



Environment Report 2019/20

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1 Introduction

1.1 Executive Summary

We are pleased to present UK Power Networks' Environment Report for the regulatory year 2019/20. This document fulfils an annual requirement under standard condition 47 (Environment Reporting) of the Electricity Distribution Licence and has been prepared on behalf of our three licensed distribution companies: Eastern Power Networks plc (EPN), London Power Networks plc (LPN), and South Eastern Power Networks plc (SPN). It updates stakeholders on our performance across the key environmental measures we work to and our efforts to deliver environmental benefits for our customers and the wider communities in the regions we serve.

As a network operator, we recognise that our activities can have a significant impact on the surrounding area. Protecting the environment is central to our corporate vision, which includes our aim to be the most socially and environmentally responsible DNO (see Figure 1). We work hard to reduce our carbon footprint and to have a positive effect on the environment in which we operate, working closely with communities and their representatives to identify areas where we can play an active, beneficial role.

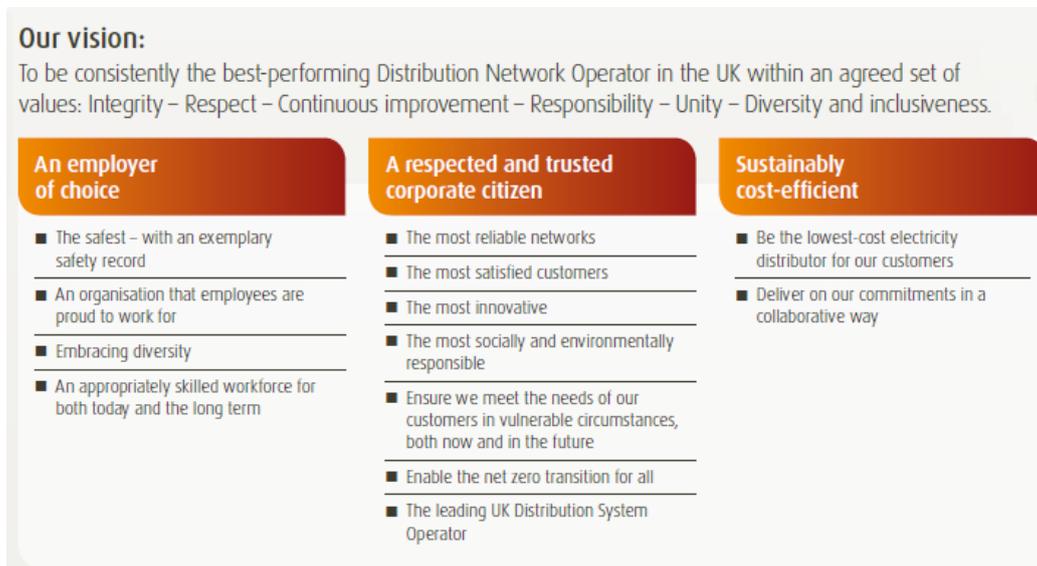


Figure 1: Our vision

The environmental commitments in our [RIIO-ED1 Business Plan](#) remain an important focus area for UK Power Networks; these are listed in section 1.3. Key activities in 2019/20 and future areas of work are described below.

- We continue to work closely with stakeholders to identify schemes that would benefit from the undergrounding of overhead lines to improve visual amenity. In 2019/20 we completed undergrounding schemes at South Walsham Marshes, Beccles Marshes, Burnham Overy and Shingle Street in our EPN licence area. Please see section 2.2 for more information.

- In 2019/20 our three licensees collectively achieved a 32% reduction in oil lost compared to average performance in the DPCR5 period – a significant improvement on our 2018/19 position. During the year, there was a continued focus on improving the prioritisation, response and repair time of cable fluid leaks. In addition, further progress was made on the installation of pressure transducers to actively manage the pressure within cables, as well as further innovative work to develop a self-healing cable fluid additive – although the latter is still very much in the development stage. We remain focused on reducing oil leakage, targeting the poorest performing circuits in our network. Some of our highest-priority projects are currently at the execution stage – for example, the Holloway to King Henry’s Walk replacement scheme in our LPN licence area. Other projects, such as Wimbledon to Wandsworth (LPN), are at the design stage with construction planned for 2021/22. Please see section 2.3 for more information.
- As of 31 March 2020 – five years into the RIIO-ED1 period – we have reduced our business carbon footprint (BCF) by 25.5%. This represents a 6.3% reduction on the previous year’s figure and places us ahead of the target we set ourselves for 2019/20 (2% for each year of the RIIO-ED1 period, as set out in our [RIIO-ED1 Business Plan](#)). In 2019/20 UK Power Networks became the first electricity network operator to achieve the Carbon Trust Standard for Carbon. Achieving this certification is a key step in our Green Action Plan, as we seek to minimise our impact on the environment whilst at the same time helping communities reach the UK government’s target of net-zero emissions by 2050. We were also recognised by the Carbon Trust for having a well-defined responsibility structure in place for carbon management which engages individuals at all levels of the organisation. Please see section 2.4 for more information.
- We achieved our target of emitting less than 0.2% of the total amount of sulphur hexafluoride (SF₆) in service. SF₆ leakage overall in UK Power Networks was 0.1% of the SF₆ in service in 2019/20. During the year, we invested in leak reduction projects such as the refurbishment of circuit breakers at our City Road 132kV and Wimbledon 132kV substations in LPN. We continue to aim to minimise the leakage of SF₆ in order to reduce the impact on the environment. Please see section 2.4.2 for more information.
- We continue to replace existing transformers with Ecodesign specification units that reduce fixed and variable energy losses. In 2019/20 we replaced a total of 1,015 distribution transformers, reducing losses by 3,778.2 MWh per annum. In addition, we replaced 28 primary and grid transformers, further reducing losses by 3,898.4 MWh per annum. We will continue to broaden our understanding of distribution losses, further develop our tools and processes, and embed these into our business-as-usual activities. We will also continue our collaboration with manufacturers and disseminate our findings to other DNOs who may benefit from this activity. Looking ahead, we will consider the impact our developing DSO capabilities are likely to have on technical distribution losses. Please see section 2.4.3 for more information.
- In 2019/20 our programme of work to tackle theft in conveyance led to 374 cases being resolved across our three licence areas. We also continued our work with other distributors and suppliers to promote more effective electricity theft reduction efforts across the industry and provided substantial input to new industry best practice guidelines which were finalised in 2019. UK Power Networks remains an active and engaged member of the industry’s Theft Issues Group and is providing a distributor’s perspective on plans for future theft detection and mitigation activities. Please see section 2.4.3 for more information.

- As part of our Green Action Plan, we set ourselves the challenging target of diverting 90% of office and depot waste from landfill, which was a significant step up from our RIIO-ED1 Business Plan commitment of 70%. In 2019/20 we narrowly missed this target, diverting 88% of waste from landfill for recycling or use in energy recovery. We continue to aim to minimise the amount of waste diverted to landfill. In order to better measure, monitor and understand our waste footprint and impact, we are working with the Carbon Trust towards achieving accreditation for waste reduction. Please see sections 2.5.9 and 2.5.10 for more information.
- A programme of engagement and environmental awareness training has continued throughout the year with our suppliers, staff and contractors to improve understanding of our requirements and ensure internal buy in for our Green Action Plan objectives. These activities have ranged from training and site visits through to contractor/supplier forums. Please see section 2.5.11 for more information.
- In 2019/20 we partnered with a UK charity, Trees for Cities, on an initiative to mitigate air pollution, improve the urban environment and biodiversity opportunities. As part of this initiative we funded the planting of 2,669 trees as a notional air pollution offset to help mitigate the existing impact of our nitrogen oxide (NOx) emissions. This will in time help to reduce air pollution, sequester carbon, provide biodiversity opportunities, improve visual amenity value and help tackle the urban 'heat island' effect. We will review this project for consideration in our long-term environmental and community planning. Please see section 2.5.17 for more information.
- In 2019/20 we continued to invest in the flood protection programme to ensure that customer supplies are protected from flood risk and to achieve our commitment of protecting 78 substations from the impact of flooding during the RIIO-ED1 period. During the year, we successfully flood-protected nine substations serving in excess of 170,000 customers, bringing the total number of mitigations so far in RIIO-ED1 to 49. We recognise that, in addition to protecting customer supplies and our own assets, we have a responsibility to neighbouring communities to be an active participant in local flooding forums and proposed projects to protect property and businesses. In 2019/20 UK Power Networks was an active and willing participant in a number of public meetings, forums and consultations, including proposals in Cambridgeshire, Yalding and Byfleet. Please see section 2.5.1 for more information.
- We are committed to being a facilitator of the low carbon transition. Our comprehensive innovation strategy informed by stakeholders, our DSO and flexibility roadmaps and our electric vehicle (EV) readiness programme are examples of how our business activities are guided by our strategic focus to provide a secure, reliable and ultimately net-zero carbon system that addresses our customers' evolving needs. Within our overall innovation portfolio, we are working extensively on facilitating the net zero transition by supporting decarbonisation in strategic areas. In 2019/20 we published both an Electric Vehicle Strategy and a Heat Strategy; the latter was the first to be created by a DNO. We also developed an annual publication of Distribution Future Energy Scenarios (DFES), following our commitment to share our baseline and outlook for both electricity demand and LCT uptake with stakeholders. In October 2019 we were delighted to receive Edison Electric Institute's (EEI) International Edison Award in recognition of our work in smart grid development and for enabling Great Britain's low carbon transition. Please see section 3 for more information.
- Smart meters will help to provide greater visibility of changes on the network that can support cost-efficient investment decision making. Our Smart Meter Benefits Realisation Strategy reflects our ambition to make effective use of smart meter data both in the current RIIO-ED1 period and looking ahead to our RIIO-ED2 business plan. In 2019/20 we developed our Smart Meter Data Privacy Plan (DPP) which was completed in consultation with the ENA, BEIS, Ofgem, the Information Commissioner's Office and Citizens Advice. Ofgem approved this plan in February 2020. In 2021/22 we will develop our smart metering system to meet the requirements of the DPP for managing energy usage data, delivering benefits to our customers and business. Please see section 3.3.2 for more information.

We very much hope that our stakeholders will find this report of interest and look forward to providing an update on UK Power Networks' performance in 2020/21.

1.2 Our business/who we are

At UK Power Networks we manage the distribution of electricity from the National Grid and locally connected generation to 8.3 million homes and businesses via our networks in London, the east and south east of England. Our licensed companies EPN, LPN and SPN are responsible for operating and maintaining these networks, ensuring we provide safe, reliable and efficient electricity supplies to existing customers and timely, cost-effective connections to new ones. We are purely a network operator. We do not generate or buy electricity, nor do we sell it to customers.

Our operating area (see Figure 2) covers more than 29,250km² and includes most of London as well as large areas of rural and agricultural land and over 500 miles of coastline around the south east of England. It has many environmental landscape features that are of great importance – Areas of Outstanding Natural Beauty (AONB), National Parks, Sites of Special Scientific Interest, unique waterways such as The Norfolk Broads, and Central London which is rich in archaeological significance.

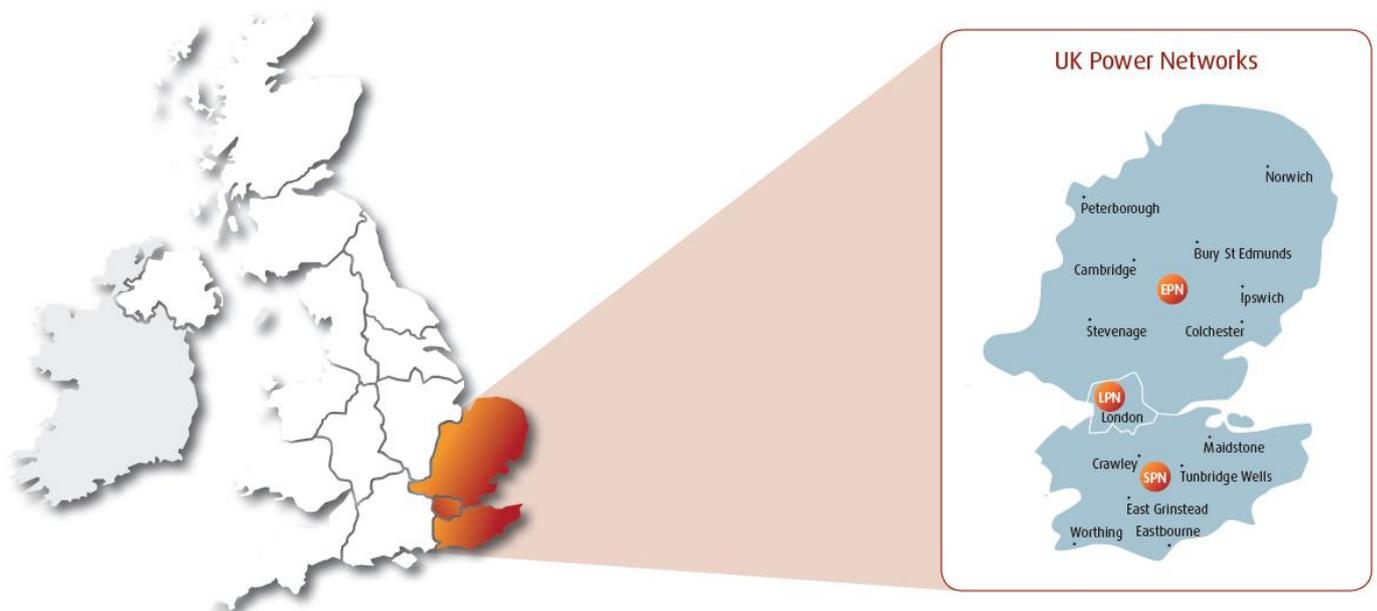


Figure 2: Our operating area

As a provider of an essential service we occupy a privileged position in society and also have an important role to play in safeguarding the environment in which we operate. We must consider the design and construction of our infrastructure, the use of oil and other insulation products on our network and the factors which contribute to our BCF, from the energy used to light and heat our offices and depots to the vehicles we use. When installing new equipment on our network we ensure that we consult with relevant statutory authorities and other appropriate bodies at the earliest possible opportunity. Every effort is made to identify potential environmental impacts at the earliest planning and design stage of projects and to mitigate any harm.

Our greatest contribution to protecting the environment lies in how we facilitate our customers' journey towards a decarbonised world and develop our future DSO capabilities to deliver a secure, reliable low carbon energy system that addresses their evolving needs. To learn more about our plans for low carbon readiness, including our smart grid and innovation portfolios, please see section 3.

1.3 Purpose of the report

This report presents our activities in relation to environmental matters during the 2019/20 regulatory year. It includes information on the following topics:

- Improving visual amenity
- Reducing oil leakage from our assets
- Managing and reducing our BCF
- Minimising SF₆ emissions from our assets
- Reducing technical and non-technical distribution losses from our network
- Protecting our substations from flood risk
- Our Green Action Plan
- Promoting biodiversity
- Reducing noise pollution from our assets
- Managing and preventing waste
- Increasing environmental and ecological awareness
- Using innovative solutions to minimise the impact of our activities on the environment and enable the low carbon transition
- Exploring and realising the benefits of smart metering

Where applicable, we present progress against the environmental targets in our [RIIO-ED1 Business Plan](#). These are:

- Underground the equivalent of 80km of HV overhead line in SPN and 96km of HV overhead line in EPN in AONB and National Parks
- Reduce cable fluid leakage of 207,000 litres by 2% per annum
- Reduce our BCF by 2% per annum
- Maintain SF₆ leakage at less than 0.2% as a proportion of SF₆ in service
- Continue to recycle 70% of office and depot waste and 98% of street works spoil
- Investigate all noise issues and address all non-compliant sites
- Protect 78 substation sites from the risk of flooding
- Innovation expenditure of 0.5% of allowed revenues and win largest market share of the NIC competition

2 Managing Our Environmental Impact

2.1 Introduction

We recognise that we have an important role to play in safeguarding the environment in which we operate, and we have robust policies and procedures in place to ensure we comply with all relevant environmental legislation and industry codes of practice. The Electricity Act specifically requires us to consider natural beauty, flora, fauna and geological or physiographical features of special interest, and sites, buildings and objects of architectural, historic or archaeological interest, and do what we reasonably can to mitigate any effects. All other environmental legislation is assessed for relevance to our activities as a DNO. Relevant activities include environmental permitting, pollution prevention, waste management and the preservation of historic and natural habitats.

Where practicable and achievable, we seek to surpass the basic level of environmental compliance and work to enhance our positive impacts on the environment, whether that be improving biodiversity opportunities at suitable locations, minimising waste and maximising recycling, or working with our supply chain to improve our environmental performance. To support this, we launched our Green Action Plan which delivers initiatives focusing on energy use, carbon reduction, waste, water, biodiversity and pollution and sought input from our external stakeholders. In addition, we are working on our network to facilitate the societal transition to net zero to ensure that we can accommodate EVs, low carbon heat and distributed energy while at the same time developing plans to reduce our own operational carbon footprint.

We have Environment Agency permits to operate three waste transfer stations and seven waste oil storage facilities. Electrical insulating oil removed during routine maintenance is reprocessed and reused, thereby reducing demand for new oil to be extracted. Through training and monitoring, high levels of compliance with our environmental permits are maintained.

When working in protected habitats such as Sites of Special Scientific Interest or where protected species may be impacted, we consult with Natural England and, where appropriate, apply for relevant licences. Suitably qualified ecologists are engaged to help us with these activities. We also consult English Heritage if our work might have an impact on scheduled monuments or other protected historic sites.

Environmental governance is provided by our Health, Safety and Environment Committee, which is chaired by our CEO. This is cascaded through the organisation via local and business Health, Safety and Environment Committees. Our Environmental Management System meets the ISO 14001:2015 standard requirements and is subject to external verification and audit by DNV-GL. This system is implemented by relevant business leads and appropriate managers within our organisation who are responsible for identifying and mitigating their respective environmental risks, with guidance and assurance from our Environment team.

We consult with stakeholders, including statutory authorities and other appropriate bodies, to help mitigate the impact of our operations on the environment. At a local level, we seek to build good relationships with local authorities and work collaboratively on initiatives to help reduce the impact of issues such as noise pollution and litter, which can be a source of concern for local communities.

We also work with the industry to identify areas of best practice and ensure continuous improvement. Members of our Environment team represent UK Power Networks on the Electricity Networks Association (ENA) Environment Committee, helping to ensure that best practice is implemented from knowledge shared across the electricity and gas sectors.

The following subsections present our 2019/20 performance in relation to visual amenity, oil leakage, our BCF, SF₆ emissions, and technical and non-technical distribution losses.

2.2 Visual amenity

UK Power Networks is a member of a long-established and successful Steering Group that nominates schemes to underground overhead lines within Areas of Outstanding Natural Beauty (AONB) and National Parks (NP) in the EPN and SPN licence areas, observing funding criteria specified by Ofgem. The group consists of landscape experts (representatives of the AONB and NP Boards within UK Power Networks' footprint) acting as stakeholder representatives and is chaired and facilitated by Natural England, who hold the national remit to advise on the management of designated landscapes. The group meets every three months to promote and manage the portfolio of work.

UK Power Networks holds the position of a non-voting member within this group, providing the necessary technical guidance to support scheme assessment. The level of support provided varies from scheme to scheme but will always include the provision of a route for the new cable network, substation position and the estimated cost of carrying out the work.

A majority voting process determines approval of schemes, with the Chair holding the deciding vote in instances where there is a tie. All new schemes proposed by Steering Group members must undergo a two-stage approval process:

- Stage 1: This is an outline of the scheme which includes indicative routes and budget costs for consultation with stakeholders. The scheme budget is ring-fenced.
- Stage 2: This is triggered once stakeholders (landowners) have been consulted, the final cable route/extent of the scheme has been determined and the scheme has been assessed in terms of applicable scoring criteria (see below) and costs.

Projects are assessed against scoring criteria prior to being considered for selection. During this process, factors such as the impact on a landscape's character, the impact on visual amenity and the potential impact of undergrounding on features in the landscape (either its biodiversity or rural heritage) are taken into account. In addition, the proposer will identify whether the scheme is linked to additional local/national government/industry funding being sought to improve accessibility to a region and increase visitor numbers to a protected landscape. To be eligible for selection, a scheme must attain a minimum score of nine points out of a maximum of 48.

Schemes are nominally capped at a cost of £200,000 per kilometre; in some instances, because of technicalities in the delivery of the scheme, the upper limit may be exceeded and the Steering Group retains the discretion to waive this cap. During the Stage 2 process, changes to the cable route or positioning of substations may impact on the overall cost of a scheme and where this cost increases by more than 20% of the initial estimate the proposer must seek the Steering Group's approval to continue. No schemes were withdrawn on this basis in 2019/20.

Approved schemes (those that have completed Stage 2) are referred to UK Power Networks to acquire the necessary consents to deliver the works. During the consenting and delivery phases, we continue to work closely with the scheme's proposer on any material issues that arise, such as the re-routing of a proposed cable or the relocation of a substation.

Table 1 identifies 38 schemes of varying size and complexity that are presently being progressed through the various stages of the consultation process. A number of these schemes involve lines operating at differing voltages. For such schemes, the benefits increase as the removal of only one voltage (line) would further highlight the impact of the remaining line(s) on the landscape. This encourages the Steering Group to identify whole distribution system schemes that focus on locations that have the potential to maximise the visual amenity improvement to the greatest number of visitors to the protected landscape.

Scheme	Protected Landscape	Licence Area
Bayfield	Norfolk Coast	EPN
Ludham Marshes	Broads	EPN
Potter Heigham	Broads	EPN
Shotley North	Suffolk Coast & Heaths	EPN
Shotley South	Suffolk Coast & Heaths	EPN
Blyth	Suffolk Coast & Heaths	EPN
Stoke by Nayland	Dedham Vale	EPN
Felixstowe	Suffolk Coast & Heaths	EPN
Blakeney/Morston	Norfolk Coast	EPN
Dunstable Downs	Chilterns	EPN
Latimer	Chilterns	EPN
Orford	Suffolk Coast & Heaths	EPN
Elham Valley	Kent Downs	SPN
Bedgebury Pinetum	High Weald	SPN
Chilham	Kent Downs	SPN
Firle Beacon	South Downs	SPN
Hurtwood	Surrey Hills	SPN
Preston Hill	Kent Downs	SPN
Malling Hill	South Downs	SPN
Raikes Farm	Surrey Hills	SPN
Abinger Hammer Phase 2	Surrey Hills	SPN
A27 Corridor	South Downs	SPN
Moat Farm	High Weald	SPN
Newenden	High Weald	SPN
Birling Phase 2	Kent Downs	SPN
Adur Valley Phase 2	South Downs	SPN
Deans Farm	South Downs	SPN
Olantigh Park	Kent Downs	SPN
Lees Court	Kent Downs	SPN
Swanborough	South Downs	SPN
Littlington South	South Downs	SPN
Royal Military Canal	Kent Downs	SPN
Telscombe	South Downs	SPN
Sheffield Park	High Weald	SPN
Winterfold	Surrey Hills	SPN
Littlington North	South Downs	SPN
Bodsham	Kent Downs	SPN
Swingfield	Kent Downs	SPN

Table 1: Underground schemes in progress in UK Power Networks' operating area

Charge Restriction Condition (CRC) 3J of the Distribution Licence allows DNOs to spend up to 10% of their allocated expenditure on undergrounding lines which extend beyond the boundaries of Designated Areas. Within these requirements we continue to work with Steering Group members to develop two such schemes in our SPN licence area: Sheffield Park and Royal Military Canal.

Achievements in the 2019/20 regulatory year are shown in the E1 – Visual Amenity worksheets (please see the Annexes and Appendices). Undergrounding schemes were completed at South Walsham Marshes, Beccles Marshes, Burnham Overy and Shingle Street in EPN.

2.3 Oil leakage

Fluid filled cables (FFCs) account for 35% of all cables running at 33kV, 66kV and 132kV in our three licence areas by length. Leaks from FFCs occur for various reasons, including the failure of ancillary oil equipment (e.g. pipe work, monitoring gauges and oil tanks), cable joint failure, cable damage due to third party excavations and incorrect installations.

In our [RIIO-ED1 Business Plan](#) we committed to reduce oil leakage from FFCs by 2% per annum for the duration of the RIIO-ED1 price control period. This section provides information about our strategy for reducing oil leakage from FFCs, a summary of 2019/20 performance and details of the work we have undertaken both independently and with key stakeholders.

Key reasons to reduce cable fluid loss include:

- Complying with environmental legislation where the operating code states that the DNO “will take all reasonably practicable steps to prevent pollution of controlled waters, taking advice from the EA as required”
- Ensuring a continuous supply to customers by reducing instances of power loss caused by leaking cables
- Ensuring the network operates as efficiently as possible by reducing the cost to customers of cleaning up oil leakages

Our strategy is to reduce cable fluid loss by investing in the network to refurbish and replace poor condition circuits. Where circuits develop new leaks we ensure we are at the forefront of new technology and best practice to identify and repair damage as swiftly as possible. For the last few years we have used perfluorocarbon tracer (PFT) for leak location. This technology is based upon introducing a controlled volume of chemical tracer (PFT) which is mixed into pumped cable fluid. Once it has reached the point of the leak, this ‘tagged’ fluid becomes detectable in the atmosphere or through bore-hole sampling using either a static detector or a vehicle-mounted vapour analyser.

Where leaks occur we have thorough procedures in place to manage, report and address them, to minimise the amount of fluid lost and its associated environmental impact.

2.3.1 2019/20 performance

Cable fluid loss is measured by the total amount of fluid used to top up cables less any fluid recovered. A summary of 2019/20 cable fluid loss is provided in Table 2 below. The 2019/20 values have been extracted from the E2 – Environmental Reporting worksheets for each of our licensees and should be read in conjunction with the notes below. For more information, please see the Annexes and Appendices.

Licensee	Average annual cable fluid losses – DPCR5 ¹	Cable fluid losses – 2019/20 ²	Difference (volume)	Difference (%)
EPN	54,239 litres	48,056 litres	-6,183	-11%
LPN	126,623 litres	62,816 litres	-63,807	-50%
SPN	54,298 litres	48,049 litres	-6,249	-12%
Total	235,160 litres	158,921 litres	-76,239	-32%

Table 2: Comparison of cable fluid lost in 2019/20 to historical performance in DPCR5

Based on our commitment to reduce cable fluid losses by 2% year on year in RIIO-ED1, our 2019/20 target was 187,112 litres. During the year, a total of 158,921 litres of oil were lost in our three licence areas and hence the target was achieved. This represents a 32% reduction compared to average performance in the DPCR5 period and is a significant improvement on our 2018/19 position.

During the year, there was a continued focus on improving the prioritisation, response and repair time of cable fluid leaks. In addition, further progress was made on the installation of pressure transducers to actively manage the pressure within cables, as well as further innovative work to develop a self-healing cable fluid additive – although the latter is still very much in the development stage.

The data in Table 2 demonstrates our commitment to reduce cable fluid losses. We are working to ensure that going forward, cable fluid losses reduce in line with the commitment made in our [RIIO-ED1 Business Plan](#). During 2019/20, the projects described in that document were reviewed in order to prioritise where circuit performance was known to be poorest. The highest-priority projects have been authorised internally, at both a senior and executive management level. Some are currently at the execution stage – for example, the Holloway to King Henry’s Walk replacement scheme in our LPN licence area. Other projects, such as Wimbledon to Wandsworth (LPN), are at the design stage with construction planned for 2021/22. We will continue to look for new ways to improve our performance and over-deliver against our targets.

2.3.2 Initiation of Network Innovation Allowance (NIA) projects

In our previous Environment Reports we have provided updates on particular innovation projects which if successful will directly contribute to a reduction in cable fluid loss. An update for the 2019/20 regulatory year is provided below.

- **Self-Healing Cables (registered for NIA as ‘Development of Oil-Filled Cable Additive – Phase 2’)**

UK Power Networks is leading this project in collaboration with Northern Powergrid to identify new additives to cable fluid that would seal leaks where they occur without the need for leak location and excavation. The second and final phase of the project is registered under the NIA project NIA-UKPN0030.

The project has resulted in several significant developments, both in regard to the self-healing cables themselves, the testing methods and facilities required for the technology to move to both FFC and network demonstration. Building on this initial success, a programme has been developed to investigate whether it is possible to move the technology to the next readiness level, i.e. closer to commercialisation.

Circuit trials have been carried out at Rayleigh Grid in our EPN licence area on a decommissioned circuit and designed to ensure the performance of the self-healing fluid as a

¹ The data in this column represents the average amount of cable fluid lost and not recovered in each year of DPCR5, the price control period from April 2010 to March 2015.

² Cable fluid losses are measured by the total fluid used to top up cables less the total fluid recovered for all three of UK Power Networks’ licence areas.

cable dielectric. The work carried out has demonstrated that the self-healing fluid is capable of reducing, or in some cases eliminating leaks. Despite this success, there are risks to the usage of such an additive. The most notable is to ensure there is no possibility of the additive (which activates in air) causing a blockage in the oil lines. Should this occur, the cable would be beyond repair and would require complete replacement.

Further work will take place during the RIIO-ED2 period when an appropriate circuit is available for further testing, and if successful, could lead to wider deployment.

- **Pressurised Cable Active Control & Monitoring**

This project reviewed the operating systems for FFCs so that cables can be operated at lower pressures to reduce leakage without the risk of customer interruptions, extending their operational life. The project is registered under the NIA project NIA-UKPN-0012. It started in September 2015 and concluded in 2019.

The project developed and trialed a new device, an Active Pressurised Control Unit (APCU), to avoid fluid leakages from cables. An APCU is operated by a variable speed pump and pressure valve to create a pressure differential across the unit, and sensors on either side of the unit to control the flow of oil into and out of the APCU. This allows the pressure of oil inside the cable to be maintained at a constant value, which is expected to avoid cable degradation versus simply operating them within their designed pressure.

Testing and implementation of five units onto live network circuits was successfully completed in 2018/19 and the APCU is operating exactly as required. The five units on the network are currently operating well and are maintaining a constant cable pressure. Sufficient data has been gathered/observed under various weather and load conditions on the network.

Having carried out significant development to date, we are assured that the APCU operates as required. The project is successful, with further work carried out to develop and procure additional units to install in our network in 2020/21. We anticipate that it provides benefits from reduced cable fluid loss from this year onwards (as indicated in our E6 submission).

The learning from these projects will be shared with other DNOs so that areas of best practice can be identified to support others in meeting similar commitments.

As the above projects are funded through work streams which require project specific reporting in the RIGs (e.g. the NIA), they are not recorded under costs or volumes within the E2 – Environmental Reporting worksheets. It is therefore not possible to compare or analyse the costs and volumes included with this worksheet.

2.3.3 Stakeholder engagement

It is imperative that the environmental impacts of cable fluid loss are managed effectively, and we have a partnership agreement with the Environment Agency outlining how we should report, notify and manage cable leaks across the network. We also work with key stakeholders to share best practice and target the poorest performing circuits in our network. In 2019/20 this included:

- Ongoing engagement with the Environment Agency at six-monthly meetings of the ENA Fluid Filled Cable Liaison Group where performance is reviewed and best practice is shared with the other DNOs
- Regular updates to the Environment Agency on the mitigation in place on specific projects and on the progress of capital replacement and refurbishment of FFCs more generally
- Enduring consultation/knowledge sharing with other DNOs, on a six-monthly basis or as required. These meetings focused on the delivery of specific projects where there were opportunities to share learning. At the ENA SHE Conference 2019 (23 May 2019) and the Smart Grid Asset Management Conference 2019 (16 May 2019), UK Power Networks demonstrated the use of new innovative technology to reduce fluid loss from cables
- Network trials and workshops to demonstrate the new technology being developed by the Self-Healing Cables and Pressurised Cable Active Control & Monitoring projects

- Discussions about individual poor performing circuits with local stakeholders including the Canal and River Trust and local authorities (as required), enabling UK Power Networks to hear and take account of stakeholders' views

2.4 Carbon impact and climate change

2.4.1 Our business carbon footprint

This section describes our business carbon footprint (BCF) reporting process, the various elements of our BCF including how these are measured, and how we track our carbon emissions throughout the year.

In our [RIIO-ED1 Business Plan](#) we set ourselves an overall target to reduce our BCF by 2% for each year of the RIIO-ED1 price control period. This amounted to a 16% total reduction against our baseline year of 2014/15 by 2022/23. As of 31 March 2020, we are pleased to report a reduction of 25.5% (see Figure 3) – significantly ahead of this target. This also represents a 6.3% reduction on the previous year's figure.

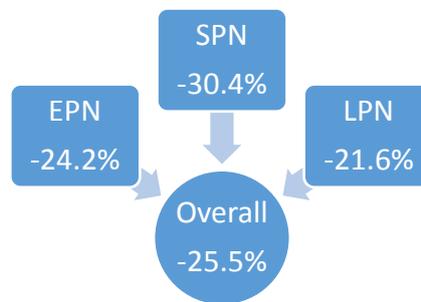


Figure 3: 2019/20 BCF reduction by DNO

Work with the Carbon Trust

The Greenhouse Gas (GHG) Protocol categorises direct and indirect emissions into three broad 'scopes'. These apply to UK Power Networks as follows:

- Scope 1: Direct GHG emissions from sources owned or controlled by UK Power Networks
- Scope 2: Indirect GHG emissions from the consumption of purchased electricity, heat or steam
- Scope 3: Other indirect emissions such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by UK Power Networks and electricity-related activities (e.g. transmission and distribution losses) not covered in Scope 2 (e.g. outsourced activities)

We are constantly looking for ways to reduce our BCF and have been working with the Carbon Trust to develop challenging science based targets (SBTs). The initial outline work for Scope 1 and 2 emissions with and without network losses was completed in the first quarter of 2020. This showed that our existing plans mean that UK Power Networks could meet a global warming well below 2 degrees Celsius (WB2D) scenario both with and without network losses. Scientific consensus states that keeping global warming to below 1.5 degrees Celsius, rather than the 2 degrees Celsius agreed at the Paris Climate Change Summit, would have a major impact in terms of limiting economic, social and environmental impacts. Further work is in progress to develop clear plans outlining how this more challenging trajectory could be developed for at least those emissions directly under our control.

UK Power Networks is also working to fully understand its Scope 3 emissions in order to acquire third-party accreditation of its SBTs and develop a net-zero whole-system plan in line with the RIIO-ED2 requirements. A materiality assessment with the Carbon Trust of our Scope 3 emissions is in progress.

In 2019/20 UK Power Networks became the first electricity network operator to achieve the Carbon Trust Standard for Carbon. Achieving this certification is a key step in our Green Action Plan, as we

seek to minimise our impact on the environment whilst at the same time helping communities reach the UK government's target of net-zero emissions by 2050. We were also recognised by the Carbon Trust for having a well-defined responsibility structure in place for carbon management which engages individuals at all levels of the organisation.

The Carbon Trust Standard for Carbon is the world's leading independent certification of an organisation's achievements in managing and reducing its greenhouse gas emissions and recognising organisations that achieve year-on-year reductions. We were certified for having an absolute reduction of 6.6% in carbon emissions including losses between 2016/17 and 2018/19³.

Methodology

The processes described in this section are used to calculate the BCF for EPN, LPN and SPN. Where data is collected centrally, this is apportioned between the three DNOs based on headcount as of 31 March 2020. If we apportioned based on geographical area, as opposed to headcount, LPN would only be allocated 2% of the shared footprint, which would result in an unrealistically small value.

Our results for the 2019/20 regulatory year are shown in our E3 – Business Carbon Footprint worksheets (please see the Annexes and Appendices). In all calculations of our BCF we have used the [government-issued carbon conversion factors](#) published on 4 June 2019 and last updated on 18 November 2019.

2.4.1.1. Our BCF reporting process

Distribution losses account for almost 96% of our total BCF and are the focus of a separate strategy (please see section 2.4.3). Focusing on our BCF without losses highlights the potential for sustainability improvements in other areas. Excluding distribution losses, in 2019/20 the largest elements of our BCF were operational transport (45%) and building and substation energy usage (27%), followed by temporary generation (15%), business travel (8%) and fugitive (SF₆) emissions (5%). We also include contractor fuel used directly on UK Power Networks projects in operational transport, contractor fuel used in plant and equipment in temporary generation, and contractor travel claims in business travel. These elements are illustrated in Figure 4.

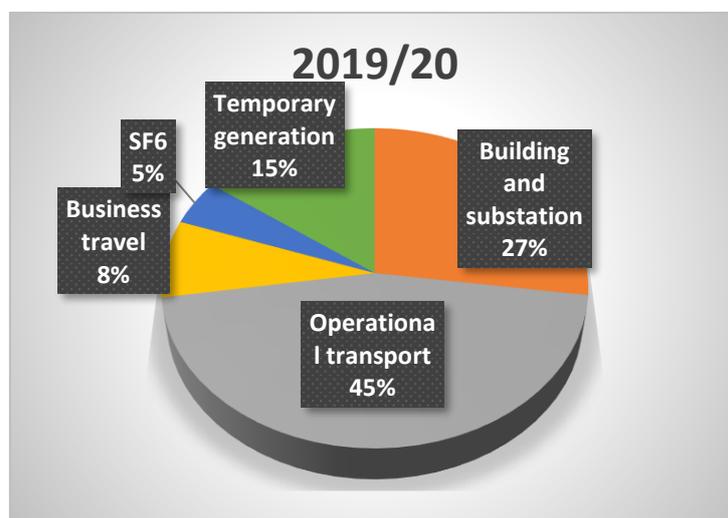


Figure 4: 2019/20 BCF breakdown excluding distribution losses

³ The Carbon Trust Standard includes network losses and measures absolute contraction, i.e. using the same carbon factor for each year of the three-year period. Figures elsewhere refer to our carbon footprint without losses and are calculated using the government's annual carbon factor for the relevant year. In recent years the carbon factor for electricity has dropped rapidly as the grid decarbonises, with an ever increasing proportion of generation coming from renewables replacing fossil fuels.

Table 3 shows our overall BCF excluding distribution losses for the regulatory years 2014/15 (our baseline measurement year as set by Ofgem) and 2019/20. Details of the individual components of our BCF excluding losses are also reported below.

Licensee	2014/15 (tCO ₂ e)	2019/20 (tCO ₂ e)	% change
EPN	32,539.49	24,657.51	-24.2%
LPN	19,776.50	15,512.51	-21.6%
SPN	25,025.12	17,413.54	-30.4%
Total	77,341.11	57,583.56	-25.5%

Table 3: Our 2014/15 and 2019/20 BCF excluding distribution losses

To check progress against our RIIO-ED1 target we prepare monthly BCF reports, at a company-wide as opposed to an individual DNO level, using data received from internal and external sources. Any anomalies in the data are closely examined and corrective actions implemented where necessary.

Monthly reports are received from various sources within UK Power Networks. These cover:

- Electricity and gas meter readings
- Fleet fuel usage
- Business mileage and transport expense claims
- Generator fuel usage
- SF₆ top-ups
- Headcount

We also receive monthly reports of modes of transport booked via our external travel provider and require our contractors to report on any work that is subcontracted or accumulated as a direct result of works undertaken on our behalf.

Our BCF reporting process takes into account carbon emissions from operational contractors who are involved in developing and operating our electricity networks and who have a significant spend threshold per annum (£250,000 or above). In this report, the values representing UK Power Networks' and contractors' emissions are shown both separately and as a combined figure.

For elements such as the purchase of fuel for temporary generation, SF₆ top-ups, substation energy use and some of our building energy, data is apportioned directly to each of our three DNOs wherever possible. The use of common systems in all three of our licence areas means that some data is captured centrally. Where this is the case we apportion the data between the DNOs on a headcount basis.

Achieving the Carbon Trust Standard for Carbon in 2019 represents highly regarded external accreditation of both the methodology that we use and our carbon reductions. Aspects have also been examined by the external auditors DNV-GL as part of UK Power Networks' ISO 14001 accreditation.

2.4.1.2. The individual elements of our BCF

There has been a shift in the relative proportions of the elements of our BCF since 2014/15, with the most significant change being the proportional decrease of 19% (from 46% to 27%) in building and substation energy usage. A contributing factor is the alteration in the fuel mix making up the UK's electricity supply. The closure of coal fired power stations and increasing amounts of renewable energy connected to the UK electricity network have led to a marked decrease in the carbon factor for UK electricity.

Our challenge going forward is that 60% of our BCF (operational transport and temporary generation) is based on diesel. The carbon intensity of diesel is unlikely to decrease so ultimately a switch to an alternative fuel source for our operational fleet will be required. Currently there is not an electric alternative with sufficient range and weight carrying capacity for the large vans which make up the majority of our operational fleet. However, there are a number of car derived vans which are suitable to replace smaller vans.

Operational transport

This element of our BCF represents the fuel used by our fleet of vans, trucks and specialist vehicles which work directly on our electricity networks. We also report on the fuel used by our contractors' operational vehicles when working on our behalf. Fuel purchased for UK Power Networks' fleet vehicles is captured using fuel cards. Contractor transport data is obtained from contractor fuel cards submitted via a manual reporting process. In 2019/20, 99.52% of fuel purchased was diesel, hence the diesel factor has been used for conversion purposes. A small quantity of diesel for temporary generation is also purchased using fuel cards, but this is recorded separately and is reported later in this section as part of our temporary generation carbon footprint.

Table 4 shows the levels of tCO₂e emitted by UK Power Networks' operational fleet and contractors when working on our networks. As previously mentioned, we apportion fuel usage on a headcount basis, as we believe this is a more accurate method than geographical apportionment, which is based on square kilometres.

Overall, operational transport emissions have reduced from 30,948.23 tCO₂e in 2014/15 to 26,142.34 tCO₂e in 2019/20. This represents a 15.5% decrease and is due to the modernisation of our operational fleet and the roll-out of more sophisticated communications technology enabling staff to access cable plans and other documents in the field.

Licensee	Direct operational staff	% of staff	2014/15 – total (tCO ₂ e)	2019/20 – our fleet (tCO ₂ e)	2019/20 – contractor (tCO ₂ e)	2019/20 – combined (tCO ₂ e)	% change
EPN	1,206	43.7%	11,450.84	7,279.40	4,148.79	11,428.19	-0.2%
LPN	759	28.8%	9,284.47	4,797.93	2,734.51	7,532.43	-18.9%
SPN	758	27.5%	10,212.92	4,574.53	2,607.19	7,181.72	-29.7%
Total	2,723	100%	30,948.23	16,651.86	9,490.48	26,142.34	-15.5%

Table 4: Levels of tCO₂e emitted by our operational fleet and contractors working on our networks

Building and substation energy usage

We collate data on building and substation energy usage from the electricity and gas bills received for each of our sites. Gas and electricity usage is billed in kWh then converted into tCO₂e using the appropriate carbon factors. In most cases, geographical location determines the apportionment of energy usage per licensee. For shared buildings, apportionment is determined by overall UK Power Networks headcount. Table 5 shows the levels of tCO₂e emitted from our offices, depots and substations.

Licensee	2014/15 – total (tCO ₂ e)	2019/20 – total (tCO ₂ e)	% change
EPN	13,574.67	7,092.88	-47.7%
LPN	6,942.63	4,962.46	-28.5%
SPN	6,648.78	3,597.03	-45.9%
Total	27,166.08	15,652.37	-42.4%

Table 5: Electricity usage at our sites

Temporary generation

This element of our BCF covers emissions from plant and equipment, such as temporary generators used during fault repairs and planned work on our networks. Data for such emissions is captured from three different sources:

1. External contractors reporting the monthly fuel usage of standby diesel generators – invoices for diesel fuel are used to collate the monthly fuel usage by licence area
2. Fuel cards capturing the amount of fuel used by company owned plant and equipment
3. Invoices submitted by the tanker company that fills the bowsers at several of the sites used to fuel our own generators

As the source data is captured by region, no headcount conversion needs to be applied.

Table 6 shows the levels of tCO₂e emitted from temporary generators and plant and equipment used on our networks. We utilise temporary generation to minimise the time customers are off supply. Stormy weather can add significantly to this element of our BCF as we restore customers' power supplies as quickly as possible, often using temporary generation whilst repairing storm damage. The LPN network is least affected by bad weather as it is almost entirely underground.

Licensee	2014/15 – total (tCO ₂ e)	2019/20 – UK Power Networks (tCO ₂ e)	2019/20 – contractor (tCO ₂ e)	2019/20 – combined (tCO ₂ e)	% change
EPN	4,321.55	2,645.12	241.05	2,886.16	-33.2%
LPN	1,717.71	693.87	158.88	852.74	-50.4%
SPN	6,328.58	4,750.85	151.48	4,902.33	-22.5%
Total	12,367.84	8,089.83	551.40	8,641.23	-30.1%

Table 6: tCO₂e emitted from temporary generators and plant and equipment used on our networks

Business transport

This element is concerned primarily with employees' business mileage and public transport (attending meetings etc.), which constitute indirect operational emissions.

We obtain data from the following sources:

- Our financial management system, which enables us to determine business mileage and travel claimed through staff expenses
- Our external travel provider
- Corporate credit cards
- Fuel cards

Business travel data is recorded by mode of transport used (e.g. air, rail and road). Total business mileage is apportioned based on the number of indirect staff employed in each region. EPN's headcount has increased from 37% in 2014/15 to 40% this year; the other two DNOs' headcounts decreased proportionally. This change in apportionment is why EPN is showing an increase while the others show decreases. Business kilometres are based on actual kilometres claimed. Fuel card usage is based on actual litres used.

For vehicles that are owned by UK Power Networks or purchased through our self-purchase company car scheme, we use the actual CO₂ rating to calculate each vehicle's contribution to our BCF and this provides us with more accurate data. Where employees claim business mileage for privately owned vehicles, the government's average vehicle unknown fuel conversion factor is used.

An increasing number of our employees are issued with fuel cards and this provides a more accurate measure from a BCF perspective. Fuel data can be captured in terms of the quantity of fuel used, eliminating the wide variations between cars and drivers in actual carbon used per kilometre. Private mileage for those using fuel cards is declared and removed.

We encourage our staff to use teleconferencing facilities, such as Skype for Business and Microsoft Teams, as an alternative to business travel.

Table 7 shows the levels of tCO₂e emitted by our staff and contractors when traveling on company business

Licensee	Indirect staff	% of staff	2014/15 – total (tCO ₂ e)	2019/20 – UK Power Networks (tCO ₂ e)	2019/20 – contractor (tCO ₂ e)	2019/20 – combined (tCO ₂ e)	% change
EPN	1,270	40%	1,651.60	1,908.96	53.80	1,962.75	+18.8%
LPN	944	29.8%	1,339.13	1,106.15	35.46	1,141.61	-14.7%
SPN	958	30.2%	1,473.05	1,360.08	33.81	1,393.89	-5.4%
Total	3,172	100%	4,463.78	4,375.19	123.06	4,498.25	+0.8%

Table 7: Business mileage summary showing the levels of tCO₂e emitted by our staff and contractors when travelling on company business

Fugitive emissions

SF₆ is a greenhouse gas which is used as an insulation medium. It can have a significant impact on the environment, being 22,800 times more harmful to global warming than CO₂.

From a BCF perspective, we measure and record the quantities of SF₆ lost as fugitive emissions. Table 8 shows the levels of SF₆ emissions reported by our three licensees in 2014/15 and 2019/20. During the year, there was a large leak at the West Ham SuperGrid site in LPN; please see section 2.4.2.

Licensee	2014/15 – total (tCO ₂ e)	2019/20 – total (tCO ₂ e)	% change
EPN	1,540.83	1,287.52	-16.4%
LPN	492.56	1,023.26	+107.7%
SPN	361.80	338.58	-6.4%
Total	2,395.19	2,649.36	+10.6%

Table 8: Levels of tCO₂e emitted from leakage of SF₆ from switchgear

We actively monitor our assets and have procedures in place to minimise the escape of SF₆ to the environment. For more detailed information about these procedures and our annual performance, please see section 2.4.2.

Distribution losses

These calculations measure units exiting our distribution network compared to units entering from Grid Supply Points and other sources. Our results for the 2019/20 regulatory year are shown in our E4 – Losses Snapshot worksheets (please see the Annexes and Appendices). Overall losses performance is presented in Table 9 and Table 10 below. The figures were correct at the time of submitting our E4 figures (31 July 2020), but may be subject to further updates given the standard reconciliation cycle in the settlements process.

Licensee	2014/15 – total (tCO ₂ e)	2019/20 – total (tCO ₂ e)	% change
EPN	1,178,315.84	448,578.00	-61.9%
LPN	913,866.74	495,864.00	-45.7%
SPN	663,791.18	380,844.00	-42.6%
Total	2,755,973.76	1,325,286.00	-51.9%

Table 9: Levels of tCO₂e emitted from direct losses as electricity travels through our networks

Licensee	2014/15 (tCO ₂ e)	2019/20 (tCO ₂ e)	% change
EPN	1,210,855.33	473,235.51	-60.9%
LPN	933,663.24	511,376.51	-45.2%
SPN	688,816.30	398,257.54	-42.2%
Total	2,833,334.87	1,382,869.56	-51.2%

Table 10: Our overall BCF including distribution losses in tCO₂e

Distribution losses are covered in detail in section 2.4.3 of this report.

2.4.2 Sulphur hexafluoride (SF₆) emissions

Reducing SF₆ leakage from our network assets is key to our vision of being a Respected Corporate Citizen. In our [RIIO-ED1 Business Plan](#) we signalled our commitment to maintain SF₆ leakage at less than 0.2% as a proportion of SF₆ in service throughout the RIIO-ED1 price control period in all three of our licence areas.

We use SF₆ in our switchgear as an insulation medium, an arc extinction method or for both functions, from 6.6kV up to 132kV. SF₆ leakage is measured in kilogrammes as the amount of SF₆ that is used to top up our gas filled switchgear. The total capacity of SF₆ utilised in electrical assets on our network is just under 115,500kg across our three licence areas; please see the corresponding breakdown in Table 11 below.

Licensee	Installed capacity (kg)	SF ₆ Bank (kg)
EPN	44,041	44,830.54
LPN	47,418	47,581.09
SPN	24,037	24,445.46
Total	115,496	116,857.09

Table 11: Installed SF₆ capacity per licensee and SF₆ Bank per licensee

In the table above, the SF₆ bank for each licence area is a summation of the amount of SF₆ in the assets on the network and the stock of SF₆ cylinders kept for topping up any leaking circuit breakers. The measurement of SF₆ leakage as a percentage of installed capacity is more reflective of the performance of the assets. By omitting the SF₆ stock from the calculation, we eliminate the diluting effect that high stock levels may have on the perception of leak performance. The SF₆ Bank figures have been included here because they are the figures we report to Ofgem.

We anticipate a slowdown in the replacement of oil switchgear with SF₆ filled switchgear on our network. This is due to three factors:

1. UK Power Networks' commitment to limit SF₆ emissions involves adopting SF₆ alternatives when they become technically feasible.
2. The development of alternative gases by equipment manufacturers is gathering pace.
3. The European Commission is reviewing the use of SF₆ in MV switchgear with a view to potentially curtailing its future use. At the 132kV voltage level, where SF₆ is the industry standard arc extinction method for circuit breakers, alternative gases and technologies such as Clean Air insulation combined with vacuum interruption have been successfully developed. It remains to be seen if alternative gases can be used in our LPN licence area or in any other licence area where space constraints might be an issue, because SF₆ filled switchgear offers space-saving advantages at installation due to its compact nature. Where alternatives can be used in such circumstances, the transition will be managed in a safe and cost-effective manner.

Although a slowdown in the use of SF₆ filled switchgear is anticipated, the timeline for widespread adoption is dependent on the technical approval of SF₆ alternative switchgear. This is a meticulous process and SF₆ switchgear will need to be used in the medium term. As a result, due to the

replacement of oil and air-blast circuit breakers, the expected trajectory of the SF₆ capacity on our network is forecast to increase by approximately 1,800kg from current levels by the end of RIIO-ED1⁴. It should be noted that this trajectory may change due to the potential introduction of SF₆ alternatives before the end of RIIO-ED1.

The decision to install air insulated (AIS) or gas insulated (GIS) switchgear is based primarily on the cost of delivery, available space and project delivery targets.

2.4.2.1 Our 2019/20 performance

The figures presented in Table 12 can be found in the E2 – Environmental Reporting worksheets (please see the Annexes and Appendices). They demonstrate that in 2019/20 our three licensees comfortably met the 0.2% target for leakage set out in our [RIIO-ED1 Business Plan](#).

DNO licence area	% SF ₆ in service emitted
EPN	0.13
LPN	0.09
SPN	0.06
Total	0.1

Table 12: SF₆ emissions per licensee

In EPN we replaced 12 leaking 132kV SF₆ current transformers at our Wymondley Main site. In LPN we refurbished three circuit breakers at 132kV substations; two at City Road and one at Wimbledon Grid.

Going forward, we are prioritising SF₆ leak reduction projects and the evaluation and implementation of innovative measures to expedite the delivery of leak mitigation, to ensure we continue to meet our RIIO-ED1 Business Plan commitment in all three of our licence areas.

2.4.2.2 Our strategy

We are taking action to minimise SF₆ emissions in order to:

- Remain compliant with the EU F-gas Regulations
- Minimise our impact on the environment and achieve our vision of being a Respected Corporate Citizen
- Minimise the network outages required to top up leaking circuit breakers – reducing costs associated with the top-up and the period of time the network is at risk
- Reduce the probability of mal-operation or failure – improving network performance
- Minimise the risk of exposure to SF₆ for our operational staff when working on the network or handling this substance

Where SF₆ leaks occur our approach is to instruct the manufacturer to carry out leak detection works on the affected unit, scope out the works and complete all refurbishment works required to mitigate the leak. This often constitutes a refurbishment, either on-site or factory based. In these situations refurbishment generally consists of a strip-down of the circuit breaker, a comprehensive clean and replacement of all worn seals or parts. Where it is not reasonably practicable or cost-effective to complete a refurbishment of the circuit breaker, an immediate replacement will be considered.

⁴ This is an estimate based on the average kilogrammes of SF₆ in a new GIS bay (F35), the average capacity of an AIS SF₆ circuit breaker (DB145), the average capacity of an SF₆ ring main unit (RMU) and a prediction of the scope of works that will be completed for switchgear projects currently in our RIIO-ED1 plan.

Our process for recording top-ups of SF₆ is set out below:

- Low gas pressure alarm automatically received by Network Control
- Top-up work order automatically raised when a low SF₆ gas alarm is detected
- Competent Person (holding a valid SF₆ handling certificate) tops up the asset to within the manufacturer's recommended pressure range; the magnitude of the top-up is a mandatory input field to close the work order

We have produced three documents specifying the operating constraints that apply to the handling of SF₆ or the operation of any switchgear containing this substance. One of these documents is *Engineering Design Standard EDS 03-0036 – Management of Switchgear containing SF₆*, which offers guidance on the management of switchgear containing SF₆ from voltages of 6.6kV up to 132kV. More specifically, it details the processes followed in identifying and managing SF₆ filled switchgear that may be leaking. This policy applies to all UK Power Networks plant and staff, including contractors who work on the network on our behalf.

In 2019/20 we invested in leak reduction projects such as the refurbishment of circuit breakers at our City Road 132kV and Wimbledon 132kV substations (see above).

Our 2020/21 plans include investment targeted at further leak reduction work at the following sites: City Road 132kV (LPN), West Ham SuperGrid (LPN) and Sellindge 132kV (SPN).

2.4.2.3 Our stakeholders

Our stakeholders include those who have been directly affected by an SF₆ leak, including operational staff and manufacturers. Correspondence is required with operational staff such as field engineers and craftsmen when ascertaining the feasibility of remedial works. For example, information about the precise source of an SF₆ leak will enable the manufacturer to decide whether the proposed remedial action is cost-effective, and will prevent costly and potentially unnecessary leak detection visits. We engage regularly and openly with manufacturers on ways to enhance our SF₆ management approach. DNOs and TNOs (Transmission Network Operators) in the UK are also stakeholders in a broader sense. UK Power Networks has worked with both of these stakeholder groups to produce a study which summarises the current state of switchgear technology with a view to charting a technological, practical and sustainable path to the reduction and ultimate elimination of SF₆ from electricity networks in the coming decades.

2.4.2.4 Our programme to reduce SF₆ emissions

Our programme adheres to the requirements of the EU F-gas Regulations – to resolve all gas leaks without undue delay. Generally, for primary switchgear and above, a refurbishment will be sought. For secondary switchgear and below, it is generally more prudent to action a replacement than to undertake remedial refurbishment works, due to the associated costs.

SF₆ leakage figures are held on UK Power Networks' asset register and are reported to the senior management team in our asset management function each month. Top-up figures are also submitted to Ofgem each year as part of the commentary accompanying the E2 – Environmental Reporting worksheet (please see the Annexes and Appendices).

2.4.2.5 Looking ahead: our future strategy

Our future strategy is focused on assessing and improving our SF₆ leak monitoring and response process, as well as continuing to assess the viability of SF₆ alternatives with significantly less greenhouse effects.

The key areas that will be explored as part of our future strategy are:

- Collaborating with research organisations, such as the Electric Power Research Institute (EPRI), and industry partners to develop and implement a quick and easy leak sealing technology which is not dependent on manufacturer availability and which drastically reduces the time between leak detection and repair

- Researching the practicality and cost-effectiveness of installing SF₆ leak detection sensors on electrical equipment with smaller amounts of gas, such as Ring Main Units (RMUs), to facilitate quicker responses to smaller leaks
- Exploring the use of SF₆ alternatives, such as Green Gas for Grid (g3), and commissioning these assets on our network where safe and economically viable to do so. This will be accomplished by maintaining contact – partly through the ENA – with manufacturers, academic institutions and electricity distribution industry participants who are considering or conducting trials in order to be well positioned to take advantage of any cost-effective breakthrough product that results from such efforts

We keep abreast of all innovations related to SF₆ as an insulation medium, including the exploration of SF₆ alternatives. Alstom and National Grid have been working together to develop g3 as a viable alternative to SF₆; we remain in contact with both parties and continue to monitor the development of this technology.

Achievements in the 2019/20 regulatory year are shown in the E2 – Environmental Reporting worksheets (please see the Annexes and Appendices).

2.4.3 Distribution losses

2.4.3.1. Technical distribution losses

Distribution losses are either technical or non-technical in nature. Technical distribution losses are a consequence of transferring electricity across the distribution system. Non-technical losses result from the under-recording or non-recording of electricity consumption – for example, when a customer extracts energy from the network illegally. As a proportion of energy lost, non-technical losses represent a much smaller value than those associated with technical losses – approximately 3.7% of overall losses⁵. The remainder of this section examines technical distribution losses. For information about non-technical losses, please see section 2.4.3.2.

Technical distribution losses have a significant financial and environmental impact on customers due to the need to generate additional electricity (with the associated infrastructure costs and CO₂ emissions), which is subsequently consumed through losses. These technical losses can never be eliminated completely, but through innovation, research and adoption of a robust losses strategy it is possible to manage them and to establish a variety of cost-effective methods to mitigate their impact.

There is a variety of technical losses, but the two principal types are fixed and variable. As energy passes through our network, a small proportion is lost as heat. This is known as a variable loss as it varies with the flow of energy distributed. Unfortunately, this relationship is not linear and so peaky loads incur proportionately higher losses than those associated with flat load profiles, especially during peak demand periods.

Fixed losses are largely independent of the energy being transferred across the network and mainly relate to energy required to energise transformers. For a typical distribution network, around 30% of technical losses will be of the fixed variety and around 70% will be of the variable type, although we observe regional variations in this ratio.

⁵ Ofgem's Energy Efficiency Paper suggested that total system losses in 2012/13 across Great Britain were 27TWh. Of these 19.6TWh related to distribution network technical losses, 6.4TWh to transmission technical losses and 1TWh to non-technical losses.

2.4.3.1.1 Our losses strategy

Our broad strategic objective for managing network technical losses is to control them at a level that is economically justified and to factor appropriate loss mitigation measures into all categories of network investment. We are also working to reduce our technical losses through the introduction of innovative solutions.

Our [Losses strategy](#) follows a three-step approach of:

- Understanding losses
- Plan and design
- Build and operate

Our strategy recognises that there are areas that can be tackled with almost immediate effect whilst others require a period of research and learning prior to implementation. Some of the areas/approaches, which rely on new technologies or processes, can only be implemented once a deeper knowledge and understanding has been gained or new technologies are more widely available.

2.4.3.1.2 Current assessment of distribution losses

In order to further our understanding and develop methods for mitigating losses, we have, through the Losses Discretionary Reward (LDR) initiative, commissioned Imperial College London's Researchers, Princeton University and other distinguished partners to undertake a variety of studies. For the benefit of our stakeholders, we continue to publish reports and other material of interest that our research produces on our losses website⁶, which also contains interactive explanations for the various losses types and causes.

Where the cost can be justified by the benefit, we have embedded various solutions into our business-as-usual activities. We accept that understanding losses is an ongoing process and while some areas of losses are well understood, others pose considerable challenges. For example, historically, LV networks contained relatively few measurement points per circuit and where they did exist, the measurement may have consisted of only a single, static maximum demand value for the total substation load.

Notwithstanding data availability challenges, we have developed robust Cost-Benefit Analyses (CBAs) that justified upsizing LV and HV mains cables. To do this, we used a mixture of engineering, statistical and economic analyses to overcome the challenges presented by data sparsity. We presented our new approach for HV cables to our peers in the ENA's Technical Losses Task Group (TLTG) in April 2019 to ensure it was widely accepted.

During LDR tranche 2, we successfully trialled 50kVA amorphous steel pole-mounted transformers. During tranche 3, we have extended our trialling to include all other sizes from 25kVA to 200kVA. We have ordered the first batch of these larger transformers, and we are working towards getting these units installed in our networks at present.

Table 13 shows a summary of total losses on our networks from data that has been developed from the E3 – BCF worksheets (see the Annexes and Appendices). From this extract, we are able to provide a position on the percentage of total losses on our three networks.

⁶ <https://www.ukpowernetworks.co.uk/losses/index.html>

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Total losses (tCO₂e)						
EPN	1,178,316	1,034,381	1,016,939	838,822	603,788	448,578
LPN	913,887	880,009	779,598	644,058	503,865	495,864
SPN	663,791	559,249	541,021	489,723	379,314	380,844
Total losses (GWh)						
EPN	2,860	2,238	2,468	2,386	2,133	1,755
LPN	2,218	1,904	1,892	1,832	1,780	1,940
SPN	1,611	1,210	1,313	1,393	1,340	1,490
Total units distributed (GWh)						
EPN	32,882	32,721	33,295	33,106	32,994	31,973
LPN	27,632	27,442	27,266	27,012	26,864	25,779
SPN	19,713	19,413	19,468	19,373	19,379	18,763
Total losses (%)						
EPN	8.70%	6.84%	7.41%	7.21%	6.46%	5.49%
LPN	8.03%	6.94%	6.94%	6.78%	6.63%	7.53%
SPN	8.17%	6.23%	6.74%	7.19%	6.91%	7.94%

Table 13: Summary of losses

Table 14 shows the losses performance reported through the E4 – Losses Snapshot worksheets for the regulatory year 2019/20 (see the Annexes and Appendices). The values in this table should be read in conjunction with the notes below.

Asset	EPN	LPN	SPN
	Saving (MWh)	Saving (MWh)	Saving (MWh)
LV cables	238.3	282.0	190.9
HV cables	405.9	331.5	249.9
Distribution ground-mounted transformers	477.7	803.8	259.8
Distribution pole-mounted transformers	66.3	0	47
Amorphous steel pole-mounted transformers	12.5	0	3.5
HV Normal Open Point Optimisation	0	200.6	0
Total	1,200.8	1,617.9	751.0

Table 14: Summary of losses performance

Based on the realised benefits reported in the 2019/20 E4 – Losses Snapshot worksheets, a total of 3,569.7 MWh of CBA-justified improvements were made over the 12-month period. This equates to 912.4 tCO₂e in the year.

Table 14 above contains a new category for HV normal open point optimisation. This new category evolved from research that was triggered by Ofgem's LDR initiative. The losses reduction is achieved by optimising the positions of normally open points between radial HV feeders, which enables us to distribute loads more evenly across our networks. Distributing loads more evenly helps us to reduce losses, since load increases lead to exponential increases in losses where no mitigating actions can be implemented.

Beyond CBA-justified activities, we undertake a large number of activities that substantially reduce losses but for which losses are not the primary driver. An example would include replacing an aged distribution transformer with a current specification Ecodesign transformer of the same kVA rating. Ecodesign transformers comply with EU Regulations setting compulsory maximum losses levels for distribution transformers that are substantially more efficient than older specification transformers. Replacement in this example therefore reduces losses, but as the EU transformer specification is a mandatory requirement, the losses benefits are not included in the E4 – Losses Snapshot worksheets. Table 15 provides a summary of losses reduced through the adoption of more efficient transformers not supported by CBAs focused on losses.

Asset	EPN	LPN	SPN
	Saving (MWh)	Saving (MWh)	Saving (MWh)
Secondary transformers	1,557.9	1,266.5	953.8
Primary and Grid transformers	1,400.7	1,584.2	913.6
Totals	2,958.6	2,850.7	1,867.4

Table 15: Losses reduced through the adoption of more efficient transformers not supported by CBAs focused on losses

The totals in Table 15 add up to 7,676.6 MWh, which equates to 1,962.1 tCO_{2e}.

Adding all figures together, we estimate that losses on our networks were reduced by 11,246 MWh per annum (equivalent to the annual electricity consumption of over 3,000 homes⁷) as a result of all the work UK Power Networks has undertaken. Of this 3,569.7 MWh per annum was explicitly driven by losses considerations.

2.4.3.1.3 Activities undertaken in this regulatory reporting year

Current programmes to manage distribution losses

The following activities are CBA-justified and are embedded in our business-as-usual activities to reduce losses:

- **HV cables** – We are installing larger cross-sectional conductors on the main lines of HV underground feeders to reduce resistance and hence variable I²R losses. We have completed a comprehensive system-wide study which demonstrated that we save 5.94 MWh/annum for every kilometre of HV underground main line that we upsize from 185 to 300 mm² aluminium. This study further revealed that the NPV for this change is strongly positive. The methodology developed in this study was presented to our peers in the ENA's TLTG to ensure that our approach is robust.

Significant volumes have been upgraded following changes to our [HV Network Design](#) policy. In total, 987.3 MWh will be saved every year going forward by upsizing main line conductors in the 2019/20 regulatory year. This is reported in the E4 – Losses Snapshot worksheets.

- **LV cables** – We are also installing larger cross-sectional conductors in LV underground feeders to reduce energy losses. Similar to HV cables, we have completed a comprehensive system-wide study which demonstrated that we save 6.35 MWh/annum for every kilometre of underground main line that we upsize from 185 to 300 mm² aluminium. This study further revealed that the whole-life benefit for this change is strongly positive.

Significant volumes have been upgraded following changes to our [LV Network Design](#) policy. In total, 711.2 MWh per annum is saved every year going forward through upsized main line LV conductors. This is reported in the E4 – Losses Snapshot worksheets.

- **Use of larger distribution transformers** – We continue to replace existing distribution transformers with larger units where the saving in copper losses (variable) outweighs the increases in iron losses (fixed). Over the last 12 months we have increased the transformer size at 271 sites where the CBA demonstrated a positive NPV, yielding an annual improvement of 1,654.5 MWh. This is reported in the E4 – Losses Snapshot worksheets.
- **Use of amorphous steel transformers** – During LDR tranche 1, we collaborated with a transformer manufacturer to develop a pole-mounted amorphous steel transformer, recognising that fixed losses in distribution transformers account for a significant percentage of overall

⁷ Average annual electricity consumption per home obtained from this website: <https://www.ovoenergy.com/guides/energy-guides/how-much-electricity-does-a-home-use.html#:~:text=How%20much%20electricity%20does%20a%20UK%20home%20use%3F,very%20large%20amounts%20of%20electricity>.

technical losses. During the 2019/20 regulatory year, we installed 13 of these units on our networks, collectively delivering an energy loss reduction of 16.0 MWh per annum for their entire lifespan.

- **Detection of contact voltage losses** – Also during LDR tranche 1, through our work with Princeton University, we discovered a new losses category that does not fit into the standard definition of either technical or non-technical losses – contact voltage losses (CVLs). We have invested in a Mobile Asset Assessment Vehicle (MAAV) and developed a programme to assess CVLs. Unlike any other category of technical losses, these are almost entirely avoidable with sufficient investment. In LDR tranche 3, we are working towards detecting these losses using our Active Network Management System (ANM) to enhance the success rate at which our MAAV detects CVLs.

For the 2019/20 financial year, the use of this vehicle realised an energy loss reduction of 2,370.8 MWh. We did not include this saving in the tables for this section on the basis that MAAV-related figures are reported in our E6 – Innovative Solutions worksheets (see the Annexes and Appendices).

- **HV normal open point optimisation** – During LDR tranche 1, Imperial's Researchers pointed out that we can significantly reduce energy losses by optimising the positions of normal open points between radial HV feeders. This optimisation process redistributes loads across the network by accessing lesser-utilised network sections to alleviate load on more intensively utilised sections. We use DPlan software to analyse the network holistically and find optimised solutions accordingly. During the past year, we have changed the positions of 11 normal open points in four feeder groups, leading to an annual energy loss reduction of 200.6 MWh.

Prior to changing the positions of normal open points between HV feeders, we consult with network planning and system control engineers to ensure that network operability and network outage management are not adversely impacted by the changes we introduce.

The following activities were not driven primarily by network losses considerations but were undertaken as part of our business-as-usual activities and have had a positive impact on energy loss reduction:

- **Replacement of distribution and power transformers** – We continue to replace existing transformers with Ecodesign specification units that reduce fixed and variable energy losses. This year we replaced a total of 1,015 distribution transformers, which reduced losses by 3,778.2 MWh per annum. In addition, we replaced 28 primary and grid transformers, further reducing losses by 3,898.4 MWh per annum. These energy loss reductions were not declared in our E4 – Losses Snapshot worksheets because the investments were not driven by energy efficiency considerations.
- **Ongoing review of design standards** – We are continuously developing new business cases to support further losses reductions. Once we have established a positive CBA in favour of an intervention, we amend associated Engineering Design Standards to ensure that our recommendations are implemented swiftly and effectively. In this way, we ensure that losses are minimised for the entire lifespan of our new assets.

2.4.3.1.4 **Forthcoming programmes to manage distribution losses**

During the next regulatory year, we will continue to broaden our understanding of distribution losses, further develop our tools and processes, and embed these into our business-as-usual activities. For example, we will be trialling further sizes of amorphous steel pole-mounted transformers. We will also continue our collaboration with manufacturers and disseminate our findings to other DNOs who may benefit from this activity. Looking ahead, we will continue to consider the impact our developing DSO capabilities are likely to have on network losses.

We will continue to investigate how new approaches and technologies such as flexibility and our ANM interact with network losses. Broadly speaking, these technologies are being developed to maximise network utilisation, which delivers financial and societal benefits to our customers by reducing the need to invest in network upgrades; but they will, as a side effect, increase technical losses. We therefore work towards making energy losses a part of every CBA that we develop to assess the economic merits of using new technologies.

We also intend to keep abreast of new technologies coming to market that may be used to minimise losses. Technological developments may also highlight new areas that we can focus on to target losses.

2.4.3.1.5 Summary of losses activities and benefits during this regulatory reporting year

Table 16 provides a summary of the costs and benefits from our CBA-justified losses activities and has been developed from the E4 – Losses Snapshot worksheets (please see the Annexes and Appendices). From this extract, we are able to present the cumulative effect of our CBA-justified losses activities during the whole of the RIIO-ED1 period to date.

Programme/ project title	Regulatory reporting year (2019/20)			RIIO-ED1
	Distributed losses – justified cost	Reduced losses	Reduced emissions associated with losses	Cumulative reduced losses to date
	£m	MWh	tCO ₂ e	MWh
LV cable	0.342	711.2	181.8	5,605.1
HV cable	0.578	987.3	252.4	1,867.6
Distribution transformers	0.314	1,654.5	422.9	5,320.9
Amorphous steel transformers	-0.002	16.0	4.1	31.5
HV Normal Open Point Optimisation	0.001	200.6	51.3	200.6
Totals	1.234	3,569.7	912.4	13,025.8

Table 16: Summary of losses costs and benefits from activities in RIIO-ED1 (technical losses)

Table 17 shows a summary of the volumes of CBA-justified losses activities during this regulatory reporting year and has been developed from the E4 – Losses Snapshot worksheets (please see the Annexes and Appendices).

Programme/project title	Description of unit	Volumes in regulatory reporting year (2019/20)	Forecast volumes for following regulatory year (2020/21)
LV cable	km	112.0	100-200
HV cable	km	166.2	100-200
Distribution transformers	ea.	271	200-300
Amorphous steel transformers	ea.	13	20-100
Primary and Grid transformers	ea.	N/A	N/A
HV normal open point optimisation	Feeder groups optimised	4	5-20

Table 17: Summary of amount of losses activities in the regulatory reporting year and estimate for the following regulatory year (technical losses)

2.4.3.2. Non-technical distribution losses

Non-technical losses result from failures to correctly record electricity consumption within industry settlement systems. Electricity suppliers have the primary responsibility and must ensure that they accurately read meters, set the appropriate energisation status against each metering point and detect and investigate situations where people tamper with their electricity meter. Separately, there is that element of electricity theft committed by persons who make unauthorised connections to the distribution system and do not register with a supplier. This is known as theft in conveyance and it falls to the distributor to resolve.

Tackling theft in conveyance is important as a licence obligation, as mandated by industry codes and via a broader legal, social and moral imperative. Ceasing ongoing theft is crucial but our operations also identify and remedy the dangerous situations often associated with unauthorised connections. Our investigators will often encounter overloaded connections, substandard wiring and exposed conductors presenting both fire and electrocution risks. UK Power Networks is helping to protect the occupiers of these premises, their neighbours and the wider general public.

As shown in Table 19, our 2019/20 programme of work led to 374 cases of theft in conveyance being resolved across our three licence areas. A further 420 cases investigated during 2019/20 remained 'in progress' at year-end and UK Power Networks is either working with property owners to facilitate appropriate connection arrangements or awaiting the customer's chosen supplier carrying out meter point registration actions. Whilst domestic sites represent the largest component, our operations in 2019/20 included significant commercial and industrial sites. Among the largest were a factory producing food products and a holiday caravan and leisure park.

The overwhelming majority of cases are resolved through the customer registering their metering point with a supplier in accordance with normal industry processes. Nevertheless, in a small number of cases UK Power Networks may be left with no option but to disconnect the unauthorised supply. In the absence of safety concerns we seek to avoid enforced disconnections but our policy recognises this as a last resort to avoid the indefinite continuation of electricity theft.

In 2019/20 we continued to work with other distributors and suppliers to promote more effective electricity theft reduction efforts across the industry and provided substantial input to new industry best practice guidelines published in Q4 2019. UK Power Networks remains an active and engaged member of the industry's Theft Issues Group and was asked to join a separate workgroup to offer a distributor's perspective on plans for future theft detection and mitigation activities. As a member of the UK Revenue Protection Association, UK Power Networks presented at one of their CPD-accredited training seminars, sharing knowledge and best practice with a large audience of professionals working in this arena.

Table 18 and Table 19 summarise key figures in respect of non-technical losses activities. Table 18 shows projected savings in megawatt-hours as a result of resolved instances of theft in conveyance. It also shows a calculation of the tonnes of CO₂ associated with this volume of electricity losses.

Programme/ project title	Regulatory reporting year (2019/20)			RIIO-ED1
	Distribution losses- justified costs	Estimated reduced losses	Reduced emissions associated with losses	Cumulative reduced losses to date
	£m	MWh	tCO ₂ e	MWh
Countering Theft in Conveyance	0.30	9,611	2,457	23,922

Table 18: Summary of losses costs and benefits from resolved theft in conveyance cases in the RIIO-ED1 reporting year

Programme/project title	Description of unit	Volumes in 2019/20 reporting year ⁸
Countering Theft in Conveyance	Resolved theft in conveyance cases	374
	'In Progress' cases	420

Table 19: Summary of theft in conveyance losses activities in the 2019/20 regulatory reporting year

2.5 Other environment-related activities

2.5.1 Flood preparedness

In 2019/20 we continued to invest in the flood protection programme to ensure that customer supplies are protected from flood risk and to achieve our commitment of protecting 78 substations from the impact of flooding during the RIIO-ED1 period. This commitment typically takes the form of investing in physical asset protection at substations to ensure that customer supplies are not interrupted during an extreme flooding event.

In 2019/20 we successfully flood-protected nine substations serving in excess of 170,000 customers, bringing the total number of mitigations so far in RIIO-ED1 to 49. Protection will usually be achieved by protecting or raising critical equipment above the 1:1,000 year flood level – allowing for a climate change factor and 300mm freeboard – to ensure that mitigations remain effective for the lifetime of our substations.

Investment has also taken the form of research, monitoring and ongoing analysis of flood risk across our operating areas. In 2019/20 we carried out 25 detailed flooding risk assessments and also worked with multiple professionals, including staff from the Environment Agency, to launch an online GIS flood map that is made available company-wide to assess flooding likelihood of all infrastructure at the initial stage. We are continuously investing to develop further capability in dynamic flood risk analysis and response across all three of our licence areas.

Alongside the typical approach of protection from fluvial and tidal flooding we ensure that supplies and critical assets are fully flood-protected from all sources. Assessments and projects also consider localised surface water flooding and groundwater flooding. In densely populated areas, such as central London, infrastructure failure of water mains or reservoirs can cause devastation to critical subterranean substation assets and must also be considered. We work closely with water infrastructure owners and implement flood protection measures where required.

⁸ Given that activities are driven by theft in conveyance being reported to, or identified by UK Power Networks, these volumes cannot be accurately forecast. In essence, the volume of work undertaken during the year will be driven principally by the quantity and quality of leads received from numerous industry parties and supplemented by self-generated leads. We estimate total leads to be broadly in line with the previous year's figures.

We have sought to provide flood-protection measures that are cost-efficient over the lifetime of the asset and deliver the maximum risk reduction to improve the number of customers protected in a worst-case scenario. Overall resilience in the network means that customers can often be very quickly reconnected at minimal inconvenience following flooding of critical equipment through automated switching. River levels and Environment Agency guidance are monitored during extreme weather events to inform the potential deployment of our 1,000 metres of demountable flood barriers.

Aside from our targeted flood mitigation programme, we have implemented improvements in business-as-usual processes to ensure that flood resilience is at the forefront of all project planning and major investment in the network. Increasingly, plant and equipment is specified or modified to ensure greater clearance from ground level and building designs have been adapted to ensure additional resilience from flooding.

Our flood protection programme complies with two key documents: UK Power Networks' policy and design guidance document [EDS 07-0106 – Substation Flood Protection](#) and the industry best practice document [ETR 138 – Resilience to Flooding of Grid and Primary Substations](#). UK Power Networks is an active participant in ENA flooding and climate change groups to ensure consistency, industry best practice and compliance to the most up-to-date regulation and standards.

We recognise that, in addition to protecting customer supplies and our own assets, we have a responsibility to neighbouring communities to be an active participant in local flooding forums and proposed projects to protect property and businesses. UK Power Networks was an active and willing participant in a number of public meetings, forums and consultations in 2019/20, including proposals in Yalding, Cambridgeshire and Byfleet.

In Yalding, UK Power Networks engaged with the Environment Agency and local parish. It quickly became evident that the local flood strategy relied on electric pumps to protect properties and without protecting the ground-mounted substations that supplied these pumps the overall flood strategy could be severely compromised. One Yalding substation has already been flood-protected in 2020 and the other will be relocated to a more suitable location soon.

In Cambridgeshire and Byfleet, UK Power Networks provided advice and data to assist in the formulation of a wider flood strategy in these areas.

We are committed to working closely with our stakeholders, including the Environment Agency, local authorities, other utilities and National Grid. We share information and play an active role in developing solutions at shared sites that are vulnerable to flooding. Through regular liaison, suitable solutions have been implemented to protect vulnerable equipment.

UK Power Networks records and reports its costs, volumes, protected sites and customer numbers to Ofgem each year. For more information, please refer to the Annexes and Appendices which contain a link to the CV16 and M1 (Flood Mitigation) worksheets for our three licensees.

2.5.2 Green Action Plan

In 2019 we launched our Green Action Plan to challenge and stretch our RIIO-ED1 commitments and signal our ambition to be the most socially and environmentally responsible DNO. Since this launch and the submission of our last annual report, the sense of urgency around environmental and social concerns has increased.

Our planning for RIIO-ED2 combined with horizon scanning has sharpened our focus on the need for business models to evolve from being just 'responsible' corporate citizens to resilient and more regenerative ones. As a DNO we need to be ready for rapidly changing markets and customer need, as well as preparing for disruptive environmental and economic events, as the global pandemic and weather impacts over the last few years have demonstrated. To meet these challenges, our business model has to address the UN Sustainable Development Goals⁹ and ensure our operations contribute to a new 'regenerative' economic, environmental and social model.

⁹ <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Our Green Action Plan has targets associated to biodiversity, carbon, energy, noise, pollution, water and waste (see Table 20). As explained below, we have made good progress against these targets.

Aim	Objectives	Targets
Energy	Reduce energy use in our top six buildings	10% reduction by 2021
Carbon	Business Carbon Footprint (BCF) reduction	20% reduction by 2021
Biodiversity	Promote net gain, minimise species decline	Enhance potential by 20-30% at 100 of our sites by 2021
Pollution	Reduce nitrogen oxide (NOx) emissions from our fleet and generators	33% reduction by 2030
Noise	Identify future potential developments and noise issues	Contact 100% of all local authorities to review their development plans by 2021
Water	Reduce water consumption in our top six buildings	10-15% reduction by 2021
Waste	Divert waste from landfill and increase recycling at our top six sites	More than 90% of waste diverted from landfill and more than 80% of waste recycled from our top six sites by 2021

Table 20: Our Green Action Plan focus areas and targets

2.5.3 Energy Management

Under the Energy Savings Opportunity Scheme (ESOS) Regulations, electricity consumed through the network and the resulting losses associated with our operations completely dwarf the occupied sites' consumption. We could have placed the occupied sites into the de minimis category and excluded these from the audits but as a socially responsible company we decided to include our top six buildings in the audit programme.

In the course of the year we have implemented lighting controls and LED replacements across our building stock and are continuing to work through the findings of the ESOS audit in tandem with our preventative maintenance and investment programmes. We are on target with the implementation of our energy reduction initiatives but the results will have been distorted by low occupancy of the buildings during the pandemic emergency measures.

2.5.4 Carbon management and science based targets

Section 2.4.1 covers our actions and emissions to date. Looking forward, we are developing our carbon management plan in line with our aspiration to achieve net-zero emissions and a science based target (SBT) in line with the requirements of the SBT Initiative¹⁰.

We also certified our business to the Carbon Trust's Carbon Standard in December 2019. This forms part of our Green Action Plan initiative to achieve the triple certification with the Carbon Trust on carbon, waste and water.

2.5.5 Biodiversity

Loss of species in the UK and globally is a great cause for concern and we have committed to increasing the biodiversity potential of 100 of our larger sites by 20-30% by 2021 as part of our Green Action Plan. Expert ecologists from ADAS and our Wildlife Trust partners have been conducting initial surveys to assess the types of habitat and species already present to establish a baseline. Their reports include targeted measures to maximise beneficial habitats – for example, management of grassland to increase

¹⁰The SBT Initiative is a collaboration between the Carbon Disclosure Project (CDP), the World Resources Institute (WRI), the World Wide Fund for Nature (WWF) and the United Nations Global Compact (UNGC). More information can be found at: <https://sciencebasedtargets.org/>

the variety of wildflowers, installing bird or bat boxes and planting native hedges. Our employees can volunteer to spend a day planting or building new habitat for wildlife, as shown in Figure 5 below.



Figure 5: Building a refugium¹¹ to provide shelter for invertebrates, reptiles and small mammals

Newly improved sites will take time to reach their full potential, but are a good investment in the future which will deliver benefits over the medium to long term for wildlife and local communities.

2.5.6 Minimising pollution

As part of our overall work on the SBT and net zero initiatives we are:

- Reviewing our operational vehicle fleet in terms of EVs and the most suitable locations and roles
- Addressing our grey fleet in terms of increasing the availability of hybrids and EVs in the vehicle fleet we offer
- Working with our suppliers on possible Green Diesel blends as an interim solution for our operational fleet to reduce both our carbon emissions and NOx

We have also worked with our supply chain to introduce and trial some hybrid generators to determine their efficacy and operational suitability.

2.5.7 Noise and local authority engagement

When operating our network we have a responsibility to ensure that any noise from our equipment is mitigated to an acceptable level, especially if it is sited in a residential area. Most of the enquiries we receive about noise are related to low frequency noise associated with our transformers. To determine if our equipment is causing a disturbance and to gauge the noise level emitted, we carry out noise surveys using a rating method developed by Salford University.

This rating method was commissioned by the Department for Environment, Food and Rural Affairs (Defra) and can determine whether a low frequency noise would be considered a Statutory Nuisance under the Environmental Protection Act. Where the acoustic landscape is more complex, we engage an acoustic consultant to assist with the investigation and provide guidance on specialist mitigation measures. Mitigations to deliver noise reduction are frequently constrained by the need to maintain safety clearances and to ensure that equipment can operate at the correct temperature.

During the year, a large noise mitigation scheme was completed at Ticehurst in East Sussex. This substation was the subject of a noise abatement notice following the building of a large residential retirement development on the site of a former coachworks adjacent to our substation.

¹¹ Refugia are areas where special environmental circumstances have enabled a species or a community of species to survive after extinction in surrounding areas.

We are committed to an open dialogue with local authority planning and environmental health officers. The National Planning Policy Framework was updated during the year and now makes clear that the 'agent of change' is responsible for the costs of mitigation. A good example of this engagement is Wickford Primary (EPN) where, through negotiation with the planning officer and the developer, we were able to secure planning conditions that should ensure future residents will not be disturbed by the existing substation.

Our Green Action Plan Noise project will identify sites in local authorities' Strategic Housing Land Availability Assessments (SHLAA) that are close to existing grid or primary substations. We have created contours around grid and primary sites based on historic acoustic data from over 130 substations. As part of this process we are overlaying our main substations, contours and SHLAA data onto a geospatial application (Figure 6 shows an example). This enables us to predict how noise may affect proposed new developments and guide local authorities in their planning deliberations.

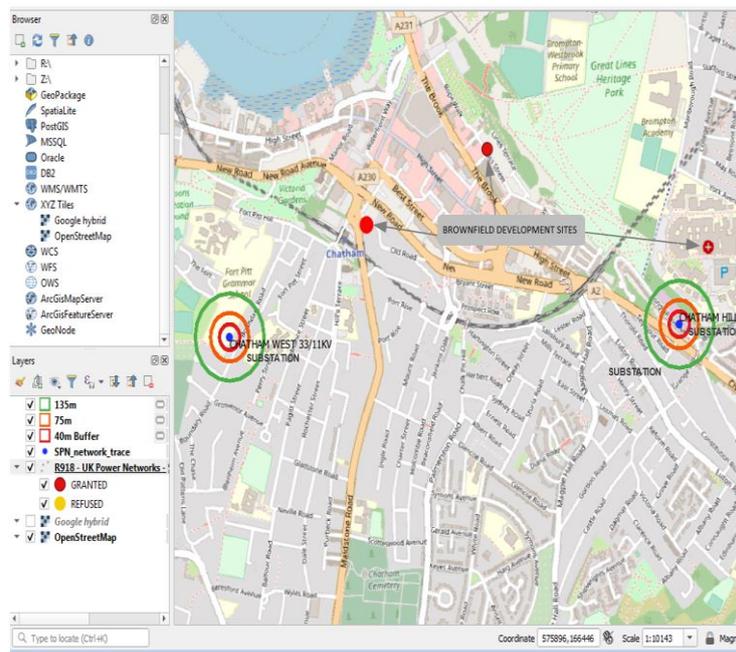


Figure 6: Geospatial map showing proximity of brownfield sites earmarked for development to grid and primary substations

Our Environment Advisers also offer to attend local authority environmental health forums to give presentations on substation noise and other topics of mutual interest including litter, fly-tipping, EMF (electromagnetic fields) and public safety, and promote collaborative interaction. During 2019/20 we engaged with environmental health teams in Norfolk, Suffolk and Cambridgeshire and delivered presentations to over 20 members of their staff.

In 2019/20 UK Power Networks received 43 enquiries and complaints about noise, all of which were investigated. These were mainly linked to substation transformer noise.

In addition to the large scheme mentioned above, we installed mitigation at five secondary substations where we believed that customers had a justified noise complaint based on the reference curves set out in the 'Procedure for the assessment of low frequency noise complaints' (NANR 45).

Our 2019/20 results are reported in our E2 – Environmental Reporting worksheets (please see the Annexes and Appendices).

2.5.8 Water management

As part of our Green Action Plan objectives we have committed to achieving the Carbon Trust Water Standard by December 2021. This standard provides industry recognition to the organisations that take a best-practice approach to measuring and managing their water use and achieve real reductions year-on-year. To date we have conducted a gap analysis exercise with the Carbon Trust for our six key offices, in February 2020 we received the Carbon Trust recommendations and we are prioritising our efforts into delivering on these recommendations, developing our policy and processes to manage our water usage effectively across all our occupied sites.

2.5.9 Office and depot waste

During the 2019/20 regulatory year, UK Power Networks generated 5,180 tonnes of office and depot waste. Of this 620.1 tonnes (12%) ended up in landfill. The remaining 4,559.9 tonnes (88%) were diverted from landfill and either recycled or used for energy recovery. This is well ahead of our existing target for the current price control period of 70% diversion from landfill, but just short of the new 90% target which has been set as part of our Green Action Plan.

2.5.10 Carbon Trust Waste Standard

As part of our Green Action Plan journey towards becoming environmentally responsible, and with a view to better measure, monitor and understand our waste footprint and impact, we are working with the Carbon Trust towards achieving accreditation for waste reduction.

Following a gap analysis exercise with the Carbon Trust in 2019, UK Power Networks was successfully awarded the verification standard for waste. This followed an assurance process which verified that the submitted data was prepared and reported in accordance with the measurement requirements of the Carbon Trust Waste Standard. As a result we were awarded the Carbon Trust Waste Standard Verification Diploma.

2.5.11 Environmental awareness

A programme of engagement and training has continued throughout the year with our suppliers, staff and contractors to improve understanding of our requirements and ensure internal buy in for our Green Action Plan objectives. These activities have ranged from training and site visits through to contractor/supplier forums, as outlined below.

- **Ecology awareness**

In 2019/20 we produced an ecology themed animation designed to provide an overview of what species and habitats can be encountered in our working environment (see Figure 7). The animation cycles through various settings where our employees might be working. Although much of our work is conducted in substations, we can also work near watercourses, trees and special habitats such as Sites of Special Scientific Interest. It is not unusual to find species in unexpected locations, such as bees nesting in the air bricks of substations or birds nesting inside road cones.

The animation shows the protected species that may be found in those environments and provides tips on how to identify them. Checking in advance for when to survey for protected species, precautionary measures and contact information for specialist teams are also covered. The animation was rolled out to all employees during our environmental focus month and is also available online. The video can be viewed [here](#).

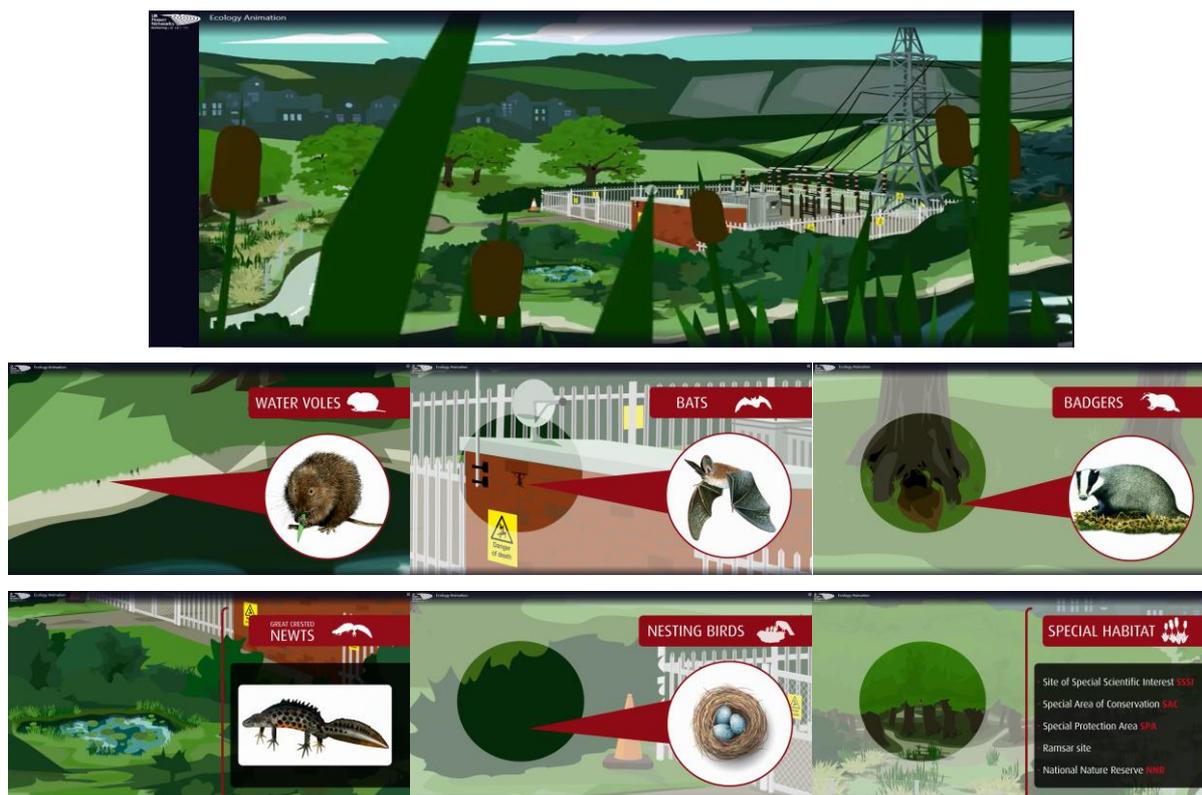


Figure 7: Screen view from Ecology Animation

- **Internal environment training course**

We maintained RoSPA accreditation of our Working with the Environment Course, which covers environmental topics linked to our business including pollution prevention, protected species and waste management. In 2019/20 a further 75 employees successfully passed this course (which has two test papers as part of the module), taking the total number of employees who have completed this course to 303 to the end of March 2020.

2.5.12 Our waste campaign

To demonstrate our vision to be the most socially and environmentally responsible DNO, we continue to deliver our waste recycling campaign, 'Talking Rubbish'. This involves visiting office depot sites throughout our operating area and holding 'waste surgeries' where employees learn about waste recycling and opportunities to reduce our waste. Our non-hazardous waste contractor, Viridor, also assists in providing expert feedback on waste management.

During the 2019/20 regulatory year, we delivered six waste surgeries; these were held at our Bidder Street, Bengeworth Road, Stephenson Way, Energy House, Maidstone and Newington House sites. In these sessions we explained the waste recycling process and provided examples of how to improve and reduce our waste impact.

2.5.13 Waste mechanical recovery facility (MRF) visit

Our non-hazardous waste contractor, Viridor, also arranged a visit to one of their subcontractors' waste sorting facilities. The visit was timed so we could see the actual general waste container from our Colchester depot tipped. This was a great opportunity to see what materials are being put into the general waste that could potentially have been put into recycling containers. At this waste sorting facility they sort all waste and extract much of the recyclable material; the remainder is sent to Energy from Waste plants to generate power back to the grid. At other sites, general waste is not sorted and can go straight to landfill – which highlighted to us that we only have one chance to get it right. Our

Colchester depot is an exemplar site for waste segregation and we are using this to inform the changes needed at other sites.

2.5.13 Alliance – contractor forum

Our Alliance meetings are a long-established feature of our stakeholder engagement programme – many attendees are regular participants. Each month our Environment team meets with our Alliance contractors (Clancy Docwra, Kier, Morrison Utility Services, and Wood Plc). The purpose of this group meeting is to review progress towards achieving UK Power Networks' Green Action Plan commitments and review the Alliance Action Plan and Sustainability and Environmental Initiatives – providing a platform for stronger collaboration with our supply chain partners to promote their involvement and ideas. The group's main objectives and responsibilities include:

- Fulfilling the requirements of the Alliance Action Plan
- Aiming for carbon neutral projects, and supporting the net zero aspirations of UK Power Networks and the industry
- Having a positive impact on the environment and improving biodiversity
- Eliminating waste to landfill
- Suggesting and promoting innovative techniques and adopting best practice
- Timely provision of accurate data
- Embedding environmental consideration into design and pre-construction
- Increasing awareness, knowledge and engagement

These meetings have assisted in the identification of greenspace sites associated to the Green Action Plan's biodiversity targets and also ensure data is submitted in an accurate and timely manner for our BCF reporting. Additionally, they enable us to review the feasibility of using new low carbon technologies such as electric powered excavators and assess other low carbon options; for example, the consideration of additives into concrete to minimise carbon impact, the use of solar powered site cabins, the creation of a 'Swap-Shop' platform to maximise the utilisation of our assets and equipment, and the embedding of sustainability requirements within contracts and tenders.

2.5.14 Critical Friends Panel (CFP)

Our CFP meetings take place at least annually. These meetings provide a channel for our stakeholders to help us test the suitability of our business strategy, to invite challenge and prioritise our long-term environmental business commitments. They also allow us to capture feedback on potential projects and help us work in partnership to develop our long-term goals.

In January 2020 we held our most recent CFP event in The Hub community space in Cambourne, Cambridgeshire. The event was attended by key environmental stakeholders such as our third party ecologists ADAS, Anglian Water, The Carbon Trust, Cambridge Government Environmental Health, Skanska, wildlife services and the Wildlife Trust. Stakeholder feedback from this event enables us to focus on various issues such as:

- The SBT Initiative, net zero initiatives and pollution reduction initiatives
- Work in partnership with procurement and suppliers to address sustainability shortcomings (e.g. circular economy and net zero initiatives)
- Work with local authorities and Wildlife Trusts (and services) to develop wildlife corridors and identify biodiversity hot spots
- Our Green Action Plan targets and ambition – challenging ourselves with stronger targets beyond 2021

This year, our stakeholders agreed that our environmental impact should remain a priority. Taking this into account, we have been able to progress with projects to reduce our energy and water usage and increase the biodiversity potential of our estate knowing that our stakeholders value our approach.

2.5.15 Environmental reporting: civil sanctions

We report on any cautions, notices, warnings, penalties, prosecutions and reportable environmental incidents. Our 2019/20 results are reported in our E2 – Environmental Reporting worksheets (please see the Annexes and Appendices).

The majority of civil sanctions related to actual or potential pollution, which we reported to the Environment Agency. During the year, we continued to experience and clear fly-tipping and to engage with local authorities, but received no valid notices.

2.5.16 Environmental benchmarking: Hang Seng and Dow Jones submissions

Each year UK Power Networks contributes to its shareholder Power Assets Holdings Limited's Hang Seng Sustainability Index and Dow Jones Sustainability Index submissions. The scope of these indices covers the full breadth of sustainability-related topics, from customer service to regulatory compliance. Each of these indices has a section regarding environmental aspects whereby we provide information and evidence that provides a level of assurance that UK Power Networks operates in an environmentally sustainable and corporately responsible manner.

Our input into this submission includes information on our strategies, corporate governance, policies, innovation (such as carbon reduction/low carbon technologies) and performance associated to environmental matters. With UK Power Networks' input, Power Assets Holdings Limited continues to retain a position on the Dow Jones Sustainability Index and an AA high score rating for the Hang Seng Sustainability Index.

2.5.17 Community engagement: Trees for Cities

In 2019/20 we partnered with a UK charity, Trees for Cities, on an initiative to mitigate air pollution, improve the urban environment and biodiversity opportunities. Trees for Cities are an independent charity working in the UK and further afield with the explicit aim of creating greener cities. The focus is on areas that are suffering from social and environmental deprivation, bringing together local communities to work on practical greening and educational projects.

As part of our agreement with them we funded the planting of 2,669 trees as a notional air pollution offset to help mitigate the existing impact of our nitrogen oxide (NOx) emissions. Obviously, this is not an immediate beneficial impact, but will in time help reduce air pollution, sequester carbon, provide biodiversity opportunities, improve visual amenity value and help tackle the urban 'heat island' effect. The immediate positive beneficial impact this can have on a community is evident, but we will review this project for consideration in our long term environmental and community planning.

2.5.18 Streetworks waste classification

As reported last year, the Environment Agency had raised concerns that waste from utility excavations was being misclassified and disposed of incorrectly as non-hazardous waste. They issued a temporary Regulatory Position Statement (RPS211) which details certain requirements businesses must meet if they wish to classify excavated waste as non-hazardous. The RPS211 was scheduled to be withdrawn in April 2020, but this was extended until 1 November 2020.

UK Power Networks and other utilities joined Streetworks UK (SWUK) to complete a study to design a new protocol for appropriate assessment and classification of excavated utility waste. The sampling work, surveys and results have been completed and delivered. Preliminary results have been provided to the Environment Agency and we await the outcome.

3 Smart Grids, Innovation and Our Role in the Low Carbon Transition

3.1 Introduction

Great Britain is in the midst of a once-in-a-generation decarbonisation, decentralisation and digitisation change as significant for the electricity industry as the advent of broadband for communications. The carbon intensity of producing electricity in the UK has fallen 50% in just eight years. The rise of commercial energy storage heralds a new era of renewable energy. In the last five years alone, we have connected more than 2,300 large generators and nearly 43,000 small solar PV systems to our network. We are putting in place a future-ready grid for a zero-carbon world, while continuing to recognise the financial, social and security of supply impacts of that change. This section highlights the changing policy context, low carbon technology (LCT) uptake, our innovation portfolio, innovation benefits delivered into business as usual, and our strategy for maximising the benefits of smart metering.

Our comprehensive innovation strategy is informed by stakeholders. Our DSO and flexibility roadmaps and our EV readiness programme are examples of how our business activities are guided by our strategic focus to provide a secure, reliable and ultimately net-zero carbon system that addresses our customers' evolving needs.

In October 2019 UK Power Networks was awarded Edison Electric Institute's (EEI) International Edison Award in recognition of its work in smart grid development and for enabling Great Britain's low carbon transition. EEI president Tom Kuhn said: "Energy grids are transforming around the globe at an unprecedented pace in response to climate change and evolving customer preferences. As UK Power Networks has demonstrated, actively listening to, and engaging with, customers is vital to realise the benefits of transformative energy solutions."

3.1.1 **Changing policy context and the developing DNO role in low carbon transition**

The key policy development over the past year was in May 2019 when the Committee on Climate Change recommended a new emissions target for the UK: net-zero greenhouse gases by 2050, rather than 80% as in the previous policy. This was legislated for in June 2019 and while detailed policy is expected to follow, that overarching legal basis is key and was reflected in February 2020 in Ofgem's decarbonisation action plan, which recognised the "urgent, but decades-long journey towards net zero".

Since a key objective of ours is to facilitate the transition to net zero, we have made a commitment to share our baseline and outlook for both electricity demand and LCT uptake within an annual publication of [Distribution Future Energy Scenarios](#) (DFES). Built on stakeholder input and leveraging multiple data sets, we have developed the DFES for the first time this year (February 2020). The outlook is framed around three potential 'scenario worlds', as shown in Figure 8 below.



Figure 8: DFES scenario worlds

The LCT uptake scenarios – just one of the data sets that we started sharing on our [Open Data](#) page in the past year – are shared at high geographic granularity (MLSOA and LLSOA, middle and lower level super output layers). The DFES and its data sets will be the foundation for innovation and planning of the networks, including the development of a Strategic Forecasting System to underpin development for the next regulatory period. Accurate modelling within DFES is key to cost-effective network delivery.

We recognise that our role in facilitating a new zero-carbon electricity system requires us to manage new challenges associated with the following:

- Significant volumes of decentralised generation
- Bidirectional power and information flows
- Significant volumes of renewables with managed intermittency
- Customer sites that both produce and consume electricity

We are able to provide flexibility services to the networks to meet these challenges – guided by the five Smart Grid priorities set out in our [DSO strategy](#) (see Figure 9). Alongside this, we are seeing increasing complexity and heterogeneity in demand – with the addition of decarbonised heat, cooling and EV load on the electricity networks, alongside increasing cost and environmental pressure towards energy efficiency of demand.

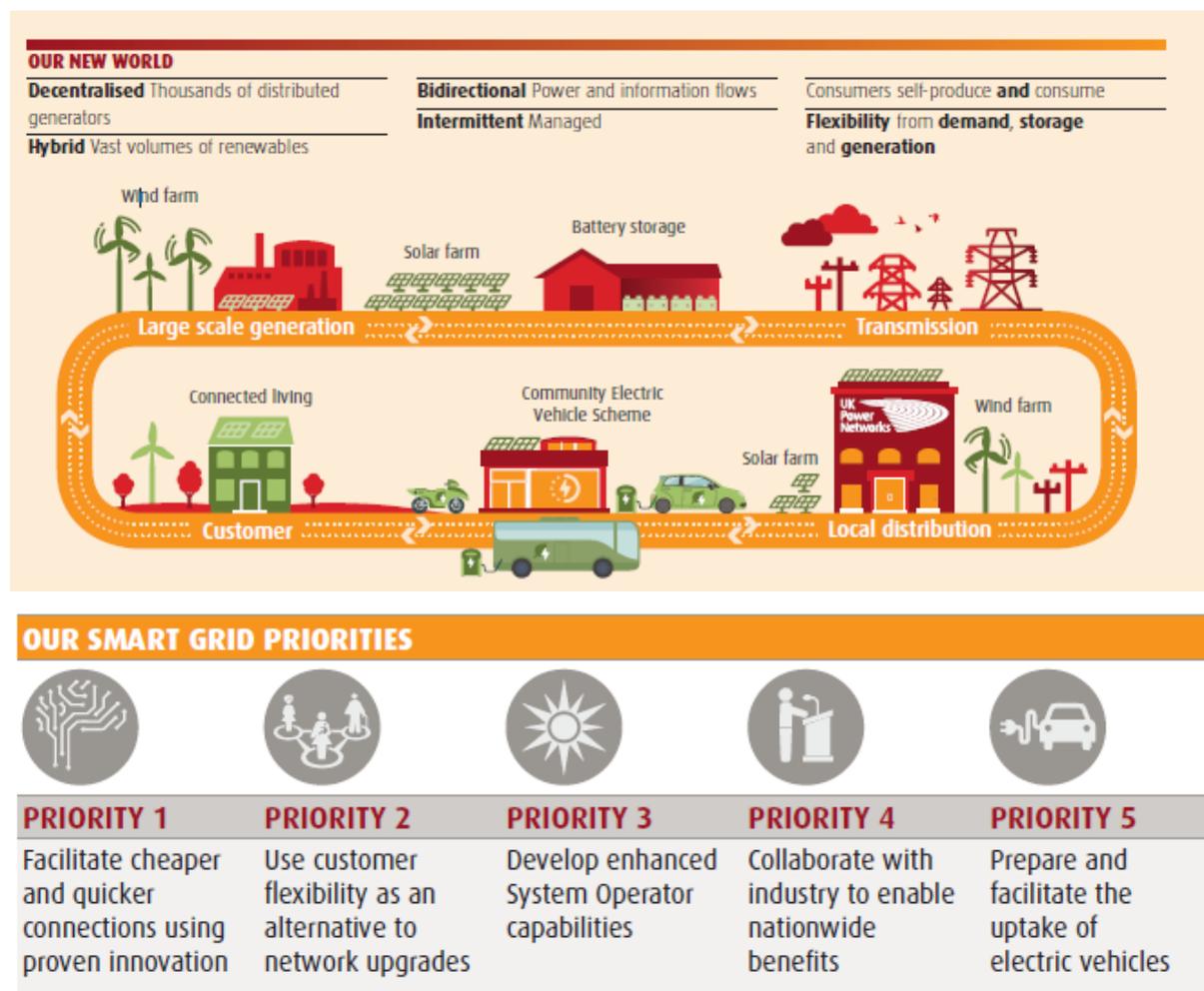


Figure 9: The new energy world and our five Smart Grid priorities

Over the last regulatory year our focus has been on delivering outcomes against our [DSO strategy](#). Examples of this include:

- Priority 1 and 3 – Building on past innovation projects, we mobilised internal and external teams following the award of a contract to a consortium including SGS and Greensync to deliver the future Active Networks Management platform and services. Integrated with our existing network management system, this will enable us to deliver flexible generator connections and other services over a wider geographic area in the coming years.
- Priority 2 – As set out in our November 2019 [Flexibility Roadmap](#), we delivered a round of [flexibility](#) tenders in 2019 and prepared for the April 2020 tender via the Piclo platform, fulfilling our commitment to transparently market-test against requirements for load-related reinforcement.
- Priority 3 – Our Power Potential innovation project delivered a live DERMS (Distributed Energy Resources Management System) integrated with our network management system and upgraded Remote Terminal Units at customer sites. We also commissioned the first generator customer to deliver reactive power services in trials with the transmission system operator.
- Priority 4 – We continued to disseminate innovation project learning and work collaboratively with other network licensees via the ENA’s Open Networks project.
- Priority 5 – We developed and implemented our [Electric Vehicle Strategy](#), which is described further in section 3.2.2.

3.1.2 Low carbon technology (LCT) uptake in the E7 tables – DG, EV charge points and heat pumps

Since 2015 we have monitored yearly uptakes of distributed generation, EV charge points and heat pumps and reported these values to Ofgem. The values presented in Table 21 and Table 22 are for the 2019/20 regulatory year and are reported in the E7 – LCTs worksheets (please see the Annexes and Appendices) for the three licence areas. They show the combined values for the primary and secondary networks.

	EPN	LPN	SPN	Total
Heat Pumps	1,267	26	386	1,679
EV slow charge	364	1,408	430	2,202
EV fast charge	3,939	1,657	2,452	8,048
PVs (G83)	1,188	210	411	1,809
Other DG (G83)	0	0	0	0
DG (non G83)	6	2	2	10
Total	6,763	3,302	3,681	13,746

Table 21: Number of LCTs connected in the last regulatory year (excluding storage)

	EPN	LPN	SPN	Total
Heat Pumps	5	0	2	7
EV slow charge	1	5	2	8
EV fast charge	40	22	24	86
PVs (G83)	4	1	1	6
Other DG (G83)	0	0	0	0
DG (non G83)	4	2	2	7
Total	54	30	30	114

Table 22: Additional MW of LCTs connected in the last regulatory year (excluding storage)

The tables above and the E7 – LCTs worksheets do not currently include information on storage assets. However, as noted in our commentary to the E7 – LCTs worksheets, the significant growth of storage connections is useful context, despite not being part of the E7 tables. We currently have 307 MW of grid scale storage connected to our network; 201 MW in EPN, 3 MW in LPN, and 103 MW in SPN. Decarbonisation of the energy system is best achieved if the renewable energy generated can be stored; as such, we believe it is key that growth of this technology is visible in this report.

Our commentary on the E7 tables confirms that the added LCT volumes were smaller than those predicted for 2019/20 in our [RIIO-ED1 Business Plan](#) – as detailed further below with additional policy context. Our specific strategies for EV and Heat are detailed in section 3.2.2.

Generation

In the last year, 1,809 small PV systems were connected under the G83 and G98¹² Engineering recommendations, plus 10 larger generators. The latter equated to 7 MW of generation connected, compared to 192 MW in the previous year.

¹² From 27 April 2019, type-tested generation of ≤16 A per phase was connected under Engineering Recommendation G98 instead of G83, to comply with [European Network Codes Requirements for Generators](#) (RfG). On the same date, larger generation connections under G59 had to comply with G99 instead.

We highlighted in previous years that changes in both the Feed-in Tariff (FiT) and Renewables Obligation schemes could result in lower volumes (1,809 units versus our 2015 prediction of 34,000). With the removal of the FiT in March 2019, and the Smart Export Guarantee not being mandated until 1 January 2020, there was a reduced incentive for new installations for over nine months of the 2019/20 regulatory year – evidenced by the lowest volumes of G83 installations over RIIO-ED1 to date. We expect no significant increase in volumes in the next regulatory year, as the economic impacts of the COVID-19 pandemic are uncertain at this time.

The removal of the FiT and associated database represents the loss of a key data source for small (<50kW) embedded generation installations. In recent years we have seen an improvement in terms of installers notifying us of the installation of small generation. However, there is very low correlation to the FiT data and the notification data and as such, we are not able to simply rely on this data set.

Low carbon electrified heat

Decarbonisation of heat has lagged expectations throughout the RIIO-ED1 period. In 2015 we expected over 40,000 heat pumps to connect in 2019/20, whereas 1,679 actually connected, 2% less than in 2018/19. In the last year there has been a shift in the focus and attention placed on this subject. There have been a number of movements in the policy space which we expect will drive uptake in future years.

The Renewable Heat Incentive (RHI), which drove the bulk of heat pump installations, had been due to close in 2021, but has now been extended until 2022. There has been a decline in applications for the domestic RHI due to impacts associated with the COVID-19 pandemic. However, despite this, the first quarter of 2020 saw an increase in air-source heat pump (ASHP) accreditations. This follows a consistent positive trend in ASHP uptake since the third quarter of 2018.

The Committee on Climate Change has highlighted that UK heat decarbonisation policy needs to be rethought if the 2050 heat decarbonisation targets are to be achieved. There are proposals to take homes off the gas grid during the 2020s, as outlined in the Clean Growth Strategy. The Clean Heat Grant (CHG) – which will replace the RHI – is expected to boost heat pump uptake from 2021/22. The government has recognised that upfront capital cost of a renewable heat source is the largest barrier to uptake for many people who may otherwise consider converting to renewable heat. This is why the CHG will move away from a tariff-based mechanism and towards an upfront grant mechanism. The proposed form of the grant is a flat rate of £4,000 for all technologies eligible under the CHG. This will put the onus on the market to find which of these offers the most cost-effective low carbon technology for each property. For a large proportion of UK Power Networks' stakeholders these are likely to be heat pumps, as highlighted in the Carbon Trust report for the GLA: [Heat pump retrofit in London](#).

In addition to the Clean Heat Grant, the government launched the Green Homes Grant in August 2020 to support home improvements until 31 March 2021. The grant covers home improvements such as insulation and energy-efficient windows, as well as heat pumps. It takes the form of a voucher which will cover two-thirds of the cost of eligible improvements up to a maximum of £5,000 in most cases. If someone in a household is receiving certain benefits, the voucher could be up to £10,000 and cover 100% of costs.

EV charge points

While the uptake in EVs is behind initial projections, it is now showing signs of acceleration. Originally, in our [RIIO-ED1 Business Plan](#) we had predicted over 36,000 charge points connecting in 2019/20. Although only 10,250 of these were realised, this still represents a 12% increase on 2018/19 charge point connections. Nearly 80% of these were fast charge points with the remaining 20% slow chargers (For the purpose of Table 21 and Table 22 above, the fast chargers category includes 7 kW and higher.)

This acceleration can also be seen in the increasing number of EVs that are being registered. In 2019/20 approximately 29,000 were registered within our licence areas – over three times as many as the 9,500 registered in 2015/16. This growth is being driven by a number of factors that are increasing the attractiveness of owning an EV. Financially, models are becoming more affordable and mainstream, with government subsidies on both EVs and at-home charge points improving affordability and feasibility further^{13 14}. Then there is the focus on air quality in urban areas – as demonstrated by the introduction of London’s Ultra Low Emission Zone¹⁵. In addition, as on-street charge points become more visible and EVs’ ranges increase, perceived range anxiety in prospective EV owners is reduced, making EVs a more viable choice.

We expect numbers of off- and on-street EV charge points to increase in the next regulatory year for a number of reasons. Most obviously, this will be as a direct result of the increase in the number of EVs on the road for the reasons stated above. Despite the economic impact of COVID-19 potentially reducing the rate of increase of new purchases of EVs, there has been a noticeable switch from public to private transport in response to the pandemic. While the majority of early adopters have likely had access to off-street parking spaces in which to charge their EVs, as adoption becomes more mainstream a greater proportion of charging will happen on-street (or at other public destinations).

In addition, the policy environment is now much more aligned to strong EV uptake and we expect this to further incentivise EV ownership. As well as the UK government’s legally binding commitment to achieve net zero by 2050, 68% of local councils have declared climate emergencies¹⁶, with a number setting more ambitious net zero target dates. This has resulted in local environment and transport strategies that prioritise the electrification of transport and the infrastructure required to facilitate this. Nationally, the government has consulted on bringing forward the ban on petrol and diesel cars to 2035¹⁷ and government schemes are also in place to encourage EV uptake and charging infrastructure, such as a £3,000 subsidy on the purchase of an EV, the Electric Vehicle Homecharge Scheme and tax relief on EVs as company cars¹⁸. At this pivotal moment in the adoption of EVs, an associated increase in charge points in the right locations will be vital to enabling the acceleration in EV volumes.

3.2 Progress of the Innovation Strategy

We published an updated [Innovation Strategy](#) in January 2020 – the third edition in ED1. Our first strategy was published in 2015, and revised in 2017. Since 2015 we have updated our approach to reflect feedback received from stakeholders who engage with us for idea and project development, and the changing industry context with the government’s May 2019 commitment to achieve net zero. The strategy sets out our approach to idea sourcing, and selection/prioritisation of ideas to take forward in our innovation portfolio.

The 2020 Innovation Strategy is the continuation of our previous work to review and improve our processes and procedures and most importantly, identify ways to make it easier and more accessible for customers, companies, innovators and general stakeholders to engage and collaborate with us. It covers aspects such as how stakeholders are embedded in the selection and delivery of innovation projects. Our primary selection criteria are effort to deliver, potential benefits and strategic fit. Our refreshed Innovation Strategy comes at a time when the opportunities and challenges facing electricity distribution have never been greater. We are encouraged by the volume of ideas that come through our innovation pipeline and the portfolio of projects that continues to grow.

As shown in Figure 1 at the beginning of this report, innovation is a key component of our corporate vision. In particular, within the objective to be ‘A Respected and Trusted Corporate Citizen’, a key success indicator in delivering our vision is to be classed as the ‘Most Innovative’ DNO.

¹³ <https://www.gov.uk/plug-in-car-van-grants>

¹⁴ <https://www.gov.uk/government/collections/government-grants-for-low-emission-vehicles>

¹⁵ <https://tfl.gov.uk/modes/driving/ultra-low-emission-zone>

¹⁶ <https://www.climateemergency.uk/blog/list-of-councils/>

¹⁷ <https://www.gov.uk/government/consultations/consulting-on-ending-the-sale-of-new-petrol-diesel-and-hybrid-cars-and-vans>

¹⁸ <https://www.gov.uk/government/publications/ultra-low-emission-vehicles-tax-implications>

Our refreshed Innovation Strategy continues to focus on three areas (see Figure 10) – the evolution for 2020 was the shift from Low Carbon Ready to Net Zero Ready. While we are committed to enabling LCTs like EVs, we will never lose sight of the fact that our primary responsibility is to keep the lights on.



Figure 10: Areas of focus in our Innovation Strategy

The overall portfolio of innovation projects – both those funded under the Network Innovation Allowance (NIA) and beyond – is summarised in the [NIA summary report](#) for this year. The final page of that document shows how the projects are spread across the Efficient and Effective, Net Zero Ready and Future Ready innovation themes. During the 2019/20 regulatory year, there were 42 live innovation projects with a total value of £65 million in delivery. 38 were NIA projects (listed in the CV36 tables in the Cost and Volumes worksheets, of which more than one-fifth are in collaboration and led by other DNOs) and four were Network Innovation Competition (NIC) projects (see Table 23). The end dates below include the impact of the COVID-19 pandemic on project delivery timescales.

Project	Licence area where trialled	Start date	Planned end date	Total budget	Area	Innovation theme
Optimise Prime	EPN, LPN and SPN	January 2019	February 2023	£18,449,810	Facilitate EV fleet charging	Net Zero Ready
Active Response	EPN, LPN and SPN	January 2018	March 2022	£17,023,824	Automated reconfiguration of network capacity	Efficient and Effective/ Net Zero
TDI 2.0 (Power Potential)	SPN	January 2017	July 2021	NGESO led, but 2/3 is UKPN	Reactive power services from DER to transmission network	Future Ready
Powerful-CB	LPN	January 2017	January 2022	£3,859,499	Fault-current limiting circuit breaker to enable more generation connection	Net Zero Ready

Table 23: NIC projects

3.2.1 Stakeholder engagement within our Innovation Strategy

We actively engage with stakeholders in order to meet three key objectives:

1. Access to great ideas, responding to real challenges
2. Collaborate with partners to take an idea forward and innovate
3. Communicate our findings and explain the benefits from our innovation projects

Last year we undertook more than 64 external innovation stakeholder engagement sessions to connect with industry, and conducted our popular Better Networks Forum, where we were able to share several of our solutions with other networks and the wider industry. We continue to promote innovation internally and externally by including innovation content across our company and stakeholder events. This allows us to develop ideas and engage early with the end users of each innovation solution.

Further information on our approach to stakeholder engagement – including our stakeholder map – can be found in the [NIA summary](#) report for the year and in the [Innovation Strategy](#).

The ‘Key Collaborations’ section of the NIA summary report highlights the scale of innovation work in collaboration with other organisations – since the beginning of RIIO-ED1, 75% of our NIA funding has funnelled to third parties, with 38% of our total projects happening in direct collaboration with other DNOs. This collaborative approach ensures we have the right people and the required skill set in each project, delivering the highest value in the most cost-effective way.

External engagement and collaboration is evidenced throughout our innovation portfolio. We are working with owners of distributed generation, such as wind and solar farms, on our Power Potential, Energy Exchange and Network Vision innovation projects. On Urban Energy Club, we are collaborating with EDF and the community energy organisation Repowering London. We are also working with the Repowering on our Home Response project – alongside the Greater London Authority and home energy storage company Moixa – to help London residents access the benefits of the growing flexibility market.

3.2.2 Specific strategies for net zero – EVs and heat

Within our overall innovation portfolio, we work extensively on facilitating the net zero transition by supporting decarbonisation in strategic areas. Within the last regulatory year, to underpin our net zero aims, we have published two specific strategies – an [Electric Vehicle Strategy](#) (October 2019) and a [Heat Strategy](#) (March 2020); the latter was the first heat strategy to be created by a DNO. We engaged with stakeholders on these at our Net Zero Networks Forum in March 2020.

EVs

In October 2019 we launched our refreshed [Electric Vehicle Strategy](#), designed as a consultation with questions for the industry. We received more than 40 responses from investors through to manufacturers and installers, helping us understand how we can work more closely with the sector. We have attended and presented at numerous conferences and events to promote engagement around our work on EVs. These range from the Low Carbon Networks Innovation Conference in October 2019 to the Worshipful Company of Fuellers Energy Conference in November 2019 and MOVE 2020 in March, a flagship event for the global electric transport industry.

Elsewhere, our TransPower V2G project portfolio has seen us partner with over 20 organisations, including local authorities, suppliers, technology providers and academics, to develop a vast cross-sector initiative involving the likes of Octopus, Nissan and Innovate UK.

Collaboration is also at the heart of our Shift project. We are working with Octopus Energy, intelligent energy platform Kaluza and EV charging platform provider ev.energy to offer EV owners the opportunity to take part in the economic, environmental and social benefits of smart charging. The trial is already gathering vital results we can share across the industry, generating further ideas. As a result, we have provided feedback to Ofgem to inform its Targeted Charging Review, which has led to new business-as-usual supplier tariffs for consumers, such as Octopus Go Faster. We are also continuing our work on Optimise Prime, the world’s largest commercial EV trial in partnership with Hitachi, British Gas, Royal Mail and Uber.

We use this suite of EV innovation projects and stakeholder collaboration to support three objectives in our strategy, as shown in Figure 11.

Our Electric Vehicle Strategy

OBJECTIVE	OBJECTIVE	OBJECTIVE
Informing investment and industry leading policies and standards	Deliver great customer experience	Network prepared for EV uptake
ACTIVITY	ACTIVITY	ACTIVITY
Achieve the best forecasting tools to support planning	Most choice available and customer convenience	Smart toolbox
Clear and accessible policies and standards	Continue to engage and provide transparency of required data	Deploy efficient investment: right sized and timed

Figure 11: UK Power Networks' Electric Vehicle Strategy

Heat

In March 2020 we hosted our first-ever Net Zero Networks Forum, attended by more than 70 industry professionals. At the event we launched our industry-first [Heat Strategy](#) which outlines our key objectives on decarbonising heat. Like our EV strategy, it was set out as a consultation to ensure we gather feedback throughout the lifetime of the strategy, acknowledging this fast-changing and dynamic sector. We were joined by eight guest speakers from across government, industry and the charitable sectors. They included Dr Matthew Aylott, Electrification of Heat Lead at the Department for Business, Energy and Industrial Strategy (BEIS), and Danni Barnes, Director of Operations at the fuel poverty charity National Energy Action (NEA). We believe that such collaboration is critical to facilitating more innovation. Ultimately, deepening our knowledge and evidence base will help us prepare a robust investment plan to facilitate the uptake of electric heat for our next regulatory price control period, commencing in 2023.

3.3 Roll-out of smart grids and innovation into business as usual

3.3.1 Rolling out innovative solutions into business as usual

UK Power Networks has a process for monitoring the progress of innovation solutions to ensure that when they are ready they are deployed by the business to achieve benefits, and these benefits are quantified. This is detailed on pages 21-22 of our updated [Innovation Strategy](#) which sets out how we deploy and track benefits of innovative solutions in the current regulatory period and our thinking on a common measurement framework for the next regulatory period.

We now have 40 business-as-usual smart solutions deployed. These are categorised into seven distinct areas:

1. **Improve network capacity** – These solutions are focused on increasing capacity within the existing infrastructure. They include our London network interconnection, any demand side response procurement, load sharing across assets, and deployment of load blinding relays.
2. **Improve asset lifecycle** – These solutions are derived from our Efficient and Effective innovation portfolio and their purpose is to extend the lifecycle of our existing assets. They include devices such as the joint shell; techniques for managing oil, such as oil regeneration or the Perfluorocarbon Tracer (PFT) fluid filled cable that helps locate leaks; tools to assess our overhead lines; and improving maintenance of our poles, such as the use of woodpecker filler.
3. **Improve network performance** – These solutions are focused on improving the quality of supply of our networks. They include devices such as LV re-closers, the automated power restoration system and our contingency analysis tools that help us plan outages.
4. **Improve vegetation** – These solutions are focused on improving the way we manage the vegetation around our assets – for example, any technique that will help us target our tree cutting practices more efficiently.

5. **Improve safety** – These solutions are focused on improving safety for our employees and anyone who comes into contact with our assets. They include 3D laser surveying, a new condensed aerosol fire suppression system and the Mobile Asset Assessment Vehicle (MAAV) that helps us assess the voltage of the network on the go.
6. **Improve environmental impact** – These solutions are focused on reducing the impact that our assets have on the surrounding environment. They include the use of polymer-based bunding equipment, which replaces the traditional concrete/brickwork for transformers.
7. **Improve connections performance** – These solutions target benefits for our connections customers. They allow customers to connect to our network quicker and more cheaply and include flexible distributed generation and timed connections.

Table 24 lists all 40 innovation projects that have transitioned into business as usual, the applicable voltage level and the associated RIIO output area. The first column indicates the Environment Report where further information describing the project can be found.

In our 2017/18 and 2018/19 Environment Reports, we described solutions that were already being deployed as business as usual. Eleven further projects are described in the next section.

The financial benefits assessment approach followed by UK Power Networks in preparing the E6 – Innovative Solutions worksheets on the impact of innovative solutions is to identify:

- + Avoided costs due to the solution
- Costs of deploying the solution
- + CI and CML saving (interruption incentive)
- + Losses saving
- + Estimated Impact on Fatality (£ million)
- + Estimated Impact on Serious Injury (£ million)

These benefits are calculated consistent with the RIIO-ED1 CBA guidance and the total of these items demonstrates the financial benefits. (The tables also indicate MVA capacity released, but this is not given a financial equivalent.) In total, our 40 BAU solutions have delivered £232 million of savings since the 2015/16 regulatory year (the first year of the RIIO-ED1 period). In 2019/20 we saved £47.56 million by deploying the smart solutions reported in the E6 – Innovative Solutions worksheets. The values are calculated based on the detailed E6 submission, but this financial summary is not included in the E6 worksheets.

Solution described in year	Solution	Voltage level of issue	RIIO Output	Benefits (£m)	
				2019/20	ED1 to date
Increase Network Capacity/Optimise Utilisation					
2017/18	Dynamic Transformer Rating (RTTR)	33kV	Load Indices	0.000	4.946
2017/18	LPN Interconnection	11kV	Totex	1.117	7.168
2017/18	Energy Storage	33kV	Load Indices	0.000	4.618
2017/18	Demand Side Response	33kV	Load Indices	0.000	1.191
2017/18	FUN-LV	LV	Totex	0.000	0.260
2017/18	Load Blinding Relays	33kV	Connections Service	0.000	11.180
2018/19	Kent Active System Management	132kV, 33kV	Load Indices	0.000	0.000
2019/20	Recharge the Future	11kV	Availability	0.000	0.000

Solution described in year	Solution	Voltage level of issue	RIIO Output	Benefits (£m)	
				2019/20	ED1 to date
2019/20	Load Blinding Relays for Busbar Protection	11kV, 33kV	Totex	0.176	0.176
2019/20	Load Share	132kV	Totex	12.054	12.054
Improve Asset Life Cycle Management					
2017/18	Joint Shell	LV	Health Indices	0.112	0.755
2017/18	Oil Regeneration	33kV, 132kV	Health Indices	0.000	-0.254
2017/18	PFT (Fluid-filled cable leak location)	33kV/66kV/ 132kV	Environment	1.134	5.427
2017/18	CNAIM Modelling	All	Health Indices	20.882	62.635
2017/18	Woodpecker filler	All	Health Indices	0.069	0.239
2018/19	OHL Assessment Tool	HV, EHV	Health Indices	1.893	1.893
2018/19	Pressurised Cable Active Management	132-33kV	Environment	0.045	0.220
Improve Network Performance					
2017/18	LV Re-energising Devices	LV	CI, CML	0.635	2.928
2017/18	Automated Power Restoration System	11kV	CI, CML	9.362	30.929
2018/19	OHL Assessment Using Panoramic Images	11kV	Health Indices	0.000	0.000
2018/19	Primary Outage Restoration Tool PORT	11kV	CI, CML	0.597	1.426
2018/19	Directional Earth Fault Passage Indicator	11kV	CI, CML	0.000	0.000
2019/20	Infrared Imaging Camera	LV	CI, CML	0.230	0.230
2019/20	OHL FPIs	11kV	CI, CML	0.027	0.027
2019/20	Remote Portable Switch	HV	CI, CML	1.508	1.508
2019/20	HaysysPIU	LV	Totex	0.064	0.064
2019/20	Fusesaver	HV	CI, CML	-0.556	-0.556
Improve Vegetation Management					
2017/18	LIDAR Vegetation Management	11kV, 33kV, 132kV	Totex	0.000	12.200
Improve Safety					
2017/18	Public Safety	All	Safety	-0.213	-0.919

Solution described in year	Solution	Voltage level of issue	RIIO Output	Benefits (£m)	
				2019/20	ED1 to date
2017/18	Mobile Asset Assessment Vehicle	LV	CI, CML, Losses, Safety	-1.654	-3.436
2017/18	3D Laser Surveying	EHV	Safety	0.090	0.067
2018/19	Fire Pro Fire Suppression System	HV, EHV	Guaranteed Standards (ATTC/Q)	-0.009	0.147
Improve Environmental Impact					
2017/18	Innovative Bunding	HV, EHV	Environment	0.000	0.045
Improve Connection Performance					
2017/18	Flexible DG Connections	LV, 11kV, 33kV	Connections Service	0.000	72.600
2017/18	Distribution Network Visibility (DNV) Application	HV, EHV	Guaranteed Standards (ATTC/Q)	-0.002	0.042
2017/18	Point of Connection (POC) Mast	33kV	Connections Service	0.000	0.478
2017/18	Timed Connection	HV, EHV	Connections Service	0.000	1.680
2019/20	Global Earthing System	11kV	Connections	0.000	0.000
2019/20	Smart Traffic Lights Kent	LV, 11kV	Safety	0.003	0.003
2019/20	Timed Connection Assessment Tool	HV, EHV	Connections Service	0.000	0.000

Table 24: Our 40 business-as-usual innovative solutions by type, voltage level, related RIIO output table and benefits delivered in £ million in 2019/20 and to date in RIIO-ED1

3.3.1.1 Solutions that changed from last year

Last year we forecast £23 million of savings for 2019/20, based on the 29 E6 solutions reported in 2018/19. We significantly exceeded these expectations. In 2019/20 our 40 E6 solutions delivered £47.56 million of financial savings as itemised in the E6 tables, alongside additional intangible safety, customer service and efficiency benefits.

While there were some specific projects with lower than expected benefits, the significant increase in these figures is due to several factors:

- Significantly increased value from CNAIM modelling to improve the targeting of interventions for asset health
- Inclusion of new solutions (shown in amber in Table 24 above) in the *Improve Network Performance* and *Improve Network Capacity* portfolios
- Continued benefits from further deployment of our Perfluorocarbon Tracer (PFT) for fluid-filled cable leak location (no deployment predicted last year)
- Additional benefits from application of the OHL Assessment Tool – expected to increase further next year
- Net losses (benefits exceed investment) as reported in the E6 worksheets for our portfolio of safety innovations, including the MAAV; however, safety remains a key priority for UK Power Networks, due to its wider intangible benefits for employees, contractors and customers.

3.3.1.2 New solutions rolled out

Our innovative solutions are at various stages of roll-out. Throughout their life cycle they undergo a process of assessment, development and monitoring through to a completed roll-out to business as usual. The process is described in our [2017/18 Environment Report](#) (see section 3.3 of that document) and the updated Innovation Strategy.

This year we have added 10 solutions to the 30 already deployed to business as usual. Table 25 describes these solutions, which innovation project they originate from, and the key assumptions and calculations made for the achieved benefits. Links are provided to further information on the trials – for example, on the ENA Smarter Networks portal. The table also includes one project – Recharge the Future – that was included in last year’s list of solutions but not described. Two of the projects were fast-followers of valuable innovations from other DNOs. Further detail and a CBA assessment for these solutions can be found in the Annexes and Appendices.

Solution	Description	Innovation project/source of solution	Benefit calculation
Recharge the Future	The EV module of the 'Element Energy Load Growth (EELG)' model, which UK Power Networks uses to forecast EV load growth, is enhanced to reforecast load investment requirements by enabling more accurate modelling tools including granular geographical and temporal distribution of EV load.	Recharge the Future NIA	<ul style="list-style-type: none"> • Currently zero. Although the Recharge the Future solution has been deployed and is delivering value through deferred load reinforcement, this cannot be directly linked with the solution in a way that allows us to quantify the benefit. • UK Power Networks is developing a strategic load forecasting system which builds on the Recharge the Future solution and is expected to be available by the end of 2020/21. This will enable us to quantify the benefits delivered by this solution.
Load Blinding Relays (LBR) for Busbar Protection	Following the successful application of load blinded directional overcurrent relays for connecting more generation, LBR is being applied at substations to enhance rough balance protection to guarantee clearance of stuck breaker feeder faults. This addresses the problem of achieving relay sensitivity and stability in substations with very long feeders.	Flexible Plug & Play LCNF Tier 2 project	<ul style="list-style-type: none"> • The traditional approach to solve the protection settings problem would be to expand the busbar with a new busbar section, which will reduce the load on each busbar section and accommodate lower protection settings. This approach has a high cost associated with it. • Counterfactual cost estimated from the Planning teams based on experience and similar past projects.
Load Share	A network and site specific solution to controlling the flow of power dynamically using an innovative technology provided by Smart Wires: Power Guardian and PowerLine Guardian. This solution can avoid costly and time-consuming traditional approaches, engagement with stakeholders on local construction impact and require system outages. Load Share is a less intrusive way to release spare capacity on the network.	LoadShare NIA	<ul style="list-style-type: none"> • The baseline counterfactual cost at initial site was £27m for undergrounding and restringing of two 132kV circuits • Benefits = [Investment cost – Baseline cost] x 50% + Maintenance cost/year • Capital cost of initial deployment shared 50% between business and innovation • Maintenance costs based on GSM transmission and site visits

Solution	Description	Innovation project/source of solution	Benefit calculation
Infrared Imaging Camera	LV faults jointers locate thermal hot spots caused by cables that have faulted or from cables that are likely to fault. An Infrared Thermal Imaging Camera (ITIC) is used with other fault location techniques to locate a fault and restore supplies more quickly. For repeated incipient faults, the ITIC is used to find the location and pre-emptively fix to avoid future faults.	Fast-follow from another DNO (SSEN NIA project) Thermal imaging Observation techniques for Underground CAble Networks (TOUCAN)	<ul style="list-style-type: none"> • Use of an ITIC reduces CMLs and occasionally CIs if defects are located prior to a fault occurring. • Data is collected from activity logs to determine the number of fault jointers using the ITIC regularly. • The fault reporting system is able to produce numbers of permanent faults and incipient faults (no fault found). These numbers are used to calculate the benefits when restoration times are reduced or estimated when events did not occur because the fault was repaired before it became permanent.
OHL FPIs	Fault Passage Indicators (FPI) with remote communications can provide an indication on PowerOn (the network management system) to enable control engineers to direct operational staff to a manually-operated switch, to restore the maximum number of customers.	Overhead Line Fault Location Concept and Directional Earth Fault Passage Indication NIA	<ul style="list-style-type: none"> • If six or more FPIs of any type are installed on a feeder then a CML reduction can be realised on 11kV overhead networks of 12% in SPN or 16% in EPN. • 11kV fault reports are matched up with feeders with at least six FPIs to identify when benefit is gained.
Remote Portable Switch	The Remote Portable Switch is an adaptation to a Siemens Fusesaver (and associated working practices) which can be used by live-line hot-glove teams to make and break connections between rings and parallels.	Additional opportunity identified during the " Better Spur Protection " NIA	<ul style="list-style-type: none"> • Instead of taking an outage to allow work to be carried out on overhead lines, causing supply interruptions to customers, the RPS is used to limit or remove the need for the outage, saving CIs and CMLs and the delivery costs of planned outages. • Benefits identified from a log of actual live-line jobs and duration of customer impact (converted to CI and CML), compared to six-hour outage expected from standard working techniques

Solution	Description	Innovation project/source of solution	Benefit calculation
HaysysPIU	<p>The Haysys Phase Identification Unit (PIU) is a handheld device that can identify to which supply phase a property is connected, at a distance away from the property or any point of the connection, so the assessment can be done quickly and in a non-invasive way.</p> <p>Each usage is recorded on the device and reported back to a database.</p>	<p>Fast-follow from collaboration with another DNO (WPD) on the "LV Current Sensor Technology Evaluation" LCNF Tier 1 project and related IFI project.</p>	<ul style="list-style-type: none"> • Use case 1: phase identification for LV load balancing – 200 properties can be assessed in two hours, rather than two days, providing information so planners can connect to the lightly loaded phase, reducing reinforcement and losses costs • Use case 2: confirm customers back on supply without disturbing customers, improve customer satisfaction score • Use case 3: restoring faults – confirms loss of supply, narrows down fault location for more accurate excavation at lower cost
Fusesaver	<p>The Fusesaver is a remotely-controlled spur switch which can break and make current under fault conditions quickly enough to prevent a phase fuse from operating and preventing supply interruptions to customers connected to main line. Spurs with large numbers of connected customers have been identified. When a fault occurs, the Fusesaver will operate before the auto-recloser, preventing supply interruptions to customers connected to main line.</p>	<p>Better Spur Protection NIA</p>	<ul style="list-style-type: none"> • Fault reports from PowerOn can be identified with Fusesaver in the description and then used to derive the CI and CML benefit. • The difference in CIs between the auto-recloser event and the Fusesaver event is the number of customers unaffected by the spur fault. Multiplying the number of customers by the duration gives the minimum CMLs saved by the Fusesaver. • The Fusesaver is monitored, allowing the control engineer visibility of voltages and currents at that point on the network. One unforeseen benefit is that the control engineer can detect an upstream broken jumper just by looking at the measured voltages.

Solution	Description	Innovation project/source of solution	Benefit calculation
Global Earthing System	Defining a distribution network as a Global Earthing System (GES) under BS EN 50522 can simplify the design requirements when adding new substations to a network. The work has allowed a number of improvements to the existing policy and procedures to be identified and that can be implemented in the earthing design tool, and deliver cost reductions.	Global Earthing Systems NIA	<ul style="list-style-type: none"> • Benefits forecast estimate based on reducing the number of earth rods required by one per secondary substation, at over 50% of 400 sites installed per year, at unit cost for each earth rod of £300. • The number of eligible substations and the cost of an earth rod will be validated with actual data.
Smart Traffic Lights Kent	AutoGreen® technology improves traffic flow at roadworks required for works on the network, improving safety and reducing customer complaints. AutoGreen® is an advanced form of smart radar-based Vehicle Actuation (VA) for Holco and Pike portable traffic signals, designed to dynamically adjust signal control to create a safer, greener and more efficient roadworks environment, optimised according to current traffic conditions, allowing the signal to incrementally adapt to an ever-changing traffic environment, without the need for an operator.	Trial funded by UK Power Networks and Kent County Council's 'Lane Rental Innovation Fund'	<ul style="list-style-type: none"> • The key safety and traffic management benefits cannot be assigned a direct monetary value. • The traffic management cost benefits are indirectly estimated based on avoided costs of Fines for Manual Control Breaches benefits, and avoided cost of a manual operator for traffic signals, set against the cost of the solution.
Timed Connection Assessment Tool	This software solution delivers an enduring solution to analysing the network for opportunities to offer timed connections to potential customers. It is able to identify the discrete periods in a 24-hour timescale when the typical peak demand on the network is, and how much additional load can be accommodated within and outside these periods. This will then inform the assessment of the suitability of a new timed connection, as an alternative to a traditional network reinforcement.	Timed Connection Assessment Tool NIA	<ul style="list-style-type: none"> • The solution will save Planning Engineers on average five hours for each timed connection referral at EHV and six hours for ones at HV. Benefits are based on labour rate for the engineers. • This solution does not claim benefits associated with the timed connection (see the separate E6 solution), only the benefits of the timed connection assessment tool.

Table 25: Innovative solutions added in 2019/20

3.3.1.3 Innovative solutions for connections

There are seven solutions that support our connection customers, as shown below. The last three are new for 2019/20.

1. Flexible DG Connections
2. Distribution Network Visibility (DNV) Application
3. Point of Connection (POC) Mast
4. Timed Connection
5. Global Earthing System
6. Smart Traffic Lights Kent
7. Timed Connection Assessment Tool

Table 26 presents the savings delivered by these seven projects to date in the first five years of the RIIO-ED1 period. The majority of savings to date come from our flexible DG connections project. Savings in this project are likely to increase towards the end of RIIO-ED1, as our flexible connections approach (reducing cost and time to connect) is rolled into our new Active Network Management solution, which is being deployed across all three licence areas.

Innovative solutions for connections	RIIO-ED1 savings to date
Flexible DG Connections	£72,600,365
Distribution Network Visibility (DNV) Application	£41,972
Point of Connection (POC) Mast	£477,846
Timed Connection	£1,680,000
Global Earthing System	£0
Smart Traffic Lights Kent	£2,875
Timed Connection Assessment Tool	£0

Table 26: RIIO-ED1 savings to date from innovative solutions for connections

3.3.1.4 New solutions being considered for business-as-usual deployment

The 17 NIA projects shown in Table 27 are expected to close down in the 2020/21 regulatory year, along with the Powerful CB NIC project. Via our innovation gate process (as described in our Innovation Strategy and NIA report), at the closedown of each project we assess its potential and plans to successfully transition into business as usual, to become part of our E6 solutions going forward.

Project name	End date	Project name	End date
EDGE FCLi	27 January 2022	Low Cost Fault Current Measurement of Wooden Poles (EIC)	23 July 2020
Network Vision	30 September 2020	RecorDER	15 October 2020
HV OHL Assessment	21 September 2020	Eye In The Sky (EIC)	29 January 2021
Cold Start	28 February 2021	Underground Fault Predictive	28 February 2021
Urban Energy Club	30 June 2021	Link Alert	28 February 2021
Firefly	28 August 2020	Mobile Field Control	4 March 2021
Engineered Pole Products	5 February 2021	Transformer Care (EIC)	25 March 2021
Unified Protection	31 March 2021	RAFL2 (EIC)	2 August 2021
Storm Joint	23 October 2020		

Table 27: NIA projects completing in the 2020/21 regulatory year

3.3.1.5 Forecast of number of times solutions expected to be deployed in the next regulatory year

Table 28 indicates the number of times our current list of innovation solutions were deployed in this regulatory year, as indicated in the E6 – Innovative Solutions worksheets. This is supplemented by our forecast for additions next year, which is not part of the E6 table. Total forecast benefits for the regulatory year 2020/21 are estimated at £23 million. The table does not include forecast benefits from projects which are yet to complete and transfer into business as usual and would be expected to deliver additional value.

Looking ahead to 2020/21, across our portfolio of deployed innovative solutions we would expect that:

- Our innovative solutions for improving network performance, including LV Re-energising devices and remote portable switches, will continue to be deployed.
- Our innovative solutions for improving the asset life cycle, will continue to provide benefits. However while our CNAIM solution to target asset health interventions delivered significant net benefits in 2019/20, its cost profile means costs may exceed benefits in 2020/21.
- Our innovative solutions for improving network capacity and utilisation will also continue, including KASM's benefits for reducing generator curtailment in the SPN licence area and the LPN Interconnection which designs the network with larger feeder groups than traditionally.
- Overall, benefits delivered to customers through reduced connection times and costs will continue if further developers connect their projects to FDG zones, but this is expected largely beyond 2020/21.
- Our new connections solutions – Timed Connections Assessment Tool and Global Earthing Systems – will deliver new benefits.

Solution	Additional deployments	
	2019/20	2020/21 estimate
<i>Increase Network Capacity/Optimise Utilisation</i>		
Dynamic Transformer Rating (RTTR)	0	0
LPN Interconnection	33	30
Energy Storage	0	0
Demand Side Response	0	0
FUN-LV	0	0
Load Blinding Relays	0	0
Kent Active System Management	1	1
Recharge the Future	0	0
Load Blinding Relays for Busbar Protection	0	0
Load Share	0	0
<i>Improve Asset Life Cycle Management</i>		
Joint Shell	98	98
Oil Regeneration	0	0
PFT	26	28
CNAIM Modelling	104	104
Woodpecker filler	23	24
OHL Assessment Tool	12	93.4
Pressurised Cable active management	1	5
<i>Improve Network Performance</i>		
LV Re-energising Devices	2,078	3,168
Automated Power Restoration System	9,498	0
OHL Assessment Using Panoramic Images	0	0
Primary Outage Restoration Tool PORT	560	0
Directional Earth Fault Passage Indicator	1	0
Infrared Imaging Camera	0	0
OHL FPIs	564	0
Remote Portable Switch	105	105
HaysysPIU	12	0

Solution	Additional deployments	
	2019/20	2020/21 estimate
Fusesaver	54	0
Improve Vegetation Management		
LIDAR Vegetation Management	0	0
Improve Safety		
Public Safety	37	0
Mobile Asset Assessment Vehicle	0	0
3D Laser Surveying	35	0
Fire Pro Fire Suppression System	11	11
Improve Environmental Impact		
Innovative Bunding	0	1
Improve Connection Performance		
Flexible DG Connections	0	0
Distribution Network Visibility (DNV) Application	0	0
Point of Connection (POC) Mast	0	0
Timed Connection	0	1
Global Earthing System	0	400
Smart Traffic Lights Kent	0	0
Timed Connection Assessment Tool	0	10

Table 28: Expected solution deployments in the next regulatory year

3.3.1.6 Additional information, methodology and CBAs

The complete methodology and CBAs can be found in our Annexes and Appendices.

3.3.2 Smart metering

Our strategy for maximising the net benefits of smart metering

Smart meters will help to provide greater visibility of changes on the network that can support cost-efficient investment decision making. Under the smart meter regulatory framework, energy suppliers have an obligation to take “all reasonable steps” to install smart meters in all homes and small businesses by the end of 2020. However, in October 2019 the government consulted on a proposal to implement a four-year extension¹⁹ to enable suppliers to reach market-wide coverage of smart meters, in support of its wider strategic aims for meeting its net zero commitment and addressing the recent economic impact of the COVID-19 pandemic.

Innovative products and services that rely on smart metering – for example, tariffs that reward consumers for using energy when cheap renewable generation is available – will be more important than ever. Smart meters have a crucial role to play in ensuring cost-effective progress towards Great Britain’s net zero commitment within the next five years and in the future.

The increasing uptake of solar panels, EVs, battery storage and other LCTs is likely to place increased demands on the distribution system and on the LV network in particular. It is therefore essential that we manage our networks to cope with the increasing demand in an efficient, coordinated and economical way.

Smart meters have the capability to record energisation status, voltage measurements and energy consumption, and to communicate with energy suppliers and network operators. Data obtained from smart meters can be used to provide a much clearer view of loads on the LV network that is currently not available from traditional meters. With better visibility of the demands on the LV network, we will be able to enhance our practices, deliver the benefits set out in our [RIIO-ED1 Business Plan](#) and support delivery of the government’s net zero commitment.

¹⁹ <https://www.ofgem.gov.uk/publications-and-updates/statutory-consultation-post-2020-smart-meter-rollout-reporting-requirements>

Our [RIIO-ED1 Business Plan](#) sets out three key areas in which benefits from smart meter data will be realised. These are shown in Table 29.

Benefit	Description
Improved asset and performance data – network condition and planning	<p>The availability of detailed consumption data across the network offers the opportunity to significantly improve network planning. For example, consumption data will support the identification of specific areas of the LV network that may need reinforcement and allow informed decisions to be made to defer network reinforcement.</p> <p>Having accurate information regarding the loading of assets (i.e. visibility of real load profiles at each substation and the LV network) will allow utilisation of these assets to be maximised whilst ensuring they are not overloaded. In turn, this may lead to a reduction in the number of faults on the network, helping to reduce overall operational expenditure and subsequently support keeping charges low for customers.</p>
Improved real-time data – fault management and customer service enhancements	<p>Smart meters providing real-time data for fault management via the ‘last gasp’ facility and the capability to remotely test the meter to ascertain the energisation status of the supply to a customer’s premises can significantly improve fault management performance and customer service. It will be possible to identify and target faults more quickly and to provide the customer with significantly enhanced information and a faster response.</p>
Improved real-time control – supporting the future network	<p>The combination of smart meter data and asset data with greater real-time control will pave the way for the network of the future. It will provide the information and capability to support expansion of LCTs and time of use tariffs.</p> <p>There will be the ability to undertake active network management on the LV network and to defer the need for further network reinforcement and new investment, paving the way for a full smart grid using smart meter data.</p>

Table 29: Key areas in which benefits from smart meter data will be realised

Since submitting our [RIIO-ED1 Business Plan](#), we have continued to explore and evaluate smart metering benefits and the best way to realise them. These discussions have informed our Smart Meter Benefits Realisation Strategy. Our strategy is guided by three principles that reflect our ambition to make effective use of smart meter data both in the current RIIO-ED1 period and looking ahead to our RIIO-ED2 business plans. These are:

1. We will continually take the learnings from other roll-outs to accelerate our ability to realise benefits.
2. We will ensure that we have the right levels of ownership and accountability across our business for realising smart metering benefits, and to develop expertise and insight into our smart meter data from the earliest opportunity.
3. We will ensure that our investment in realising the benefits of smart metering aligns with our plans to develop DSO capabilities.

We reviewed our smart metering stakeholder engagement plan in 2019/20, taking into consideration changes to benefits that may be realised from smart meters so that our stakeholders have an understanding of how smart metering enables our Business Plan.

To realise the benefits from smart metering, we recognise that we must continually learn from the data provided from SMETS1 and SMETS2 meters, mindful of the requirements of our Smart Meter Data

Privacy Plan (DPP)²⁰. We have two teams working on our smart meters programme to deliver a system that will enable us to realise benefits from these assets:

- Our Smart Meters Programme team, which is designing and developing the technical solution that will deliver smart meter benefits to the business from the utilisation of power outage and restore alerts, voltage threshold violation alerts, energy consumption data and voltage measurements
- Our Smart Meter Operations team, which is the business owner of the Data Communications Company (DCC) adaptor that allows us to connect to smart meters through the DCC's infrastructure

Combining data expertise, technological capability and business knowledge, these teams have the following responsibilities:

- To act as UK Power Networks' key point of contact with the DCC and other relevant industry partners
- To deliver UK Power Networks' benefits realisation plan
- To develop understanding and insight into smart meter data within the business, to support other functions on how best to embed smart meter data into their day-to-day activities to deliver business benefits

Smart meter installation volumes

Table 30 shows the volumes of cumulative smart meter installations reported by our three licensees for the 2019/20 regulatory year in the CV34 – Smart Meter Intv DNO worksheets. During the year, installation volumes increased such that 38% of UK Power Networks' domestic customers now have a smart meter installed. This compares to 30.2% in the previous regulatory year.

Licensee	2017/18 smart meter volumes	2018/19 smart meter volumes	2019/20 smart meter volumes	2019/20 percentage penetration of smart meters
EPN	302,478	1,000,437	1,340,557	40%
LPN	153,186	494,187	667,376	34%
SPN	200,416	652,697	877,245	38%
Total	656,080	2,147,321	2,885,178	38%

Table 30: Smart meter installations

At the end of the 2019/20 regulatory year a total of 2.88 million smart meters (38% of UK Power Networks' domestic customer base) had been installed in our operating area. The proportions of SMETS1 and SMETS2 meters installed were 72% and 28%, respectively.

Current status of IT and communications investments

Our DCC adaptor has been developed with a strong security framework for our smart metering systems, in accordance with the Smart Energy Code security obligations. The adaptor is the interface to the DCC infrastructure and provides a landing point for smart meter data within our business.

We work closely with the DCC adaptor vendor and other network operators who share the same DCC adaptor platform (Northern Powergrid and Scottish Power Energy Networks). Through this forum we are able to coordinate queries with the DCC to leverage challenges related to infrastructure and data quality issues and jointly achieve the successful resolution of issues.

²⁰ <https://www.ofgem.gov.uk/publications-and-updates/approval-letter-ukpns-data-privacy-plan-access-household-electricity-smart-metering-data>

We remain committed to delivering changes to our IT systems that will allow us to realise benefits from smart meter data. We have therefore continued with developments during the 2019/20 regulatory year that will initially deliver customer service-related benefits from the energisation status check of smart meters once this work is completed.

There are ongoing industry-wide data quality issues and challenges associated with the accuracy of power outage and restore alerts received from smart meters and as such, we have been working with the DCC and another DNO to support the industry in finding a resolution to these issues. We have aligned the timelines of our programme to the smart meter roll-out plans so as to avoid the risk of stranded investment from the changing requirements or other issues outside our control. Delays to the programme and work to resolve the above issues and challenges have resulted in additional costs that have included some changes to our IT systems, delaying the delivery of benefits to customers.

Actions taken in 2019/20 to maximise the value of smart meter data

Our Smart Meter Operations team works closely with the DCC and other DNOs, including through the ENA, to support the delivery of improvements within the DCC infrastructure and data communications systems. The work to leverage improvements is ongoing and includes the testing of meters; timely delivery of power outage alerts; accuracy of the power outage and restore alerts; quality of voltage violation alerts; and more recently, discussions around the testing of polyphaser meters.

During 2019/20 we developed our Smart Meter DPP²¹ that was completed in consultation with the ENA, BEIS, Ofgem, the Information Commissioner's Office and Citizens Advice. The DPP was approved by Ofgem in February 2020, permitting access to smart meter data and enabling us to deliver benefits to our customers and business.

We also continue to support the supplier-led roll-out of smart meters, addressing any required interventions identified within our network on supply termination equipment that could prevent a smart meter from being installed. This work has been recognised by industry partners to be of a high standard, resulting in high levels of customer and supplier satisfaction being recorded through our internally managed satisfaction surveys.

Our approach to this work complies with all of the industry defined Smart Meter Intervention performance Service Level Agreements. Our Smart Meter Interventions team performs a coordinating role to help our engineers support energy suppliers' installations. Within this team a continuous improvement capability has been established, helping to realise further outperformance of the industry-defined metrics. This provides an enhanced installation experience for our customers and for the energy suppliers who require our support at the point of meter installation.

Summary of estimated smart meter benefits realised to date

The communications infrastructure and provision of data services via the DCC into the UK Power Networks gateway has been operational for two years and we are receiving data from SMETS2 smart meters. Testing of systems and application upgrades has been ongoing since the gateway went live. This is required to ensure that the UK Power Networks platform remains compliant with security standards and is aligned to DCC's version of the system, which has also seen frequent updates. An update to the gateway systems will be implemented during the regulatory year 2020/21 that will allow UK Power Networks to receive SMETS1 smart meter data once DCC has adopted those meters into its systems.

While we have not yet realised benefits from smart meters, our project to provide the capability for use of the smart meter energisation status (ping) check will be completed during the 2020/21 regulatory year and allow us to start delivering benefits from these assets.

²¹ <https://www.ofgem.gov.uk/publications-and-updates/approval-letter-ukpns-data-privacy-plan-access-household-electricity-smart-metering-data>

Currently, we are only able to communicate (through the DCC gateway) with the 806,000 SMETS2 meters installed in our operating area. The industry-wide power outage and restore alerts and data quality issues and the relatively small volume of SMETS2 meter installations have provided us with a valuable period to develop and better understand the SMETS2 data and functionality to leverage additional benefits from the smart meter energisation status check capability.

Our plans for realising smart meter benefits in 2020/21 and in future years

We plan to integrate the DCC adaptor into our business systems and applications, providing users with a smart meter energisation status check. We are also working with staff in our customer services function to ensure that opportunities identified for the use of smart meter data are embedded into our digital investment plan. Our digital strategy guides our investment in developing our social media capabilities as well as our website, contact centre automation and Interactive Voice Response (IVR) capabilities. By ensuring that smart meters are part of our thinking in these areas, we will enable our customers to realise the benefits of smart meter data.

We aim to have the new functionality operational from Q1 2021, in line with our Smart Metering Benefits Roadmap that was updated to reflect changed priorities within the programme. These changes related to technological and business changes to realise our smart meter strategy, aligning with SMETS1 smart meter adoption by the DCC and the SMETS2 smart meter roll-out plans released by energy suppliers.

Ongoing concerns about the quality of data received from SMETS2 smart meters continue to be discussed at an industry level, with network operators, the DCC and BEIS working to identify a solution to address the data quality issues and improve the accuracy and timeliness of data received by network operators. These issues coupled with the low volumes of installed SMETS2 meters relative to the higher SMETS1 smart meter volumes have prompted us to further review our programme timescales for the delivery of benefits from power outage and power restore alerts.

A number of projects are under way which will increase the accessibility and visibility of smart meter outage data for our customer service and operational staff. These are explained below.

There are industry-wide issues with the voltage data available from smart meters. We will be analysing the data to better understand the quality of information provided, so that we can develop the capability to deliver benefits to our customers and business from improving the quality of electricity supplied.

Our Smart Meter DPP allows us to collect and process consumption data from all smart meters. During the regulatory year 2021/22, we will develop our smart metering system to meet the requirements of the DPP for managing energy usage data, delivering benefits to our customers and business.

We have also been refreshing our Network Modelling toolsets used within our licence areas. Once completed, this will provide an opportunity to leverage benefits from the use of smart meter data for network analysis. We will also implement the capability to analyse smart meter data for active, reactive, import and export power that can support our management of network losses and planning decisions.

The above highlights our goals for 2020/21 and onwards, with key investments that will enable benefits to be realised from smart meter data once significant volumes of SMETS2 meters are installed and SMETS1 meters have been adopted into DCC's system. We will have suitable tools and processes in place using smart meter data that will enhance our reporting capabilities for operational performance and regulatory report outputs.

While our realisation of smart meter benefits is dependent on the wider roll-out of SMETS2 compliant meters and establishing access to smart meter data including from SMETS1 meters, we have continued to support the industry roll-out of smart meters and are preparing our systems to receive their data. This expenditure, including IT expenditure, is presented in Table 31 for the 2019/20 regulatory year and reported in the E5 – Smart Metering worksheets (please see the Annexes and Appendices).

Source	Category	EPN	LPN	SPN	Total
C22/E5	Smart Meter Communication Licensee Costs	3.63	2.28	2.28	8.19
C22/E5	Smart Meter Information Technology Costs	1.09	0.68	0.69	2.46
CV34	Smart Meter Interventions – On-site/Physical Activities (including prior year restatement)	3.95	0.84	1.47	6.26
CV34	Smart Meter Interventions – Extra Scheduling & Call Centre	0.43	0.12	0.49	1.04
CV34	Smart Meter Interventions – Smart Meter Registration	-	-	-	-

Table 31: Summary of 2019/20 smart metering-related expenditure in £ million

4 Annexes and Appendices

4.1 EPN

[Environment and Innovation Pack – tabs E1-E8 – 2019/20](#)

4.2 LPN

[Environment and Innovation Pack – tabs E1-E8 – 2019/20](#)

4.3 SPN

[Environment and Innovation Pack – tabs E1-E8 – 2019/20](#)

4.4 UK Power Networks

[CV16 and M1 Flooding Mitigation – 2019/20](#)

[Environment and Innovation Commentary – 2019/20](#)

[RIGs E6 CBA – 2019/20](#)

[Generic CBA RIIO-ED1 – GMTs – 2019/20](#)

[Generic CBA RIIO-ED1 – PMTs – 2019/20](#)

