive with regards to how funds are spent. On the one hand, this can be useful for ensuring specific delivery outputs. On the other hand, it can restrict innovation and reduce operators’ ability to plan their networks in an efficient and programmatic way. There is a danger that with an increasing number of re-openers, funding is pigeonholed into overly prescriptive funding streams.

When Ofgem published their final funding decision for the Storm Arwen re-opener it had 55 price control deliverables attached, some of which were for projects worth just tens of thousands of pounds.<sup>113</sup> The Commission has also heard other examples of Ofgem scrutiny being disproportionate to risks or objectives. One network operator reported that Ofgem provided significant scrutiny of workforce decisions affecting less than five full time employees.

### Box 5: Storm Arwen re-opener

In late November 2021, Storm Arwen hit the UK, bringing severe weather conditions and causing widespread disruption, leaving nearly one million consumers without electricity. Damage to distribution infrastructure was extensive with over 9,700 faults caused primarily by fallen trees and debris carried by the wind reaching 98 mph in some areas.<sup>114</sup>

In the aftermath, Ofgem and the Energy Emergencies Executive Committee held separate reviews with each publishing a series of recommendations in June 2022.<sup>115</sup> Ofgem introduced a re-opener and provided a window in January 2024 for network operators to submit proposals for the cost of work required to address these recommendations.<sup>116</sup> Ofgem's strategic steer was that the re-opener should focus on the reduction of long term outages following storm events and deliver long term value for money for consumers.<sup>117</sup>

In response to the 75 project submissions combined from all six distribution network operators, Ofgem decided to fund just over half the total value of projects.<sup>118</sup> Many proposals were rejected on the grounds that Ofgem felt they fell into normal business practice which should have been included in existing business plan submissions. This followed an assessment process which took eight months, exceeding the standard estimated time to decision for re-openers set out by Ofgem of between three and six months.<sup>119</sup>

## Resilience in the price control

The economy and society's reliance on electricity will increase as the economy decarbonises. While reliability has been a strong theme in past price controls, there is more to do to embed wider resilience. For the current price control, resilience strategies were introduced as a requirement on distribution network operators, but there was little demonstration that they had an impact on investment decisions. This is not necessarily a problem for the initial plans, but going forward resilience objectives will need to be better integrated to have impact. Alongside this, Ofgem will need to ensure any changes to security of supply standards – as recommended in part two – are funded sufficiently.

Current financial incentives need to go further to galvanise investment in resilience. One positive example is the Guaranteed Standards of Performance for connections, which was updated in 2023 to reflect the recommendations from the Storm Arwen review.<sup>120</sup> It now incorporates a stronger climate resilience dimension, including greater penalties for severe weather-related outages.

The Network Asset Risk Metric, which assesses the long term monetised risk faced by individual assets, is designed to prevent operators from underspending by not replacing or upgrading assets. As discussed in chapter one, the distribution network faces changing climate risks, and these should be incorporated into the metric. As outlined in the Commission's report on *Developing Resilience Standards in UK Infrastructure*,<sup>121</sup> Ofgem should progress work on

the metric to incorporate threats to the system from increased deterioration due to chronic stresses caused by changing climate conditions. This revised metric should be in place for future price controls.

In order to embed resilience, operators will also need to understand the cost of adapting to a changing climate. The Commission recommended this be required for all infrastructure operators in the second *National Infrastructure Assessment*.<sup>122</sup> As part of this assessment, there would also be merit in looking at the wider framework of resilience standards to assess if they are appropriate and fit for future requirements.

## Reforming the price control to deliver proactive investment

Wholesale change to the price control framework would likely create more uncertainty and risk investor confidence, leading to delayed investment in infrastructure. However, evolution of the framework is needed. The objectives of the current price control are not primarily to facilitate long term investment, and distribution network operators have not yet significantly increased investment to prepare for higher future demand. A slow start at the beginning of a price control period is common. However, if investment is delayed for too long, the spare capacity on the network will be used up and operators will be under pressure to deliver a high volume of upgrades in a constrained timeframe. Skills and supply chain constraints could make this very challenging, with lead times for some equipment – such as 33 kV transformers – now well over a year. Given the projected increase in pace of investment required, the price control framework must undergo reform to ensure that investment is delivered in a smooth, managed way.

### Changes to objectives and incentives

The framework needs to evolve away from ‘keeping costs to a minimum’ to one that delivers wider value for consumers. Ofgem’s new growth and net zero duties are a good starting point for this. Many other key network objectives are captured in the price control in some form – enabling digitalisation and flexibility, resilience and reliability and customer service, alongside costs. These remain right, but they need to be rebalanced.

Some of these objectives also need a degree of reorientation – in particular, moving away from ‘flex first’ and instead shifting toward building smarter, more flexible networks. The distribution system operator incentive is a key incentive under this objective. While it remains too early to tell how this incentive is working in the current price control, Ofgem should continue to promote the system operator role to encourage efficient network management, strategic investment and to build network capability. It will also need to ensure that it does not overly incentivise using local flexibility to defer investment, where investment would be more beneficial for the energy system overall.

Ofgem will also need to address the imbalance in incentives that rewards operators more for making efficiencies than for delivering outcomes for consumers. Following large returns made by operators in the previous price control, performance targets on financial incentives were made more challenging for the current price control. The potential financial returns were also reduced, and the overall incentives package increased in complexity. Despite being reduced for the current price control, the TOTEX (Total Expenditure) Incentive Mechanism remains stronger, in terms of the size of reward available, than most individual incentives linked to network performance outputs. To drive proactive investment, a greater emphasis should be placed on a smaller suite of financial incentives that provide genuine upside potential for operators' performance, alongside appropriate penalties for inadequate performance.

**Recommendation 7 – Ofgem should base future price controls around a rebalanced set of objectives focused on long term requirements for the distribution network that deliver wider consumer value, alongside consumer costs. These objectives should include Ofgem's net zero and growth duties, as well as strengthening network resilience and delivering high quality customer service, including connection outcomes. Funding mechanisms and incentives should be designed to deliver these objectives.**

## Changes to funding mechanisms

A proactive investment model will mean that many investments will need to be approved before uncertainty is fully resolved. Ofgem will need to adopt a higher risk appetite and take a longer term view on the needs case for investment.

Funding network investment through re-openers rather than baseline allowances will retain uncertainty for distribution network operators and their supply chains. While some re-openers work well, they do not provide reliable indicators of funding. For example, in the 2019 'High Value Projects' re-opener, every application from operators was rejected.<sup>123</sup> Even where projects are accepted, operators often receive much lower allowances than they applied for. Or allowances can change significantly between Ofgem's draft and final decisions, making it difficult for networks to plan investment with confidence. Regardless of whether the rationale for each decision to deny funding is justifiable, re-openers are clearly not a way to provide investment certainty.

This is particularly challenging in the current context of global competition for materials and investment where unit costs have risen with inflation and lead times for equipment have increased. There is an appetite from distribution network operators and equipment manufacturers to build more strategic partnerships, but this requires more investment certainty and recognition from Ofgem of the changing nature of risk.

Re-openers and price control deliverables increasingly break funding down to individual projects and increase the volume of scrutiny to a case-by-case basis. This can inhibit operators' ability to manage their networks efficiently across different investment programmes. Looking at the needs case and at risk at a programme level would reduce the requirement for so many re-openers. It could also support longer term planning and more continuity across price controls.

For future price controls, more funding for investment ahead of need should be allocated within baseline allowances. There should be a greater focus on more automatic uncertainty mechanisms, such as volume drivers, rather than re-openers. Uncertainty mechanisms should be reserved for areas of genuine long term uncertainty and, where they are required, the process and scrutiny should be proportionate to their objective.

## Taking a ‘touch the network once’ approach

Much of the cost of upgrading the local network is in civil works, such as digging up the road, which causes disruption every time it is done, as well as taking time and money. Many distribution network operators are attempting to implement a ‘touch the network once to 2050’ approach to spread and reduce costs over the longer term, and Ofgem is generally encouraging this. However, there are examples of where allowances do not support this. For example, distribution network operators are required to remove all polychlorinated biphenyls from pole-mounted transformers by 2025.<sup>124</sup> Transformers could be replaced with a modern 80/100 kVA transformer that would meet capacity up to 2050. However, allowances are sometimes insufficient to facilitate this ‘sizing up’. This means operators either have to make unfunded investments, or risk needing to upgrade the network a second time.

Setting allowances that enable a ‘touch the network once to 2050’ approach as standard should be uncontroversial. Distribution network operators should install higher capacity equipment as standard where future demand justifies it – as set out in the Regional Energy Strategic Plan pathway. However, there may be occasions where this is not the appropriate approach and distribution network operators should have the flexibility to take a different approach, where an exceptional approach can be justified.

**Recommendation 8 – Ofgem should orientate the next price control around allowances set before the price control begins. Funding mechanisms should be set at a sufficient level to enable proactive investment. This should include:**

- **using re-opener mechanisms only where there is genuine long term uncertainty and the process and objectives for re-openers is proportionate to the investment being considered**
- **setting allowances to enable a ‘touch-the-network-once to 2050’ approach as standard, to build resilience and minimise the overall costs of investment to deliver net zero.**

## Protecting against under investment

In return for higher investment allowances, consumers need to have confidence that distribution network operators will actually invest in the network, delivering better outcomes and consumer value. Confidence in the sector will suffer if consumers see operators making large returns, with little to no improvements in the service they provide. Distribution network operators must therefore be held to account for delivering, and Ofgem should put in place appropriate mechanisms to ensure this.

Ofgem has noted this risk in its framework consultation for the next price control, both through their general plan to move towards a ‘plan and deliver’ model for some investment and in the specific recognition of under-delivery risk.<sup>125</sup> Ofgem will need to ensure that any new mechanisms strike the right balance between holding companies to account without becoming overly prescriptive regarding network solutions. To do so would risk blurring the roles of the regulator and the network operator with respect to the duty to supply and the responsibility for network planning.

There are a range of options that could be employed to hold distribution network operators to greater account for investing to higher allowances. Options are not mutually exclusive. The Commission believes a mixed approach – potentially using different tools for different investments – is likely to be most effective at balancing the trade-offs involved and to avoid introducing further complexity to an already complicated price control process:

- **Reform of the TOTEX (Total Expenditure) Incentive Mechanism.** There are a variety of forms this could take from reducing the reward level or sharing factor that operators receive, to excluding load related expenditure, or raising the level of the clawback which currently protects against expenditure falling below 80 per cent of allowances.<sup>126</sup> Incentivising efficient delivery is still important so Ofgem would need to manage the trade-offs with this approach.
- **Splitting total expenditure out into capital and operating expenditure with separate incentives.** Distribution network operators have historically underspent their capital expenditure allowances. To avoid this in future the relevant portion of the underspend for load related expenditure would not be added to the Regulatory Asset Value of the company.<sup>127</sup>
- **Introducing new outcome incentives.** New incentives could target a specific outcome designed to measure the value of load related expenditure – for example, a measure of network capacity. This would need to be significant enough to counteract any wider incentives not to invest. It may be possible to redesign existing incentives to achieve a similar effect – the business plan incentive may be a good candidate for this.
- **Greater specification of inputs/outputs through price control deliverables.** These are already increasingly used and provide much more detailed specification by Ofgem of specific investments operators should make. This approach makes the most sense for strategic investments or programmatic work and should only be applied where the inputs required are clear and/or the outputs can be easily monitored. Outputs and the corresponding allowances should be agreed as early as possible to streamline the process and give the supply chain adequate foresight.
- **An assurance focused approach.** This would involve strong reporting requirements to assess whether operators made the investments they were funded for. Tracking investment in this way would prevent investments networks did not make from being funded again at a later date.

## Managing the ‘cliff edge’ between price controls

One of the challenges in the price control process is the natural discontinuity between them. The end of one price control can add additional uncertainty, making it harder for the sector to plan over the long term, therefore creating new risks around investment. If distribution network operators are unsure what investment will be approved, they are less willing to make commitments to their supply chains. This in turn makes it difficult for those suppliers to invest in new manufacturing capacity or skills development where it could be needed. This contributes to the high levels of underspend in the early years of price controls, as mobilisation takes time once final decisions have been taken.

The Commission has heard some arguments that price controls should be extended as was the case for the first electricity distribution price control. However, it is not clear the overall arguments have materially changed since Ofgem considered these in 2019.<sup>128</sup> A longer price control could have advantages in setting longer term allowances, but it also comes with potential downsides. It offers less frequent opportunities to adjust the trajectory (or requires greater complexity to do so) and an incentive to be more conservative about investment given the greater number of investment decisions required.

There is no objective ‘right’ length for how long a price control should last and, regardless of length, issues around transitioning from period to period will always remain. While it is possible to shift when this ‘cliff edge’ occurs, it cannot be eliminated entirely. The ‘cliff edge’ effect can be more severe when there are already high levels of uncertainty, when there is a desire for significant policy changes or when final decisions are taken close to the start of the new price control.

It is not possible to eliminate ‘cliff edges’ from price controls entirely, but their impacts can be managed down. Firstly, Ofgem should be as clear as possible about the long term trajectory for investment, affirming the increased centrality of the energy transition and meeting net zero to network investment. It should provide clear signals that this approach is expected to endure beyond the next price control.

This sort of approach has been used in other growing sectors. For example, Ofcom has a ten year strategy for fixed telecoms markets – spanning multiple review periods – which recognises that long term network investment requires certainty and stable regulation.<sup>129</sup> The introduction of Regional Energy Strategic Plans can also support this by setting a clearer, more certain direction of travel. This will enable ongoing planning and adjustments that minimise the need for major changes between price controls.

Secondly, distribution network operators should develop a programme of work to deliver high volume, long term investment. This should enable better long term planning and certainty for operators and supply chains. This approach will not be appropriate for all investment, but could work well for investment on the low voltage network where there is a high volume of work that needs to be delivered over a long period of time and where it is difficult to optimise against demand signals.

Ofgem has overseen such an approach for other networks. The 30 year programme to remove iron mains from the gas network was delivered on this sort of programmatic model. A long term objective was set by the Health and Safety Executive and Ofgem has overseen delivery against this objective across multiple gas distribution price controls. Delivery and targets are reviewed during individual price controls and complemented with periodic programme reviews.<sup>130</sup>

Thirdly, Ofgem should aim to make price control decisions as early as practically possible to minimise discontinuity in delivery. While the timing of final determinations is key, taking clear decisions early on objectives and methodology can help set direction and enable operators and their supply chains to plan more effectively. Earlier clarity has a better chance to enable efficiencies across different programmes (such as asset replacement and load related expenditure), which should reduce the overall costs of investment.

## Ofgem should also focus on quick win, 'no regrets' actions

There are certain 'no regrets' activities which present easy wins for the electricity system and should be accelerated in the next price control. Unlooping activity, which is already in progress, is the most obvious candidate, but there is also a case for accelerating investing in areas not on the gas grid.

While in some circumstances it may not be necessary to unloop (for example if there is to be a heat network in the area), in most cases it will be – and the move to heat network zoning in England should make heat networks much easier to plan around. Scottish Power Energy Networks estimates that it will need to unloop 50 times as many service cables from 2023-2028 as it did in the previous five year price control.<sup>131</sup> Electricity North West estimates that half a million of the 2.4 million homes in its licence area require unlooping.<sup>132</sup>

Accelerating unlooping where appropriate, to avoid frictions in low carbon technology deployment, should be seen as a quick win, 'no regrets' action. This is particularly important for ensuring heat pumps can be fitted easily. If a customer's boiler breaks and they find they may need to have their service unlooped before fitting a heat pump, they will likely be forced to install another boiler instead, as the process will take too long.

Government should consider how it can support Ofgem and the distribution network operators to plan for this across forthcoming price controls, by setting a target date for eliminating looped supplies.

Around 15 per cent of domestic properties across Great Britain are not connected to the gas grid.<sup>133</sup> These are found in both urban areas, often in high rise blocks of flats, and in rural areas. While high rise blocks of flats will usually already be decarbonised by using a heat network or electric heating, in rural areas many of these houses will be heated using alternative fossil fuels such as oil.

Off-gas grid rural areas of the network are on the periphery of the electricity grid, where resilience and reliability are lower and increased demand from decarbonisation could have a relatively higher impact. These areas are also at the forefront of decarbonisation efforts – 43 per cent of grants under the Boiler Upgrade Scheme have been to off-gas grid homes.<sup>134</sup> Off-gas rural homes therefore represent another good candidate for early investment.

**Recommendation 9 – Ofgem should accelerate no regrets activities such as proactive unlooping and off-gas grid reinforcement. Government should also set a date for the elimination of looped supplies to inform Ofgem’s approach to delivery and enable distribution network operators to develop a programme for completing the work across multiple price controls.**

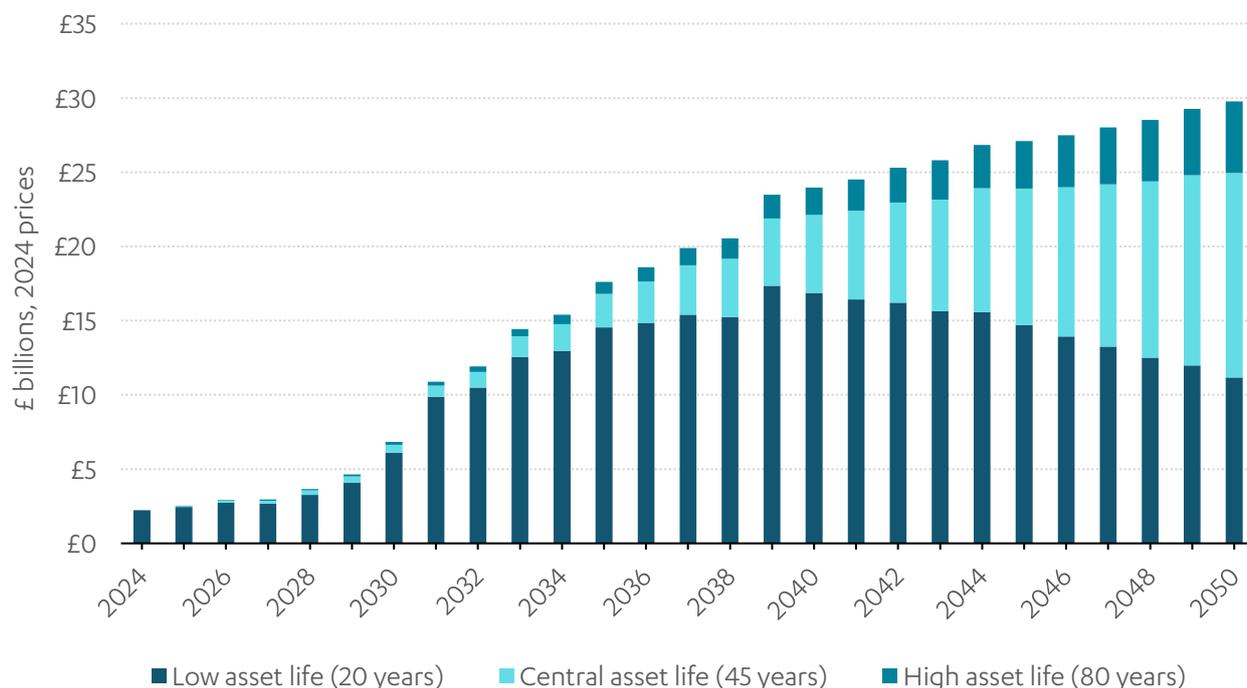
## Maintaining the financeability of the network

If proactive investment is going to be delivered, then electricity distribution networks must remain attractive to investors. Access to finance is always vital for asset-heavy industries, and the capital expenditure needs for distribution are increasing. Ofgem has a duty to ensure licence holders can finance their activities, and licence holders should expect to generate an overall rate of return that is commensurate to the risks they are being asked to shoulder. Changes to the price control framework need to be consistent with both Ofgem’s financing and customer duties.

The Commission has heard concerns about long term financeability from distribution network operators over the course of the study. Concerns are driven largely by the transition from a 20 to a 45 year asset life since the start of the previous control, but some of the issues have also come up in the Commission’s own analysis of the impacts of increased investment. For example, the Regulatory Asset Value is likely to grow significantly over time, as shown in Figure 3.6. It is important that investors can see a route to a return on investment beyond selling on an increasingly valuable asset base to new owners.

### Figure 3.6: 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



Sources: 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.

Providing more funding upfront can help give investors some additional confidence that higher levels of investment will net them a return on investment. However, Ofgem may also need to consider other measures to maintain financeability over the long term. There are various ways Ofgem could consider addressing this, including adjusting the cost of capital, capitalisation, depreciation or through the broader incentives package.

Given the scale of investment being proposed ahead of need in an increasingly competitive investment environment – both globally and with other utilities in Great Britain – Ofgem should think carefully about this risk in the next price control. A key part of this should be taking account of the impact of investment on key measures like Regulatory Asset Value and consumer bills beyond the price control and over the longer term. The latter of these measures is important for considering intergenerational fairness, as well as financeability.

## The relationship between government and Ofgem

Determining an appropriate risk appetite and level of investment in the distribution network cannot be a responsibility solely for Ofgem.

Government should take a more active role in setting a strategic vision to aid Ofgem in fulfilling its duties as a regulator. In particular, government should use this strategic vision to provide a clearer steer on how priorities for the sector should be balanced. This should take the form of a stronger strategy and policy statement which more effectively clarifies government's priorities for the energy sector and how the government wishes to see them weighed up. In line with the current framework, this should be updated once every Parliament, or in exceptional circumstances.

The current Strategy and Policy Statement, designated in May 2024, is not fit for purpose. It lists relevant government policies but gives no sense of prioritisation. There are too many strategic priorities and policy outcomes. This does not give Ofgem an effective steer on how it can further the delivery of government's required policy outcomes, as the legislation requires Ofgem to do.

The government indicated in the Clean Power Action Plan that it will amend the Strategy and Policy Statement to ensure that the 2030 clean power objective and broader decarbonisation goals are sufficiently weighted in decision making, with a particular view to ensuring Ofgem approves strategic network investments.<sup>135</sup>

This commitment is welcome, but government has previously indicated that it does not have the powers to give greater strategic direction to Ofgem through the Strategy and Policy Statement.<sup>136</sup> Other regulators are given more detailed and directive steers through their strategy and policy statements, which are underpinned by very similar legal frameworks. For example, the 2019 statement of strategic priorities for Ofcom gave an explicit steer to Ofcom to prioritise investment in digital networks over reductions in prices.<sup>137</sup>

Given Ofgem's increasingly complex role in the delivery of energy infrastructure, it may be appropriate for government to have a stronger ability to direct Ofgem on strategic matters. Government's review of Ofgem should assess whether the legal framework underpinning Ofgem's role gives government sufficient ability to provide strategic direction.<sup>138</sup>

If required, government should take additional powers to give stronger strategic steers to Ofgem. These steers should be limited to strategic decisions and not to intervention in operational decisions, which must remain Ofgem's sole responsibility. For example, it would be reasonable for government to guide Ofgem in prioritising objectives when setting the price control framework for the distribution network, but not for them to intervene in the setting of individual determinations.

Government should also provide clarity to the sector and to the regulator on key issues in the energy sector as early as possible. For example, the ongoing uncertainty around the use of hydrogen in domestic heating has caused Ofgem to be cautious around the amount of load related expenditure that may be required to support electrified heating, creating a more complex framework with lower levels of baseline funding as a result.

**Recommendation 10 - By the end of 2025, government should provide a stronger strategic vision to Ofgem through an updated strategy and policy statement. This should include clarity on a more focused set of priorities and outcomes for the energy sector, that better reflects government’s objectives and the trade-offs between them. The revised strategy and policy statement should include the importance of proactive investment in the distribution network.**

## 4. Enabling reforms and improving delivery



**Delivering a distribution network fit for net zero will require changes beyond governance and regulation. Proactive investment can help to tackle the current connections challenge, but further reform is required to improve the experience of connecting to the network, and wider reforms are required to minimise uncertainty and delays to infrastructure being built.**

**As demand increases, customers must be able to easily connect to the distribution network when they need to. Introducing minimum service standards for all customers will reduce disparities between distribution network operators, and reforming the major connections incentives will ensure that operators are suitably incentivised to deliver a high quality service across the full connections process.**

**Delivery also needs to be improved. Small changes to the planning and consenting system will remove barriers to maintaining, upgrading and enhancing the distribution network in a timely fashion.**

**Providing higher levels of certainty, over a longer period of time, will also support networks and their supply chains to plan investment strategically and deliver programmes of work over multiple price controls. While this should also make longer term skills and workforce planning easier, further action is needed to build the large workforce required to deliver the energy transition sustainably.**

## **Connections**

### **Context and challenges**

Almost all demand customers connect via the distribution network – only the very largest demand projects, like factories and larger data centres, connect at transmission. As more of the economy decarbonises and demand for electricity increases, so will the demand for new and larger connections. Domestic customers will need to connect new low carbon technologies, like heat pumps, solar panels, or electric vehicle chargers. And businesses who are seeking to decarbonise away from gas may need larger connections to account for their much greater electricity demand.

Electricity connections will also be increasingly critical to a wider set of priorities beyond decarbonisation. This includes ensuring new housing can be built where it is needed, but also wider development activity that can support economic growth, such as supporting investment in high productivity sectors with high energy needs, such as data centres and artificial intelligence.

Without access to timely grid connections, decarbonisation and development – and the benefits these provide – risk being delayed or the opportunity missed entirely. All demand customers should be able to easily connect to the network when they need to, regardless of size and connection type. Households must be able to connect low carbon technologies like

heat pumps and electric vehicle chargers without long wait times or complications. And large demand customers, like data centres, housing developments and factories, should be able to connect in line with business need.

At the same time, an increasing proportion of electricity generation is likely to be connected to the distribution network. These projects will also need grid connections so that they can export energy across the network, or up to the transmission network when required.

A move towards proactive investment in the network should aid connections – keeping sufficient capacity on the network so that it is available when customers need it. But this will not be sufficient in and of itself. The connections process needs to be reformed to ensure that it works effectively, particularly for customers who are not accustomed to engaging with their distribution network operator.

Reform is already underway to both speed up connections – as set out below in the section on reforming the connection queue – and to improve the experience of connecting to the network. The issues highlighted in Ofgem’s end-to-end review of the connections process, published in November 2024, are consistent with Commission evidence regarding the extensive challenges that customers can face when connecting.<sup>139</sup> The Commission particularly welcomes proposals to improve the visibility and accuracy of connections data, improve standards of service across the customer journey and ensure that connection offers are high quality and ambitious.

## Reforming the connections queue

The connections queue is the list of projects waiting to connect to the electricity network, either at distribution or transmission levels. In recent years, the queue has grown significantly as higher numbers of low carbon technologies have sought connections. As of December 2024 the connections queue stood at 753 GW, including 175 GW at distribution.<sup>140</sup> The increased size of the queue has had an impact on connection times, with some projects applying to connect to the network receiving connection offers that are well over a decade away.

Most of the projects with the longest waits are those that require transmission network reinforcement, as capacity constraints are most acute there. Ongoing work to increase transmission network capacity will therefore be critical to improving the connections process. This includes projects that are applying to connect to the distribution network as any requirements for upstream transmission reinforcement can cause significant delays for distribution connected projects.

Based on the current projects in the connections queue, the volume of generation is four times larger than the amount required to achieve net zero.<sup>141</sup> This means many projects will never connect to the network at all. Significant reform is therefore already underway to prioritise projects which are ready to connect, as well as projects which are deemed critical to achieving the clean power by 2030 mission and net zero. Government, Ofgem and the National Energy System Operator are taking actions to tackle the queue as it continues to grow. Over the course of this study, attitudes to connections reform have shifted, with calls for much stronger action as the scale of the problem has become clearer. This has been reflected in the further steps taken by the National Energy System Operator.

In April 2024, the then Electricity System Operator proposed to tackle the connections queue by shifting the approach from ‘first come, first served’ to ‘first ready, first connected’.<sup>142</sup> This would see projects follow a connections process with two gates, only receiving a full offer at Gate 2 after meeting further requirements, such as proof of having secured land rights. By September 2024, the queue had continued to grow, reaching 722 GW.<sup>143</sup> While reforms had freed up 22 GW of queue capacity, it was clear that further work was required – particularly in light of the new government’s ambitions to reach clean power by 2030.

Government and Ofgem determined that reforming connections through project readiness alone was unlikely to reduce the queue sufficiently to resolve connection delays or deliver the balanced energy mix needed to achieve clean power efficiently and by 2030. Consequently, proposals for reform have been strengthened through the addition of technological and locational criteria that would allow the National Energy System Operator to further prioritise connections. But even these further reforms have not been enough to deter further applications and reduce wait times. In January 2025, the National Energy System Operator announced that due to continued high numbers of applications, it would temporarily close the queue to new applications from projects connecting at transmission level, with the exception of demand projects and some modifications, to free up resources to implement connections reform.<sup>144</sup>

Not all distribution connections are in scope of these reforms. Within the distribution queue, only generation and storage projects that impact upon the transmission system are covered.<sup>145</sup> However, queue reform should have positive consequences for the ability of customers to connect to the distribution network by minimising competition for capacity. Ongoing investment in the transmission network and a shift to proactive investment in distribution will also help ensure capacity is available when customers want connections. However, given the expected increase in electricity demand – and therefore in connections demand – the Commission has also considered how the distribution connections process is working more generally.

## Current distribution network operators’ connections performance

As of July 2024, the distribution connections queue stood at 171.66 GW across 7,469 projects. Almost half of the queue, by number, is made up of demand projects, but they represent less than 15 percent of the capacity in the queue (22.9 GW).<sup>146</sup> Much of the capacity in the queue is dependent on some sort of reinforcement at transmission and/or distribution level in order to connect, with only 20 per cent of capacity not requiring any reinforcement. However, this 20 per cent equates to more than half of the number of projects in the queue – mostly small demand connections which can expect to connect relatively quickly. Further detail is set out in Figure 4.1 below.

## Figure 4.1: The network reinforcements of the distribution connections queue

*Length of the electricity network queue as of July 2024*

Length of the queue	Gigawatts (GW)	Percentage of projects
No reinforcement	35	47%
Transmission + distribution reinforcement	16	5%
Transmission reinforcement	52	15%
Distribution	18	18%
Awaiting decision	51	14%
<b>Total</b>	<b>172</b>	<b>100%</b>

Source: Electricity Networks Association analysis of distribution network operator data.

Note: Percentage of projects is based on the number of projects in the queue rather than gigawatts and does not add up to 100 per cent due to rounding.

Distribution network operators currently expect that typical projects – excluding those which need transmission reinforcement – should be able to connect within around four years of accepting a connection offer. Connections at higher voltages can usually expect to wait the longest to connect due to the inherent complexity of larger projects, and projects are also likely to experience longer connection times if they need third party consents or network reinforcement.

Different projects have more or less complicated connection requirements so variation is to be expected. And the fastest connection is not always the best one – for example, developers do not want to pay for a connection years before their project is complete. What is important is that connections are delivered to a timescale that suits the customer and that the process works effectively and predictably.

The previous price control saw improvements in almost all operators' performance against connections and customer service targets, with incentives driving service improvements for customers including a decrease in connection times for minor connections customers. The latest performance data (2021-22) indicates an average overall satisfaction score of nine out of ten, representing a seven per cent improvement over the past seven years.<sup>147</sup>

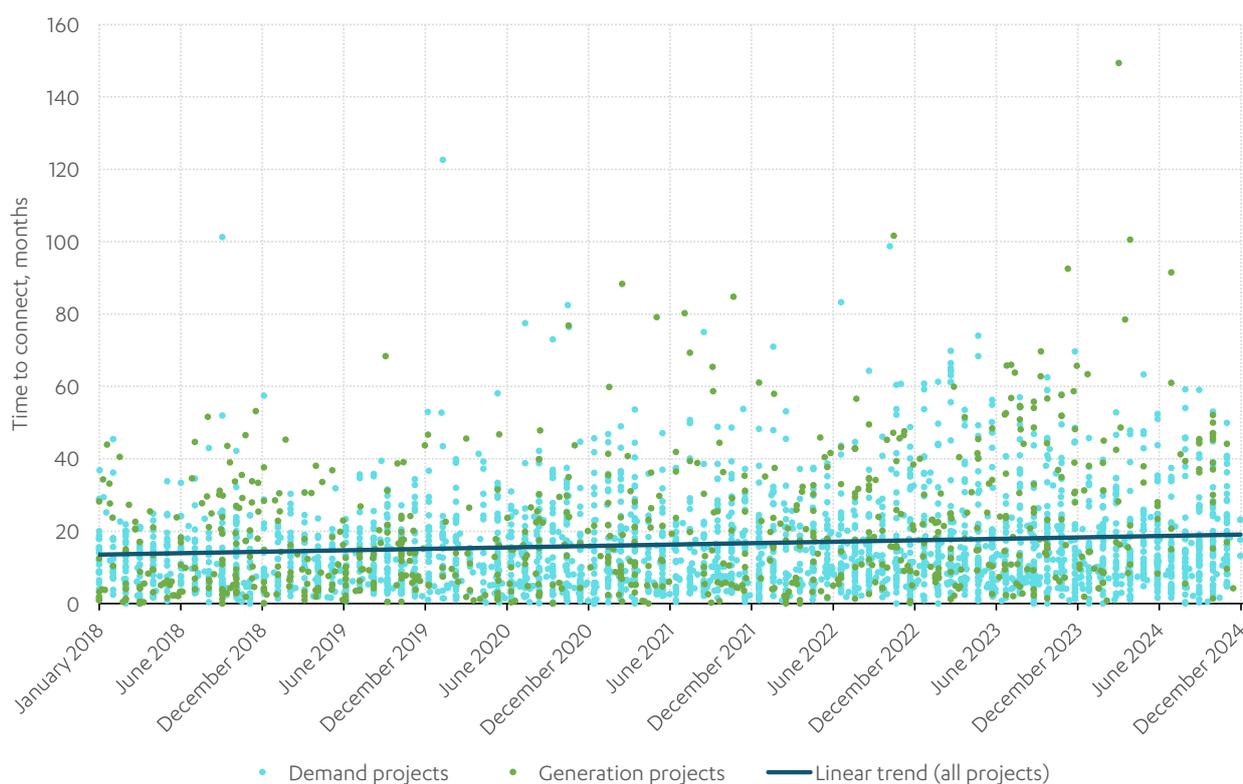
These high scores reflect the fact that most connections proceed fairly smoothly. However, they do not fully align with what the Commission has heard throughout the study about customers' experience of connecting to the distribution network.

Network customers of all sizes, across demand and generation, have raised issues with the connections process itself, and the customer service that they have received from distribution network operators. These issues are far from universal, but they are not uncommon.

The Commission has seen data which shows there has been a steady increase in the average connection times since the start of the previous price control period. In parallel, this data also shows that the range of connection times has increased over time, as shown in Figure 4.2 below.

**Figure 4.2: The average time it takes to connect to the distribution network is increasing**

*Time taken for individual projects to connect to the distribution network from 2018 to 2024*



Source: Commission analysis based on data from four out of the six distribution network operators.

Note: This is based on management information from distribution network operators based on connection date – from offer acceptance – for projects above 1 MVA. There may be some recording errors and projects that require transmission reinforcement, particularly in earlier years or when there have been transitions to new reporting systems. However, the vast majority required no reinforcement, or reinforcement of the distribution network only.

This increase in the average connection time is not necessarily driven by decisions within networks’ control. However, the fact that an increase has happened during a relatively ‘steady state’ period for the network shows connections must remain a focus as demand increases.

In addition to the anticipated increase in the number of connection requests, a wider group of stakeholders will need to engage with the connections process, which will create additional challenges for networks. At present, many connections customers are familiar with the process, and have experience engaging with distribution network operators.

But as more customers need new or bigger connections, customer service will need to adapt to meet their expectations and requirements. For example, industrial customers who currently use gas may require a much larger electrical connection in order for them to decarbonise through electrification.

Network operators' connection teams must be sufficiently skilled and resourced to deal with customers who need additional support to navigate the process successfully. And while distribution network operators do provide some guidance on connecting to the network, this must be up to date and sufficiently detailed.

## Standards and incentives

As well as managing the network and existing connections, it is the responsibility of distribution network operators to connect projects to the distribution network. When a new customer requests a connection, the relevant operator must provide them with an offer, including an expected connection date and cost, as set out in the Electricity Act 1989.

Distribution network operators are obligated to provide customers with a level of connection service under standards of service. These standards set out the timescales within which connections customers can expect distribution network operators to deliver different activities, such as providing an estimated cost of connection, issuing a connection quotation, or completing works to deliver a connection. Where operators fail to meet these guaranteed standards, customers are entitled to receive payments depending on the type and size of the project impacted and the length of the delay. There are also incentives under the price control which reward operators for delivering minor connections within industry average timescales.

Given the differences between minor and major connections, performance is incentivised for each type through different mechanisms.

### Minor connections

Minor connections are those at lower voltages on the distribution network, typically including connections at the domestic level to small, non-domestic connections. Major connections include projects which connect at higher voltage levels, or which have more than four single-phase connections.<sup>148</sup>

Minor connections customers can expect a relatively more straightforward connection process. Most households looking to install low carbon technologies will simply need to 'connect and notify', meaning they can connect without needing to apply first. For these customers, a move to proactive investment should ensure that networks have enough capacity that notifications to their network operator, rather than applications for a connection, remain

sufficient. However, only smaller installations up to 16 amps are able to connect and notify. Anything larger must apply to connect. This requires them to fill in a form and wait for the network operator to issue a connection date within ten working days.

Some progress has already been made in speeding up domestic connections – the Energy Networks Association’s Connect Direct initiative – a digital service which can provide instant approvals for routine connection applications – has an average processing time of 1.5 days, where processing previously took around ten days.<sup>149</sup>

Even where an application is required, most minor connections customers will follow a relatively straightforward process and most connections are relatively simple. Consequently, it is appropriate that the speed and ease of connecting to the network are the measures used and rewarded. Currently, the Time to Connect incentive encourages reduced connection times for minor connections through financial rewards and penalties for performance against the industry standard time. It includes two measures – the time it takes for an operator to provide customers with a connection quote and the time between a customer accepting an offer and the delivery of the connection.

### **Major connections**

Given that major connections are inherently more complicated, and include a wider range of project types, distribution network operators are incentivised differently. While the minor connection incentive Time to Connect is financial, major connections specific incentives are reputational. Rather than incentivising operators to deliver connection quotes, or connections, within a set number of days, the Major Connections Incentive is based on operators developing a strategy against which they must report annually.

However, major connections are also covered by the customer satisfaction incentive. This is measured as part of the ‘broad measure of customer satisfaction’, which scores individual distribution network operators on their customer service by surveying customers. Six hundred customers are surveyed on connections overall, who are asked about their satisfaction with either the connection quote process or the overall connections process. But the sample size for major connections is small, with the major connections customer satisfaction incentive based on only 200 surveyed customers, of which only 20 customers have completed connections.<sup>150</sup> Moreover, the score is based on customers’ responses to one question, rating their overall satisfaction from one to ten. This is not a robust method for capturing the experiences of the full range of major connections customers.

### **Issues facing connections customers**

It is not uncommon for customers to face delays and wider issues with the connections process. While different types of network customers report different issues with the connections process, many of the challenges are driven by the same overarching factors: a lack of connections resourcing, a lack of standardisation or common service standards across operators and misaligned connections incentives.

## Minor connections

Broadly, minor connections incentives seem fit for purpose, for now. However, not all processes for minor connections are fully covered by incentives or the Guaranteed Standards of Performance. This includes some domestic processes such as ‘unlooping’ supplies.

Domestic customers also face a ‘postcode lottery’. Because households are bound to the network operator that services their area, they are unable to pursue another option – only the largest households, upgrading from single to three-phase connections, can opt to use an independent connections provider. And there are also variations between the actual connections processes that operators use, meaning some customers face more complicated and onerous connections processes, while others are able to install low carbon technologies easily.

To further complicate the process, different installers use different assumptions to estimate a household’s electricity demand when they calculate whether a premise will need to apply to connect, or whether further works will be required. This can significantly delay households looking to install heat pumps or electric vehicle charging infrastructure, who may already have enough capacity. To enable the take up of low carbon technologies, it is important that all customers face as few barriers as possible.

The number of minor connections customers is likely to increase – particularly domestic customers who are fitting low carbon technologies. Customers fitting multiple low carbon technologies at the same time –for example a heat pump and solar panels – are more likely to need to apply, rather than simply notify. Network operators will need to be ready to cater to their needs and the overall increased demand for connections, as well as ensuring sufficient network capacity is in place.

## Major connections

Major connections customers face more significant challenges. Disparities between operators are a problem for larger connections in different ways. For customers who can choose where to locate their project, this may mean they relocate to a site where they may receive better service. On the other hand, customers that operate nationally – for example, an electric vehicle charge point installer – will have to deal with several distribution network operators with different processes. This can hinder their ability to learn lessons over time and become more efficient. The Commission has also heard that there can be variance not just between operators, but between different licence areas owned by the same company and even between different customer service agents at the same operator. Ultimately, the quality and timeliness of a customer’s service is highly dependent on the individual handling their request, the overall resourcing of the operator they are engaging with, and the volume of requests that the operator is currently facing.

## The connections process

While there are incentives for operators to deliver timely connection offers and timely connections, this fails to incentivise high quality performance across the full connections process. There are currently no incentives which cover the pre-application period, where

customers discuss their project requirements before making a connection application, or the post-offer 'negotiation' period, where customers may need to clarify the offer that the distribution network operator has provided. However, the Commission has heard that these two phases are where issues tend to arise. These are often key for larger connections, which are generally more complex than smaller ones.

Pre-application, customers often need to engage with their distribution network operator to discuss what their project will be, where there is capacity on the network already, and where network capacity may be increased in the future. Operators may also provide an estimated connection quote, setting out rough costs and an indicative connection date. Responses from the operators can be slow at this stage, and information provided can be vague. The Commission has heard from stakeholders that, in some instances, customers may not get any helpful information at all. Distribution network operators also offer engagement through events like connections surgeries and webinars. While some stakeholders are positive about these, anecdotally they are seen as less beneficial than direct, project specific engagement.

Insufficient or poor quality pre-application engagement can have a knock on impact on the quality and speed of customers' applications. Customers may take longer to apply for connection or fail to provide all the information needed. Without sufficient data or engagement, customers may simply guess at where capacity on the network might be. Distribution network operators are still required to issue a connection offer but this is likely to be lower quality, causing delays for the customer and/or using up connections team resources. High quality pre-application engagement therefore supports better outcomes for projects, but also for operators, who are less likely to waste time and resource on producing offers for speculative connections.

The next phase of the connections process, the connection quote phase, is covered by an incentive: Time to Quote. However, it does little to ensure that offers are detailed, understandable and ambitious. Stakeholder evidence suggests that, in order to meet the Time to Quote incentive, many distribution network operators respond with low quality offers which may lack detail, may be difficult to understand, or do not meet customer requirements. If the number of connections sought continues to increase as expected, connections teams are likely to need additional resourcing and better incentives to avoid low quality offers becoming more widespread.

If the customer is satisfied with their connection quote, they can accept it. The delivery phase will then begin and the project will proceed in line with agreed project milestones. But further delays can arise if the quote does not meet the customer's needs. In such cases, the post-offer 'negotiation phase' will begin, where customers seek further engagement with the operator to explore alternative connection offers, or gain further information. At present, there is no incentive for this process to be timely and this phase is often the longest, with even small issues and queries sometimes causing big delays to projects. In a worst case scenario, a customer may receive a very poor offer in good time, but then not hear back from their distribution network operator during the negotiation phase. Some customers have even been known to start new applications because they could not get a response from their operator after the initial quote was not accepted.

To improve the quality of offers, distribution network operators should proactively look at their network and guide customers to areas where queues are shorter, where capacity might already be available, or where flexible and ramped connections could be applied. Stakeholder engagement has suggested that this could make the biggest difference, as it would ease the connections process and may deliver an expedited process with better results. Data provision by networks to help customers make informed decisions has improved significantly in recent months, though there is still more that could be done to make this as comprehensive and accessible to all customers as possible.

Some operators also seem to be making progress in adopting a more proactive and innovative approach to maximising available capacity. For example, in west London, following capacity constraints, Scottish and Southern Electricity Networks and National Grid Electricity Transmission developed a new solution which allowed schemes which could not receive their full required connection to gradually ramp up the size of their connection each year. This has unblocked the connection of almost 8,000 homes in west London.<sup>151</sup>

## Improving service standards

All network customers, regardless of size, location, and project type, should receive high quality customer service. Introducing minimum service standards is one way to ensure that all network customers receive high quality service and a more consistent approach across Great Britain. It should also speed up the process.

Distribution network operators should be encouraged to innovate to improve the connections experience, and good practice extended nationally. For example, UK Power Networks allows customers to apply for the connection of two low carbon technologies – like a heat pump and electric vehicle charger – through a single application. While some stakeholders would like full harmonisation of the process, this could limit distribution network operators' ability to innovate, or to manage network constraints and complex connection requests creatively. Instead, minimum standards should be designed to ensure that all customers are guaranteed high levels of service, regardless of project characteristics or location.

Minimum standards also need to encourage the less tangible, 'softer' factors which improve customer experience – for example, understandability, a proactive approach to making connection offers, and regular communication. Better guidance and common documentation can both help with this.

As network investment ramps up over the coming decade, it should also make providing a high quality customer service easier for operators, so long as there is adequate resourcing for customer service teams. As operators increasingly digitalise their networks, their understanding of available capacity will enable them to make higher quality offers. Increased network capacity – delivered through more proactive investment – should also reduce wait times, allowing customers to connect faster if they want to.

Proactive investment in 'no regrets' activities like unlooping should also ensure that customers face as few barriers as possible to fitting low carbon technologies. The next phase of Ofgem's end-to-end review of connections should continue to explore whether further reforms and standardisation will be needed to enable the required take up of heat pumps and electric

vehicle chargers and that all customers receive timely and high quality service. Even if this is judged not to be the case now, further or higher standards may be needed as the transition progresses.

**Recommendation 11 – Ofgem should introduce minimum standards for distribution network operators. These standards should include:**

- **agreed connections guidance for all customer types and all distribution network operators, including indicative pricing and connection timescales**
- **enabling all domestic customers to apply for the installation of more than one low carbon technology through a single application, regardless of where they live**
- **developing common digitised connection documentation to be used across all network operators.**

## Incentive reform

The Time to Connect incentive is effective in encouraging distribution network operators to provide timely connection offers and connections for households and small businesses. But the speed of actual connections delivery is too slow for many major connections customers, and evidence suggests that connection times for these customers are already getting longer. If connection times continue to slow, and fail to meet the requirements of major connections customers, this risks becoming a constraint on economic growth.

To ensure that the connections process and the incentives which underpin it meet the requirements of all customers, operators should be incentivised to perform well across each part of the major connections process, including the ‘pre-application’ engagement and post-offer ‘negotiation’ phases. The varied characteristics of major connections projects make it difficult to set the same type of time-based targets for the ‘pre-application’ and ‘negotiation’ phases that exist for smaller, more straightforward connections under the ‘Time to Connect’ incentive. However, where a timeframe cannot be set, Ofgem should set much clearer expectations about performance and what good customer service looks like for these phases. In return for more stretching targets and reporting, distribution network operators should be better incentivised to perform well, with rewards for excellent performance as well as a strong penalty regime.

In order for rewards and/or penalties to be provided, performance needs to be measured more robustly. Across the whole connections process, performance measures are limited and the current broad measure of customer satisfaction is very limited. As well as being a lagging indicator, it is insufficient to judge whether the current connections process is working as well as it could be. It is critical that government, Ofgem and the National Energy System Operator are able to understand how well connections are being delivered, both to track progress and take appropriate and timely action to remedy issues. It is also key to ensuring that performance expectations are able to rise over time, as proactive investment increases capacity and good practice is rolled out.

More data is now being collected and, while data on the size of the queue is now being published, more detailed data on distribution network operators' performance should also be made transparently available. Although operators are required to publish some data it is neither easy to find nor navigate, and it is not sufficiently detailed.

**Recommendation 12 – Ofgem should reform the incentives for major connections in the next price control, with a view to sustaining it in future price controls. The reformed incentives should:**

- **appropriately incentivise performance across each part of the major connections process, including 'pre-application' engagement and post-offer 'negotiation' phases, through financial rewards and penalties based on clearer performance expectations**
- **measure distribution network operator performance robustly, with requirements to publish connections performance data, including timeliness of connection offers and connections delivery**
- **offer appropriate rewards for high performance, as well as penalties for poor performance.**

## Planning and consenting reforms

### Context

The Commission has previously explored how the planning and consenting regime for Nationally Significant Infrastructure Projects should be reformed to speed up the delivery of major new projects. The study found that the planning and consenting system has slowed down and become more uncertain, while the need for it has increased dramatically.<sup>152</sup> Given that over the next decade, the country needs to consent and build transformational infrastructure, the system should be reformed to remove unnecessary barriers. Failing to address the planning and consenting system risks minimising and/or delaying the social and economic benefits that infrastructure can bring. Planning reform is also a priority for the new government. In the King's Speech 2024, the Planning and Infrastructure Bill was announced. And the Clean Power 2030 Action Plan highlights issues that are specific to the energy sector.<sup>153</sup>

### How the planning and consenting regime works

In England and Wales, distribution network operators have the power to acquire land, or land rights, for new or existing apparatus, through compulsory purchase powers or acquiring necessary wayleaves, or fixed term statutory consents (typically 15 years in length). In the absence of agreement with a landowner – which can sometimes be challenging to achieve – operators must follow a legal process to acquire rights, usually via the lengthy necessary wayleave process, which can take two to four years to conclude. And further complications can arise if equipment needs maintenance or upgrading, as there is no mechanism which

allows operators to provide a notice to landowners to retain or upgrade equipment – the only notice that can be served regarding existing equipment is a ‘Notice to Remove’. There is also no way for operators to force a landowner to participate in the necessary wayleave process. Consequently, operators report that landowners will compel them to pursue the necessary wayleave process to leverage compensation negotiations, effectively holding them to ransom. This also leads to an increased administrative burden for government, which is responsible for administering wayleaves.

Distribution network operators in England and Wales require planning consents for works on new and existing apparatus. This can be achieved through permitted development rights – which enable certain types of work, designated under the Town and Country Planning Act 1990, to be undertaken without the need to submit a planning application, or through planning consents – applications under section 37 of the Electricity Act 1989 which relate to installing and keeping installed overhead lines.

Distribution network operators also have rights to access land under the Electricity Act, which they can use to access existing apparatus for maintenance. Operators can also access land to carry out essential tree lopping and felling works.

While the legislative framework for electricity consenting is the same across Great Britain, decision making is devolved in Scotland, with Scottish Ministers responsible for determining consents. The Scottish planning and consenting regime is broadly very similar to that of England and Wales, and follows the same legislation.<sup>154</sup> However, there are some technical differences between the planning and consenting regimes for electricity infrastructure. As it is devolved, planning and consenting in Scotland is outside the Commission’s remit.

## Targeted reforms

Many of the economy wide reforms to planning and consenting that the government is planning will have an impact on the delivery of distribution network infrastructure. The Commission has also identified several small, procedural reforms which are specific to distribution networks and which could make significant impacts to maintaining, upgrading and enhancing the distribution network.

Attempts to reform the planning and consenting system to speed up network infrastructure delivery are not new. In 2022, the then Department for Business, Energy & Industrial Strategy ran a call for evidence on land rights and consents for electricity network infrastructure. This sought to understand whether processes were fit for purpose or whether they acted as a barrier to building the electricity network infrastructure.<sup>155</sup> The Department for Energy Security and Net Zero published a summary of responses in November 2024, including proposals for a number of ‘quick-win’ reforms, including guidance updates and enhancements to internal processes.<sup>156</sup> It also announced the intention to consult on further reforms in 2025. Some of these overlap with the reforms identified by this study.

## Overhead lines

When overhead lines require maintenance, upgrading or replacing, the work typically does not have significant environmental or visual impact. In some cases, these works can be undertaken without planning permission or section 37 consents. But in other instances, even where equipment is just being replaced, planning permission is required. A wider category of exemptions for works with no material impacts could speed up upgrades. The Commission suggests that the following scenarios should not need further consents:

- **Two wire to three wire upgrades.** The majority of two wire lines are likely to need to be upgraded to increase the capacity of the circuit by enabling three-phase operation. Two wire to three wire upgrades typically have a negligible additional visual impact.
- **Increasing the height of supports of existing overhead lines.** The existing regulations allow for the supports for lines (pylons and poles) to be increased by no more than ten per cent above their existing height.<sup>157</sup> This is often too restrictive and does not provide sufficient flexibility. Increasing the threshold to 20 per cent would allow operators to comply with Electricity Safety, Quality and Continuity Regulations 2002 in the majority of cases.
- **Permanent diversions of a line (at the same voltage).** To maximise the capacity of existing overhead lines while minimising disruption, operators will commonly construct a new line parallel to the existing infrastructure and then remove the existing line when the new one has been built and connected. At present, there are provisions for such permanent diversions within defined distance parameters of the existing route corridor. Increasing the allowed distance could improve operators' ability to choose routes that avoid environmental constraints, conflicting land uses and better meet landowner preferences. This should both deliver better outcomes and speed projects up. The Commission supports the Electricity Networks Association's call for the 30m distance parameter relating to 'small supports' to be increased to 60m, and for the 60m distance parameter for 'any other support' to be increased to 100m, as this would align with the regulations in Scotland.

Government also needs to amend its guidance on Section 37 exemptions. This should clarify what works are routine maintenance and repair and what works are exempt, as the current lack of clarity means consents are sometimes sought for upgrades which do not need them. This would have the added benefit of reducing administrative burdens on the officials who oversee Section 37 consents.

## Consents in private streets

At present, there is ambiguity in the process for operators to acquire rights in private streets. This ambiguity can slow down the consenting process for new or upgraded connections, and risks consumers being liable for additional, uncapped costs. As a result, network operators do not often exercise these rights.

Generally, all land is served by a street, but where a street is not dedicated to public use – such as a shared driveway – there is no clear way for operators to get consent to undertake works. This ambiguity can be removed by aligning the definition of private streets in the Electricity

Act 1989 with that of the Gas Act 1986, allowing for a general right to install cables within any street where the purpose is to connect a consumer to the grid. This will not extend the existing rights of distribution network operators, but instead will clarify them, removing ambiguity and uncertainty, preventing delays.

### **Access rights to apparatus for access and maintenance**

Distribution network operators are able to access existing apparatus on third party land to carry out maintenance. In some instances, access to this equipment must be gained by passing through an adjacent property which is owned by another third party. Under current regulations, there is no clear way for operators to be permitted access through that third party's land, which can delay essential works to maintain the distribution network. This problem is further exacerbated if the operator is required to cross the land of multiple parties. Government should extend the existing rights under Schedule 6 Paragraph 9 of the Electricity Act 1989 to facilitate access over as much land as is necessary, regardless of the number of ownerships, when that route is the most reasonably expedient for their operational purposes.

### **Planning permission for small sub stations**

At present, smaller high voltage substations of 1 MVA or lower, which follow standard design, can be housed in kiosks of less than 29 m<sup>3</sup>. This means that they fall within the threshold for permitted development and so do not need to submit a planning application where they meet the relevant conditions. Consequently, where additional substation capacity is needed, rather than seeking planning permission for a larger substation, many operators will install a second 1 MVA substation – even if this is costlier and less efficient.

Given the expected growth in demand, this is clearly not desirable. The Commission recommends that government amend the Town and Country Planning (General Permitted Development) (England) Order 1995 to increase the volume threshold of substations from 29 m<sup>3</sup> to 45 m<sup>3</sup> so that larger 2 MVA substations could be installed without the need for a planning application. Scotland has already introduced legislation that provides permitted development rights for substations housed in units of up to this size.

**Recommendation 13 – Government should reform the planning and consenting system by the end of 2025 to enable new connections and network upgrades to be made more quickly. Changes should include:**

- **amending the Overhead Lines (Exemption) (England & Wales) Regulations 2009 and the process for seeking consent under section 37 of the Electricity Act 1989 to allow a wider set of alterations to overhead lines to be made without the need for planning permission**
- **addressing the ambiguity in the process for acquiring rights in private streets under Section 10 and Schedule 4, Paragraph 1 of the Electricity Act 1989**
- **amending Schedule 6 Paragraph 9 of the Electricity Act 1989 to extend access for operators conducting maintenance activities on third party land, so that they can cross as much land as is necessary, when that route is the most efficient**

- **amending the Town and Country Planning (General Permitted Development) (England) Order 1995 to increase the volume threshold for substations to be built with permitted development rights from 29 cubic metres to 45 cubic metres.**

## Potential for further structural reforms

Delivering these straightforward, procedural reforms has the potential to speed up the planning and consenting system, enabling distribution network operators to maintain and upgrade existing network equipment more efficiently. But there is scope for government to go further in reforming the planning and consenting regime through more structural changes. Providing new powers for electricity operators and aligning them with other statutory undertakers, such as water and telecoms operators, could significantly speed up the planning and consenting required for new apparatus. Consolidating the land rights process could further accelerate the planning and consenting process, while providing operators with more certainty and minimising the administrative burden on the Department for Energy Security and Net Zero. Government should investigate the potential effects of wider, structural reforms to the planning and consenting regime, and consider their impact on supporting government's decarbonisation ambitions.

## Supply chain and workforce

Delivering a distribution network fit for net zero will require more active management of supply chains and workforces. 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, supports supply chains to plan as well as providing opportunities to build more strategic relationships with suppliers to deliver programmes of work over multiple price controls. It should also 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.

Electricity distribution is not unique in facing supply chain pressures, skills gaps or wider workforce challenges. Along with many other sectors, electricity networks have faced increasing supply chain pressures in recent years and both the potential workforce needs and opportunities of the energy transition, as well as general issues with skills policy, have been well documented.<sup>158</sup>

In their consultation on the next price control, Ofgem acknowledged the supply chain and workforce challenges that distribution networks face.<sup>159</sup> Left unaddressed, these pressures are highly likely to increase as distribution network operators build out the larger network necessary to meet decarbonisation targets and growing electricity demand. But they clearly cannot be solved within the distribution sector alone and a combination of distribution-targeted measures and ones focused on the energy transition overall are therefore required.

## Supply pressures are already biting across the energy sector

Supply chain challenges have been a common theme in recent years, due in part to high inflation, disruption during the Covid-19 pandemic and stronger global competition for equipment. The prices of key raw materials, such as copper, have also been rising.<sup>160</sup> This is resulting in longer lead times for equipment and higher prices. Research conducted for the Department for Energy Security and Net Zero identified pressures across the supply chains for renewable generators and electricity networks.<sup>161</sup> And supply chain pressures also featured strongly in the recommendations in the Winsor Review on accelerating electricity transmission network deployment.<sup>162</sup>

As part of the next electricity transmission price control (which runs two years ahead of distribution), Ofgem has been considering options to support the transmission supply chain. In November 2024 Ofgem launched a consultation on the 'Advanced Procurement Mechanism', which would fund transmission operators to book manufacturing capacity ahead of time.<sup>163</sup> This is in addition to measures already taken on infrastructure being delivered through the Accelerating Onshore Electricity Transmission Investment programme, such as early construction funding.<sup>164</sup>

While the Commission has heard that supply chain pressures overall are not as acute for distribution as they are for transmission, they are linked. Transmission infrastructure in England is 275-400 kV, whereas in Scotland it also includes 132 kV infrastructure, which overlaps with the highest voltage level of the distribution network in England and Wales. High voltage distribution equipment has some overlap with the equipment required for transmission infrastructure and, more generally operators are already facing challenges around higher voltage equipment.

For example, Scottish Power Energy Networks reported that lead times for 33 kV transformers have increased from six months to 18 months and that prices have increased by 30 per cent, compared to the six months prior to the Covid-19 pandemic.<sup>165</sup> This aligns with analysis for the Department for Energy Security and Net Zero which identified lead times of up to 15 months for 33 kV transformers and two years for 132 kV transformers.<sup>166</sup> While this is not as challenging as the four year wait times for 400 kV transformers, it is still a sign of a difficult environment. As action is taken at transmission level, there is a risk that issues could become more acute for distribution especially if global competition for distribution equipment increases.

## A more competitive global environment

Distribution supply chains are global.<sup>167</sup> Globally felt effects – such as inflation and disruption from the Covid-19 pandemic - are creating pressures, but so too is global competition for equipment as countries seek to expand their electricity networks and deploy low carbon technologies. While the focus globally is currently on high voltage equipment and infrastructure, at some point, global attention will inevitably turn to lower voltages as well.

In this increasingly competitive global environment, suppliers have reported that the UK is seen as less favourable for investment than other large economies. This is due to both significant financial support offered elsewhere – such as the Inflation Reduction Act in the

United States or the Net-Zero Industry Act in the European Union – and a lack of policy clarity and certainty in Great Britain. Anecdotally, suppliers have also reported finding it more difficult to form strategic partnerships with distribution network operators in Great Britain than with their European counterparts. Some of the equipment approval processes, such as the Energy Networks Association’s Product Assessment System, are also sometimes seen as burdensome – especially for new products.

## **A proactive approach should help to ease supply chain pressures, but further action is likely to be needed**

Greater certainty is needed to tackle the challenges around skills and supply chain shortages. Adopting an approach which encourages proactive investment in the distribution network, with continuity over time, should allow distribution network operators to take a longer term approach to investing in the equipment required for network build. This will enable them to make stronger volume commitments to the supply chain than they do today and, in turn, it will allow the supply chain to invest in manufacturing, installation and maintenance capacity, with much greater confidence and lower risk. Smoothing the gaps between price controls periods and creating sustainable demand from programmes of work spanning multiple price controls will also support this.

Further proactive action is also likely to be needed from distribution network operators directly. Some are moving towards cultivating longer term, strategic partnerships with suppliers. And this is already happening at transmission level, where supply chain pressures are more acute. For example, National Grid Electricity Transmission have reformed both how they work and communicate with suppliers in response to supply chain pressures.<sup>168</sup> Strategic partnerships will likely need to become the standard approach across the industry.

With greater investment certainty, it will be important that distribution network operators make firm commitments to their suppliers. While this will not be entirely risk free, greater certainty on future investment can provide some mitigation, as well as supporting greater efficiencies through bulk purchasing and guaranteeing availability in advance.

Government and Ofgem will need to consider further action. For government, the focus on clean energy in the forthcoming industrial strategy provides an opportunity to support the distribution sector, including its domestic supply chain. And Ofgem will need to consider what distribution-specific supply chain measures may be required, after recognising supply chain pressures in its framework consultation. This should include considering whether there are supply chain measures that already exist (or are currently in development) for transmission equipment, that could be extended or adapted for distribution.

There are also some specific areas where government and Ofgem could provide specific signals to support supply chain planning. The most prominent of these is the phase out of sulphur hexafluoride equipment. As box 6 sets out, there is no consistent approach to this across distribution and equipment manufacturers would welcome a clear direction of travel.

### **Box 6: Sulphur hexafluoride containing equipment**

Sulphur hexafluoride is a nontoxic gas used as an insulator in equipment in both the distribution and transmission networks. It is also a greenhouse gas 23,500 times more potent than carbon dioxide.<sup>169</sup> Within distribution there are over 200,000 assets containing approximately 350,000 kilograms of sulphur hexafluoride.<sup>170</sup> In 2022/23 these had a leakage rate of 0.4 per cent, the equivalent to 27,089 tonnes of carbon dioxide.<sup>171</sup>

The distribution networks have targets for minimising leakage and some individual networks have also set their own targets for equipment from the network. Technological solutions are either available, being trialled, or in development. While these are only 0.7 per cent of distribution network emissions,<sup>172</sup> continuing to install equipment with this gas risks locking in emissions for the long term.<sup>173</sup>

The European Union has set a timetable for banning the installation of new electrical switchgear containing sulphur hexafluoride.<sup>174</sup> The Department for Environment, Food and Rural Affairs is in the process of reviewing the relevant regulation, including consideration for reducing the use of and emissions from sulphur hexafluoride in electrical equipment in the power sector.

## **The workforce needs to grow to deliver the required level of investment**

Like the challenges around supply chains, skills shortages are not unique to the distribution network. While the distribution workforce has specific needs and challenges, the overall challenge aligns with that of the energy transition more broadly – a need for significant workforce expansion. 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.<sup>175</sup> Good estimates of the specific requirements for distribution are hard to come by and further work is needed to update the estimates that do exist in light of sectoral developments, such as bringing forward the target for decarbonising the power sector from 2035 to 2030.

In discussions with the Commission, all distribution network operators have indicated that they are putting significant effort into building their workforces to meet future needs. Individual operators take different approaches to the volume of work they contract out versus that undertaken by their own workers, but all are expected to need to increase their resources. The workforce strategies produced for Ofgem as part of the current price control planning process give a sense of the scale of change, with the collective workforce predicted to grow by around 20 per cent by the end of the price control period.<sup>176</sup> At the same time, the current distribution workforce is also ageing, with a fifth of the wider energy workforce expected to retire by 2030.<sup>177</sup> This creates a potential crunch point in the late 2020s.

## Skills gaps are already apparent

While there is a growing challenge around the overall size of the workforce, there are already skills challenges impacting networks' – and their supply chains' – ability to deliver investment. The most substantial shortage seems to be craft skill workers, who form the bulk of the workforce – around half the workforce based on analysis by Energy and Utility Skills.<sup>178</sup> The Commission has heard concerns around shortages of cable jointers and overhead lines workers. Beyond this there are common challenges with finding sufficient engineers and other skilled roles, such as data and digital specialists, which are becoming more important. General shortages of project managers, and transferable construction skills, such as excavation teams, are affecting distribution networks as well as other sectors.

There is competition for these skills, both within distribution specifically and with other parts of the energy sector and the wider economy. Within distribution there is competition between distribution network operators themselves, but also with contractors, equipment manufacturers (especially where they are responsible for installation and/or maintenance), independent distribution network operators and independent connection providers. For example, one distribution network operator told the Commission that they had lost 30 jointers to contractors in their supply chain in just ten months and another reported that contractors often ask for workers who are trained to work on the distribution network. Skills are often transferrable across different voltages, which means there is also competition with the transmission network.

And skills are often required more widely across the energy sector. Renewable generation and end users of electricity have overlapping skills requirements and their needs are also growing. Patterns of investment have seen workers move back and forth – for example, cable jointers moving from distribution to the rail sector to deliver electrification works and then back when rail electrification works slow. Some skills – particularly construction – are also common across utilities. Having transferable skills across sectors is positive, but not if there are not enough people with the right skills to go around.

## Filling gaps is an area of focus but remains a major challenge

Different actors in the sector are taking different approaches to filling skills shortages. All distribution network operators are increasing their graduate and apprenticeship programmes at different scales. However, even with some initiatives to improve graduate and apprenticeship training, there is limited capacity to train the necessary workforce, with significant competition for available programmes. National Grid has reported receiving 16 applicants for each graduate place available and UK Power Networks reported receiving 40 applications for every craft apprenticeship place. The capacity of further education institutions to expand has also been raised as a limitation on the ability to scale the distribution workforce.

The long lead times needed to train new staff also presents a challenge. Most distribution network operators offer training programmes, with apprenticeship programmes usually lasting three years. But even after an apprenticeship, further training is usually needed before an employee can become fully certified for solo work. Overall, estimates range from around five to seven years to train an engineer for solo working.

To fill the skills gap required to meet the expected peak build rates in the late 2020s with the required new talent, there needs to be resources in the training pipeline now. Or alternatively, new shorter training routes need to be developed. The main options being considered by the sector are retraining for those with similar skillsets, or accessing overseas workers with the right skills.

On retraining, most distribution network operators offer fast track apprenticeship courses, which last one to two years and/or target specific groups, such as ex-armed forces members. Some operators are working with partner organisations from other infrastructure sectors, where workforce demands are changing. For example, Scottish Power Energy Networks is exploring the potential to retrain fibre engineers for the energy sector, given the predicted slowdown in broadband build rates. However, concerns have been raised that even these fast track courses are not bringing enough people into the distribution sector at the pace required. One operator also reported that a significant barrier to retraining workers from adjacent industries was the need for them to take pay cuts to move across.

The sector could also do more to manage the frictions around onboarding and training and increase the use of common standards across the sector, which have been cited by a number of stakeholders as a challenge for workforce development. At present, the different authorisations and health and safety rules used by distribution network operators mean that even fully qualified individuals need to be retrained to work on different networks, limiting the pool of workers who can be accessed quickly. Increased standardisation in this area might increase the risk that staff could go to competitors, but it would also increase flexibility across the sector as a whole and could open up potential for collaboration on common training routes, or the development of centres of excellence.

The immigration system has also been raised as a challenge across the distribution sector for higher skilled roles, both for filling short term vacancies and recruiting and retaining graduate students. For short term roles, the issues raised tend to focus on the cost and speed of the process, whereas the longer term retention of international graduate students is more about the broader rules of the system. While these issues have been raised regularly, it is not clear quite how much of a barrier the migration system represents. And given the global focus on the energy transition, building up the domestic workforce cannot be avoided.

## **A skills strategy is needed to prepare the wider energy workforce**

Even with significant further action within the distribution sector, if this were to happen in isolation it would not be sufficient to resolve challenges that extend far more widely. The Commission is not the first body to recognise the pressing need to address skills shortages and workforce planning for the energy transition as a whole. The Winser Review called for an urgent government led review of engineering and technician skills to identify gaps in the workforce needed to deliver net zero.<sup>179</sup> While some work on this has been undertaken, more is needed.

Since the 2024 general election, the government has made several announcements on skills policy, launching Skills England and establishing the Office for Clean Energy Jobs. While the Clean Power Action Plan included some useful analysis of skills needs across the sector, more analysis is needed and clear actions need to be developed to resolve workforce issues.

Further work must be undertaken, as a priority, to understand the scale of the skills challenge that faces distribution networks and the wider energy sector. Given skills policy is devolved, this will need to involve close cooperation with the devolved administrations, as well as with the strategic authorities that have responsibility for skills.

The outcomes of further review and analysis then need to inform a strategy for managing these workforce pressures over the course of the transition. Given the pace of change required to meet the 2030 Clean Power Target, as well as the investment required to meet accelerating demand in the 2030s and beyond, this strategy needs to be developed urgently.

**Recommendation 14 – Government should identify the skills gaps and actions required to attract, recruit and retain the large workforce needed to deliver the energy transition. This should form the basis of a net zero skills and workforce strategy, published by the end of 2025.**

# Glossary

## **Capital expenditure**

Funds spent on assets which are usually physical, such as buildings, equipment and other longer term network infrastructure.

## **Carbon budget**

Carbon budgets specify the volume of greenhouse gases that the UK can emit over a set five year period to stay on track to reach the 2050 net zero target. These are set by the government based on the advice of the Climate Change Committee and are legally binding. The Sixth Carbon budget period runs from 2033 to 2037.

## **Constraint costs**

Payments made to energy generators due to a lack of capacity in a specific location on the electricity network. This covers both the cost of turning down a generator 'behind' the constraint, in order to relieve it, and the cost of turning up another unconstrained generator to satisfy the energy balance.

## **Cut out**

The equipment that links the electricity service cable with the internal wires of a property. It contains a fuse to ensure that electricity passes safely into a property.

## **Critical national infrastructure**

As defined by the UK Government, the parts of infrastructure which if compromised could result in major detrimental impact on the availability of essential services, significant casualties or significant impact on national security.

## **Determinations**

Decisions made by Ofgem within the price control, which set out the level of revenue distribution network operators are allowed to recover. Draft determinations are consulted on before Ofgem makes its final determinations.

## **Distribution connected generation (also known as 'embedded generation')**

Electricity generation which connects into the distribution network, rather than the transmission network. Some renewable technologies such as solar and onshore wind are more likely to be connected to the distribution network.

Distribution generation is often referred to by the sector as 'embedded generation'.

## **Distribution network operator**

Distribution network operators operate and maintain the distribution network within a specific licence area. They are responsible for planning and delivering new network assets to meet demand, managing the health of the network and ensuring reliability as well as managing the process of connecting to the network.

## **Distribution Price Control Review**

Distribution Price Control Review was the price control framework used by Ofgem prior to the current Revenue = Incentives + Innovation + Outputs price control model.

## **Distribution system operator**

Responsibility to develop, operate and optimise an electricity distribution system. This includes forecasting and monitoring generation and demand, using flexibility instead of network investment where appropriate and managing flexible connections to the network.

## **Diversity of demand**

The principle that large groups of customers are less likely to use energy at the same time.

## **Electricity distribution network**

The distribution network 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.

## **Electricity transmission network**

The transmission network moves electricity around the country via high voltage wires, from generation sources to areas of demand.

## **Feeder**

A power line through which electricity is transferred within a network.

## **Financeability**

Assessment of the long term financial health and stability of a company, which includes the ability to secure adequate funding and financing to support operations and necessary investment.

## **Flexibility**

Alteration to the amount of electricity consumed or generated based on demand signals. Flexibility has broadly two uses: national flexibility, used to reduce the size of peak demand and balance supply with demand, and local flexibility, which is used to manage pinch points in networks. Some aspects of flexibility are referred to as 'demand side response' by the sector.

## **'Flex first'**

An approach introduced in the current Revenue = Incentives + Innovation + Outputs price control framework, which requires distribution network operators to consider using local flexibility where it is more cost effective than traditional network reinforcement for managing constraints.

## **Flexible asset registration**

A register of assets capable of operating flexibly, such as heat pumps, electric vehicle chargers and home battery storage systems, which system operators can use to assess the flexibility that is available in the system.

### **Grid supply point**

The point at which a distribution network connects to the transmission network and the voltage is reduced for safe and efficient distribution.

### **Guaranteed Standards of Performance**

Standards of service that network operators are required to meet, including timeframes for restoring supply to consumers after an interruption. If a network operator fails to meet these standards, they may be required to pay compensation to consumers.

### **Heat network (including district heating)**

A network of pipes supplying hot water for heating from a central source to multiple buildings (district heat networks) or to multiple dwellings in the same building (communal heat networks).

### **Heat pump**

A technology which transfers heat from a source (such as the outside air, ground or water) and concentrates it so it can be used for heating and hot water.

### **Licence area**

The distribution network in Great Britain is split into 14 regional areas for which a network operator is authorised to operate and maintain the network.

### **Load related expenditure**

Investment in network infrastructure to provide additional capacity and accommodate growing demand on the network.

### **Local Area Energy Plans**

A method for spatial planning of the energy system at local level, developed by the Energy Systems Catapult and delivered by local authorities. All Welsh local authorities have developed Local Area Energy Plans, as well as many English local authorities.

### **Local Heat and Energy Efficiency Strategies and Delivery Plans**

Strategies and delivery plans produced by all local authorities in Scotland to improve the energy efficiency of buildings and reduce greenhouse gas emissions from heating buildings.

### **Looped supplies**

Where a property shares an electricity service cable from the main network with a neighbouring property or properties, rather than having its own individual cable. Removing looped supplies by installing an electricity service cable to each property is known as 'unlooping'.

### **Low carbon technology**

Technologies, usually within households, which emit low or no levels of greenhouse gases such as heat pumps, electric vehicles, solar panels and batteries.

### **Major connection**

Larger customer connections to the distribution network at higher voltage levels and higher demand, or which have more than four single phase connections.

### **Market-wide half hourly settlement**

An Ofgem program currently in the process of being implemented meaning domestic and commercial customers will have electricity consumption measured and billed in half hourly intervals based on the amount of electricity used in that time.

### **Minor connection**

Customer connection to the distribution network at lower voltage levels such as a supply to households or small businesses.

### **Nationally Significant Infrastructure Projects**

Large scale developments in England relating to energy, transport, water or waste infrastructure which require development consent under the Planning Act 2008.

### **Network Asset Risk Metric**

Framework used to assess asset health and monetised risk of network assets. In the current price control, Ofgem set a penalty based on this metric to deter network operators from underspending on asset maintenance and replacement.

### **Network reinforcement**

Building additional infrastructure to increase the capacity of the network, either through additional physical assets or upgrading assets to a higher capacity.

### **Off-gas properties**

Properties which are not connected to the gas network and therefore rely on electricity or alternative fuel sources for heating, such as oil or liquid petroleum gas.

### **Operational expenditure**

Funds spent on operating and maintaining the network. This includes activities such as fault repairs, tree cutting, inspection and maintenance, engineering and business support costs.

### **Peak demand**

The highest level of demand in a system over a period of time (usually a year or a day).

### **Proactive investment**

Investment to increase the capacity of the network ahead of long term need, with the objective of bringing forward consumer and system benefits. This is based on forward looking assumptions about supply and demand.

### **Price control**

Price controls set the amount of money that network companies can recover from consumers over a set period of time as well as any rewards and penalties to incentivise desired outcomes. Ofgem set price controls for the companies that operate Great Britain's gas and electricity networks.

### **Price control deliverable**

A type of funding mechanism within the current price control where allocation of funding is tied to the delivery of specified outputs. This includes the mechanism to refund consumers if an output is not delivered, or not delivered to a specified standard.

## **Primacy rules**

Agreed rules which set out the actions that will take place when activities from national operators and local operators come into conflict with each other within the electricity system.

## **Priority Services Register**

A list of vulnerable customers maintained by network operators alongside other utilities providers. This allows customers who might need extra support during network outages to be easily identified.

## **Ramped connection**

A customer connection that provides an initial capacity with a commitment from the network operator to increase the available capacity to an agreed maximum, based on an agreed schedule. This is sometimes called a flexible connection.

## **Redundancy**

Additional capacity within a system which means a service can continue to run despite the failure of an individual asset.

## **Regional Energy Strategic Plans**

Regional plans that will set out supply and demand pathways for the energy system to inform the setting of network investment plans. The plans will be delivered by the National Energy System Operator, with the first transitional plans expected in 2026.

## **Re-opener**

A type of uncertainty mechanism where Ofgem adjusts allowances during the price control. The process requires network operators to submit an application for additional funding which is then reviewed by Ofgem.

## **Regulatory Asset Value**

A regulatory financial construct that reflects the value of a company's assets after accounting for historical investment and depreciation. It is sometimes known as the Regulated Asset Base.

## **Regulatory incentives**

Mechanisms used to encourage network operators to achieve specific performance targets and objectives. Financial incentives include rewards or penalties based on performance which impacts allowed revenue. Reputational incentives are non-financial, with Ofgem instead publicly recognising performance levels.

## **Revenue = Incentives + Innovation + Outputs (RIIO) price control**

Ofgem's current regulatory framework which determines allowed revenues for network operators. This has been used for the current and previous price control periods.

## **Security of supply**

Ability of the electricity system to consistently meet consumer demand without interruption, ensuring consumers have access to a stable and reliable electricity supply.

### **Service cables**

Electrical cable that connects a property to the distribution network.

### **Smart devices**

Devices or appliances which can automatically shift their consumption in response to a signal, including reducing load and turning off for a period. For example, smart heat pumps can move demand away from peak hours by preheating a house.

### **Stranded assets**

Network assets which are no longer needed before they reach the end of their economic life, usually due to demand not materialising as expected.

### **Strategic planning**

A long term and high level approach to planning the infrastructure needs of a sector. For regulated sectors such as electricity distribution networks, this can provide additional confidence in levels of supply and demand and therefore in the needs case for investment. A new approach to strategic planning for local energy networks is being introduced through the Regional Energy Strategic Plans.

### **Strategy and policy statement**

Statutory document in which government sets out strategic priorities and objectives for the energy sector and which Ofgem has regard to in carrying out its functions.

### **Stress testing**

Testing a representation or simulation of a system to reveal its performance under certain conditions or to reveal the conditions that could lead to failure.

### **Substation**

Facility which includes a transformer to reduce the voltage level and enable the network to branch out to multiple destinations. These are situated between each voltage level in the distribution network.

### **Thermal storage**

A device for storing heat for later use. For example a hot water cylinder enables heating water at times when electricity is cheap and storing for use when needed.

### **TOTEX (Total Expenditure) Incentive Mechanism**

An incentive mechanism under the current price control framework which aims to encourage network operators to run their networks efficiently and share cost savings from doing so with consumers. It covers both capital and operational expenditure – that is total expenditure (TOTEX).

### **‘Touch the network once’**

Building assets which are designed to manage future, rather than current demand. This avoids the need for multiple future interventions to increase capacity as demand increases, minimising disruption and the need to replace assets before the end of their life.

## **Transformer**

Equipment which changes the voltage between two different electrical circuits.

## **Uncertainty mechanism**

Funding mechanisms used in the price control to scale funding up or down as required in response to changing circumstances – usually the level of demand that is realised.

## **‘Use is it or lose it’ allowances**

A specific price control funding mechanism where revenue is ringfenced and capped for a specific purpose or activity. If network operators choose not to use the allowance, it will be returned to consumers.

## **Voltage**

Voltage is the pressure within an electrical system. A kilovolt (kV) is equivalent to 1,000 volts (V). The distribution network operates at multiple different voltages from 230 V up to 132 kV (in England and Wales, and below 132 kV in Scotland).

## **Kilovolt Amperes (kVA) / MegaVolt Amperes (MVA)**

Units used to measure the power capacity of a transformer.

## **Volume driver**

A type of uncertainty mechanism which automatically releases funding during the price control based on the actual level of demand which materialises and the volume of investment which is required to meet it.

## **Watt**

A watt is a unit of measurement for the rate of energy transferred at any point in time. One watt is equal to one joule of energy transferred per second.

A kilowatt (kW) is equivalent to 1,000 watts (W); a megawatt (MW) is equivalent to 1,000 kilowatts (kW); a gigawatt (GW) is equivalent to 1,000 megawatts (MW).

## **Watt hour**

A Watt hour (Wh) is a unit of measurement for the amount of energy transferred over time. One Watt hour is equal to the energy transferred when a power of one watt is used over one hour.

A kilowatt hour (kWh) is equivalent to 1,000 watt hours (Wh), A megawatt hour (MWh) is equivalent to 1,000 kilowatt hours (kWh), A gigawatt hour (GWh) is equivalent to 1,000 megawatt hours (MWh), A terawatt hour (TWh) is equivalent to 1,000 gigawatt hours (GWh).

## **Wayleave**

Contractual agreement between a landowner and a network operator which gives permission for the network operator to access private land to install or maintain network infrastructure.

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## References

- 1 Department for Energy Security and Net Zero (2024), [Historical electricity data: 1920 to 2023](#)
- 2 HM Treasury (2024), [Terms of reference – distribution networks study](#)
- 3 Subject to approvals, the acquisition of Electricity North West Limited by Iberdrola will reduce the number of companies to five, by bringing them into the same ownership group as SP Energy Networks
- 4 Commission analysis of Department for Energy Security and Net Zero (2024), [Digest of UK Energy Statistics \(DUKES\): electricity](#)
- 5 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#)
- 6 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#); Energy Networks Association (2015), [Climate Change Adaptation Reporting Power Second Round](#)
- 7 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#)
- 8 Commission discussion with Northern Powergrid
- 9 Department for Energy Security and Net Zero (2023), [Connections Action Plan](#)
- 10 National Infrastructure Commission (2019), [Strategic Investment and Public Confidence](#)
- 11 UK Government (2025), [Electricity Act 1989](#)
- 12 Department for Energy Security and Net Zero (2024), [Strategy and Policy Statement for Energy Policy in Great Britain](#)
- 13 Ofgem (2024), [Ofgem’s Multiyear Strategy](#)
- 14 Ofgem (2022), [RIIO-ED2 Final Determinations Overview document](#)
- 15 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](#)
- 16 National Energy System Operator (2024), [Clean Power 2030](#); Department for Energy Security and Net Zero (2024), [Strategic Spatial Energy Plan](#)
- 17 HM Treasury (2024), [National Wealth Fund](#)
- 18 Department for Energy Security and Net Zero (2024), [Great British Energy founding statement](#)
- 19 Department for Energy Security and Net Zero (2024), [Digest of UK Energy Statistics \(DUKES\): electricity](#)
- 20 Ofgem (2022), [RIIO-ED2 Final Determinations Overview document](#)
- 21 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 22 Regen and EA Technology's analysis for the Commission using the Electricity System Operator’s *Future Energy Scenarios 2023* publication and the second *National Infrastructure Assessment* in combination with distribution network operators’ data. Regen and EA Technology (2024), EA Technology (2025), [National Modelling of Electricity Distribution Network Capacity Analysis](#)
- 23 Climate Change Committee (2020), [Deep-Decarbonisation Pathways for UK Industry](#)
- 24 Gailani & Taylor (2024), [Assessing Electricity Network Capacity Requirements for Industrial Decarbonisation in Great Britain](#)
- 25 Aurora Energy Research (2023), [The impact of decarbonising heating on the power sector \(C\)](#)
- 26 BloombergNEF (2021), [Data Centers and Decarbonization](#)
- 27 National Energy System Operator (2024), [Clean Power 2030 Annex 1: Electricity demand and supply analysis](#)

- 28 Department for Levelling Up, Housing and Communities (2024), [Operational reforms to the Nationally Significant Infrastructure Projects consenting process: government response](#); Ministry of Housing, Communities and Local Government (2024), [Government response to the proposed reforms to the National Planning Policy Framework and other changes to the planning system consultation](#)
- 29 Department for Science, Innovation and Technology (2025), [AI Opportunities Action Plan: government response](#)
- 30 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#)
- 31 Greater London Authority (2024), [West London electricity capacity constraints](#)
- 32 Energy Networks Association (2015), [Climate Change Adaptation Reporting Power Second Round](#)
- 33 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#)
- 34 Department for Energy Security and Net Zero (2024), [Clean Power 2030 Action Plan: A new era of clean electricity](#); Regen and EA Technology (2024), EA Technology (2025), [National Modelling of Electricity Distribution Network Capacity Analysis](#)
- 35 UK Climate Risk (2021), [Findings from the third UK Climate Change Risk Assessment \(CCRA3\) Evidence Report 2021](#)
- 36 Energy Networks Association (2021), [3rd Round Climate Change Adaptation Report](#)
- 37 Met Office (2022), [Unprecedented extreme heatwave, July 2022](#)
- 38 Climate Change Committee (2021), [Independent Assessment of UK Climate Risk](#)
- 39 Ofgem (2022), [Storm Arwen Report](#)
- 40 Met Office, [UK and Global extreme events - Wind storms](#); UK Climate Risk (2021), [UK Climate Risk Independent Assessment \(CCRA3\) Technical Report Chapter 4: Infrastructure](#)
- 41 UK Climate Risk (2021), [UK Climate Risk Independent Assessment \(CCRA3\) Technical Report Chapter 4: Infrastructure](#)
- 42 UK Climate Risk (2021), [UK Climate Risk Independent Assessment \(CCRA3\) Technical Report Chapter 4: Infrastructure](#)
- 43 National Cyber Security Centre (2023), [NCSC Annual Review 2023](#)
- 44 National Infrastructure Commission (2020), [Anticipate, React, Recover](#)
- 45 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 46 National Infrastructure Commission (2020), [Anticipate, React, Recover](#); National Infrastructure Commission (2024), [Developing resilience standards in UK infrastructure](#)
- 47 Ofgem (2023), [Open letter on future reform to the electricity connections process](#)
- 48 Regen (2024), [Toxic constraint coverage could damage Clean Power Plan](#)
- 49 National Energy System Operator (2024), [Clean Power 2030](#)
- 50 Department for Business, Energy and Industrial Strategy (2022), [Appendix 1: Electricity Networks Modelling](#)
- 51 Aurora Energy Research (2023), [The impact of decarbonising heating on the power sector \(C\)](#)
- 52 EA Technology (2025), [National Modelling of Electricity Distribution Network capacity analysis](#)
- 53 EA Technology (2025), [Low Voltage Network Case Studies](#)
- 54 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.
- 55 EA Technology (2025), [Low Voltage Network Case Studies](#); EA Technology (2025), [National Modelling of Electricity Distribution Network Capacity Analysis](#); Regen and EA Technology (2024), EA Technology (2025), [National Modelling of Electricity Distribution Network Capacity Analysis](#)

- 56 Department for Business, Energy and Industrial Strategy (2022), [Appendix I: Electricity Networks Modelling](#); National Infrastructure Commission (2024), [Commission to explore capability of local electricity grid to support renewables push](#)
- 57 Higher flexibility sensitivities included a wider uptake of smart charging, vehicle to grid, and heat pumps with thermal storage, battery storage had a supporting role in the network. Lower flexibility sensitivities did not include vehicle to grid chargers or managed heat pumps, and fewer smart chargers, battery storage had a neutral impact on the system
- 58 See 'Managing the cost of investment for consumers' section
- 59 See May Street Case Study. EA Technology (2025), [Low Voltage Network Case Studies](#)
- 60 See Brockhill Drive, Chaddesley Corbett, Spen Road and Duxmoor. EA Technology (2025), [Low Voltage Network Case Studies](#)
- 61 See Mosborough Crescent and Dunston Industrial. EA Technology (2025), [Low Voltage Network Case Studies](#)
- 62 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 63 Aurora Energy Research (2023), [The impact of decarbonising heating on the power sector \(C\)](#)
- 64 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 65 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#); National Energy System Operator (2024), [Clean Power 2030](#)
- 66 Department for Business, Energy and Industrial Strategy (2022), [Appendix I: Electricity Networks Modelling](#)
- 67 UK Government (2025), [The Electric Vehicles \(Smart Charge Points\) Regulations 2021](#)
- 68 Electricity System Operator (2023), [Powerloop: Trialling Vehicle-to-Grid technology](#)
- 69 Energy Systems Catapult (2021), [V2GB Vehicle to Grid Britain](#)
- 70 Energy systems catapult (2020), [Thermal Energy Storage for Heat Networks](#)
- 71 Aurora Energy (2023), [Energy sector modelling for Second National Infrastructure assessment](#)
- 72 Department for Energy Security and Net Zero (2024), [Delivering a smart and secure electricity system: implementation](#)
- 73 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 74 Electricity North West (2015), [Customer Load Active System Services Second Tier LCN Fund Project Closedown Report](#)
- 75 Department for Business, Energy and Industrial Strategy (2021), [Appendix I: Electricity System Flexibility Modelling](#)
- 76 EA Technology (2025), [Low Voltage Network Case Studies](#)
- 77 Ofgem (2024), [Market facilitator delivery body](#)
- 78 Department for Energy Security and Net Zero (2024), [Clean Power 2030 Action Plan: A new era of clean electricity](#)
- 79 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 80 Public Accounts Committee (2023), [Update on the rollout of smart meters](#)
- 81 Department for Energy Security and Net Zero (2024), [2024 Q2 Smart meter statistics report](#)
- 82 Department for Energy Security and Net Zero (2024), [Smart Meter Statistics in Great Britain: Quarterly Report to end September 2024](#); House of Commons Committee on Public Accounts (2023), [Update on the rollout of smart meters](#)
- 83 Department for Energy Security and Net Zero (2023), [Smart Meter Targets Framework: Government response to a consultation on minimum installation requirements for Year 3 \(2024\) and Year 4 \(2025\)](#)
- 84 Ofgem (2021), [BSC Modifications P272 and P322 Factsheet](#)
- 85 Ofgem (2024), [Distribution Connection and Use of System Agreement \(DCUSA\) – DCP445 'Implementation of Market-wide Half Hourly Settlement \(MHHS\) Arrangements'](#)

- 86 Haakana et al. (2024), [Effects of negative spot market prices on Electricity distribution network loading, experiences from the Finnish distribution system](#); Nordic Green Energy (2023), [Tuore tutkimus: Pörssi sähköopimusten määrä kaksinkertaistui vuoden 2023 aikana](#)
- 87 Haakana et al. (2024), [Effects of negative spot market prices on Electricity distribution network loading, experiences from the Finnish distribution system](#)
- 88 Sarkkå (2023), [Pörssi sähkö oli ennätys halpaa, tämä siitä seurasi – moni voi kohdata ikävän yllätyksen](#)
- 89 Haakana et al. (2024), [Effects of negative spot market prices on Electricity distribution network loading, experiences from the Finnish distribution system](#); Savon Voima (2024), [Annual Report 2023](#)
- 90 Department for Energy Security and Net Zero (2022), [Automatic Asset Registration Programme: Phase 2 project](#)
- 91 Ofgem (2024), [Flexibility Market Asset Registration](#)
- 92 Ofgem (2023), [RIIO-ED1 Network Performance Summary 2020-21](#)
- 93 Energy Networks Association (2023), [Engineering Recommendation P2](#)
- 94 Brockhill Drive case study in EA Technology (2025), [Low Voltage Network Case Studies](#)
- 95 Department for Business, Energy and Industrial Strategy (2020), [Electricity Engineering Standards Review](#)
- 96 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#); Department for Business, Energy and Industrial Strategy (2020), [Electricity Engineering Standards Review](#)
- 97 UK Power Networks (2024), [Extra support for people reliant on electricity for medical reasons](#); Northern Powergrid (2021), [Silent Power: Smart vans that keep your house energised in a power cut](#)
- 98 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 99 Ofgem (2022), [RIIO-ED2 Final Determinations Core Methodology Document](#)
- 100 National Grid (2022), [Work begins on new substations to power up Biggleswade in Bedfordshire](#)
- 101 National Grid (2022), [Work begins on new substations to power up Biggleswade in Bedfordshire](#)
- 102 Central Bedfordshire Council (2019), [Biggleswade Masterplan](#)
- 103 Ministry of Housing, Communities and Local Government (2024), [English Devolution White Paper](#)
- 104 Scottish Government (2024), [Policy: Climate Change](#)
- 105 This would also mean additional funding would be provided to the Scottish and Welsh Governments under the Barnett formula
- 106 Ofgem (2025), [Scope of the transitional Regional Energy Strategic Plan](#)
- 107 Commission analysis based on Ofgem RIIO-ED1 Annual Report 2021-22 and electricity distribution company performance 2010 to 2015
- 108 Commission analysis based on RIIO-ED1 Network Performance Summary 2021-22. Ofgem (2023), [RIIO-ED1 Network Performance Summary 2021-22](#)
- 109 Commission analysis based on Ofgem's ED3 Framework Consultation. Ofgem (2024), [ED3 Framework Consultation](#)
- 110 Figure 19 in Ofgem (2024), [ED3 Framework Consultation](#)
- 111 Ofgem (2023), [RIIO-ED1 Network Performance Summary 2021-22](#)
- 112 Commission analysis based on data from Ofgem (2024), [ED2 Price Control Financial Model, version 4](#)
- 113 Ofgem (2024), [RIIO-2 Re-opener Applications 2024 Final Determinations – ED Annex](#)
- 114 Ofgem (2022), [Storm Arwen Report](#)
- 115 Department for Business, Energy and Industrial Strategy (2022), [Energy Executives Committee Storm Arwen Review](#); Ofgem (2022), [Storm Arwen Report](#)
- 116 Ofgem (2022), [RIIO-ED2 Final Determinations Overview Document](#)
- 117 Ofgem (2024), [RIIO-2 Re-Opener Applications 2024 Draft Determinations – ED Annex](#)
- 118 Of the total £266.8m worth of proposals submitted, Ofgem proposed to fund £149.64m worth in final determinations, see Ofgem (2024), [RIIO-2 Re-Opener Applications 2024 Final Determinations – ED Annex](#)

- 119 Ofgem (2023), [Re-opener Guidance and Application Requirements Document](#)
- 120 Ofgem (2023), [Statutory consultation on proposed amendments to the Electricity \(Connection Guaranteed Standards of Performance\) Regulations 2015](#)
- 121 National Infrastructure Commission (2024), [Developing resilience standards in UK infrastructure](#)
- 122 National Infrastructure Commission (2023), [The Second National Infrastructure Assessment](#)
- 123 Ofgem (2019), [RIIO-ED1 Reopener Decision – High Value Projects](#)
- 124 UK Government (2025), [The Environmental Protection \(Disposal of Polychlorinated Biphenyls and other Dangerous Substances\) \(England and Wales\) \(Amendment\) Regulations 2024](#)
- 125 Ofgem (2024), [ED3 Framework Consultation](#)
- 126 Ofgem (2019), [RIIO-ED2 Framework Decision](#)
- 127 Regulatory Asset Value – the value ascribed by Ofgem to the capital employed in each licensee’s regulated distribution business
- 128 Ofgem (2019), [Open Letter Consultation on approach to setting the next electricity distribution price control \(RIIO-ED2\)](#); Ofgem (2019), [RIIO-ED2 Framework Decision](#)
- 129 Ofcom (2024), [Telecoms Access Review 2026](#)
- 130 Ofgem (2023), [RIIO-3 Sector Specific Methodology Consultation – GD Annex](#)
- 131 SP Energy Networks (2021), [Enabling the path to Net Zero](#)
- 132 Electricity North West (2021), [Engineering Justification Paper RIIO-ED2 Project Level Report](#)
- 133 Department for Energy Security and Net Zero (2024), [Subnational Electricity and Gas Consumption Statistics](#)
- 134 Department for Energy Security and Net Zero (2024), [Boiler Upgrade Scheme statistics October 2024](#)
- 135 Department for Energy Security and Net Zero (2024), [Clean Power 2030 Action Plan: A new era of clean electricity](#)
- 136 Department for Energy Security and Net Zero (2024), [Summary of Consultation Response for Draft Strategy and Policy Statement for Energy Policy in Great Britain](#)
- 137 Department for Digital, Culture, Media and Sport (2019), [Statement of Strategic Priorities for telecommunications, the management of radio spectrum, and postal services](#)
- 138 Department for Energy Security and Net Zero (2024), [Review of Ofgem: call for evidence](#)
- 139 Ofgem (2024), [Connections end-to-end review - consultation](#)
- 140 Energy Networks Association (2025), [Connections Data](#)
- 141 Electricity System Operator (2024), [GB Connections Reform](#)
- 142 Electricity System Operator (2024), [GB Connections Reform](#)
- 143 Department for Energy Security and Net Zero (2024), [Open letter from DESNZ and Ofgem: Aligning grid connections with strategic plans \(5 November 2024\)](#)
- 144 National Energy System Operation (2025), [Joint Direction and Letter of Comfort request from NESO and all three GB Transmission Owners \(NGET, SSENT and SPT\)](#)
- 145 National Energy System Operator (2024), [Great Britain’s Connections Reform: Overview Document](#)
- 146 Taken from data shared with the Commission by the Electricity Networks Association
- 147 Ofgem (2023), [RIIO-1 Electricity Distribution Annual Report 2021-22 and Regulatory Financial Performance Annex to RIIO-1 Annual Reports](#); PA Consulting (2023), [RIIO 10 years on: The jury is still out](#)
- 148 Ofgem (2022), [RIIO-ED2 Final Determinations Overview Document](#)
- 149 Energy Networks Association (2024), [ENA’s Connect Direct passes 15,000 applications as the project enters its next phase](#)
- 150 Ofgem (2012), [Electricity Distribution Price Control Customer Service Reporting - Regulatory Instructions and Guidance: Version 2](#)
- 151 Greater London Authority (2024), [West London Electricity Capacity Constraints](#)

- 152 National Infrastructure Commission (2023), [Delivering net zero, climate resilience and growth](#)
- 153 Department for Energy Security and Net Zero (2024), [Clean Power 2030 Action Plan: A new era of clean electricity](#)
- 154 House of Commons Library (2016), [Comparison of the planning systems in the four UK countries: 2016 update](#)
- 155 Department for Business, Energy and Industrial Strategy (2022), [Land rights and consents for electricity network infrastructure: call for evidence](#)
- 156 Department for Energy Security and Net Zero (2024), [Land Rights and Consents for Electricity Network Infrastructure](#)
- 157 Electricity Networks Association (2023), [Our Common Sense Plan for Planning](#)
- 158 Green Alliance (2024), [Green shoots: growing the green workforce of the future](#); IPPR (2024), [Skills Matter](#)
- 159 Ofgem (2024), [ED3 Framework Consultation](#)
- 160 Wood Mackenzie (2024), [Supply shortages and an inflexible market give rise to high power transformer lead times](#)
- 161 Baringa (2024), [UK renewables deployment supply chain readiness study - Executive summary for industry and policymakers](#)
- 162 Department for Energy Security and Net Zero (2023), [Accelerating electricity transmission network deployment: Electricity Networks Commissioner's recommendations](#)
- 163 Ofgem (2024), [Electricity Transmission Advanced Procurement Mechanism](#)
- 164 Ofgem (2022), [Decision on accelerating onshore electricity transmission investment.](#)
- 165 SP Energy Networks' call for evidence response. National Infrastructure Commission (2025), [Electricity distribution networks study: responses to the call for evidence](#)
- 166 Baringa (2024), [UK renewables deployment supply chain readiness study - Executive summary for industry and policymakers](#)
- 167 SP Energy Networks' call for evidence response. National Infrastructure Commission (2025), [Electricity distribution networks study: responses to the call for evidence](#)
- 168 Commission discussions with National Grid Electricity Transmission
- 169 Department for Energy Security and Net Zero (2024), [Greenhouse gas reporting: conversion factors 2024: condensed set \(for most users\)](#)
- 170 Ofgem (2022), [Sustainability First - RIIO ED2 BPs - Response to Ofgem - Annex 2 - SF6 STRATEGIES](#)
- 171 Ofgem (2022), [Sustainability First - RIIO ED2 BPs - Response to Ofgem - Annex 2 - SF6 STRATEGIES](#)
- 172 Ofgem (2022), [Sustainability First - RIIO ED2 BPs - Response to Ofgem - Annex 2 - SF6 STRATEGIES](#)
- 173 Ofgem (2024), [ED3 Framework Consultation](#)
- 174 EUR-Lex (2024), [Regulation \(EU\) 2024/573 of the European Parliament and of the Council of 7 February 2024 on fluorinated greenhouse gases, amending Directive \(EU\) 2019/1937 and repealing Regulation \(EU\) No 517/2014 \(Text with EEA relevance\)](#)
- 175 Baringa (2024), [UK renewables deployment supply chain readiness study - Executive summary for industry and policymakers](#); National Grid (2020), [Building the Net Zero Energy Workforce](#)
- 176 Commission analysis of distribution network operators' workforce strategies for the current price control
- 177 National Grid (2020), [Building the Net Zero Energy Workforce](#)
- 178 SP Energy Networks' call for evidence response. National Infrastructure Commission (2025), [Electricity distribution networks study: responses to the call for evidence](#)
- 179 Department for Energy Security and Net Zero (2023), [Accelerating electricity transmission network deployment: Electricity Networks Commissioner's recommendations.](#)

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