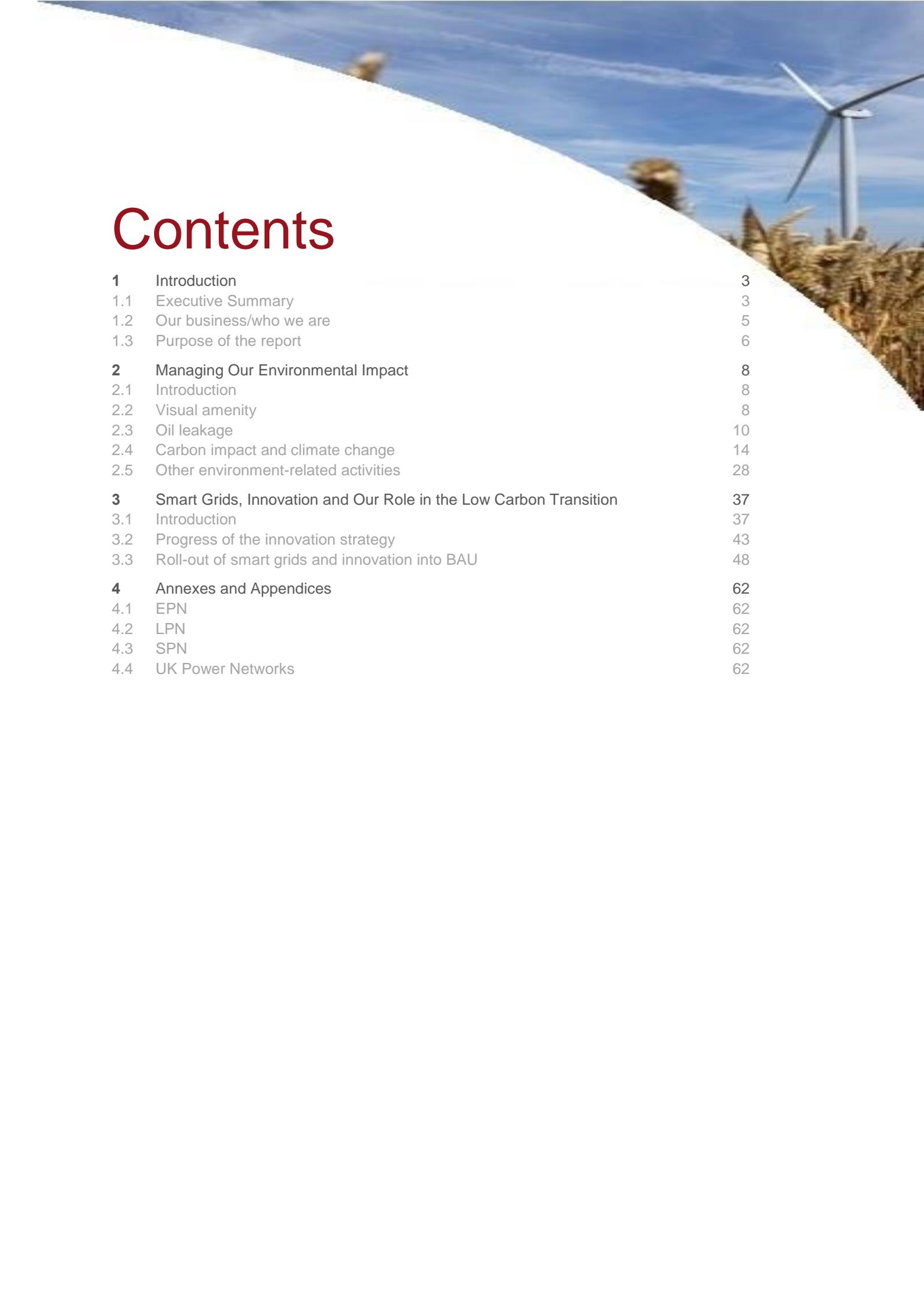


UK Power Networks' Environment Report 2018/19





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1 Introduction

1.1 Executive Summary

We are pleased to present UK Power Networks' Environment Report for the regulatory year 2018/19. 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 an impact on the surrounding area. Being a respected corporate citizen is a key part of our vision (see Figure 1) and we work 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 achievements in 2018/19 and envisaged future areas of activity are set out below:

- In March 2019 we launched our Green Action Plan (GAP), which includes a new set of company-wide environmental targets to challenge and stretch our RIIO-ED1 commitments. The GAP aims to create a structure and roadmap for us to achieve our aspirations on the environmental aspect of sustainability, and details initiatives and opportunities to deliver tangible outcomes over a two-year period. More information is provided in section 2.5 and we look forward to updating stakeholders on our performance against the GAP next year.
- Four years into the RIIO-ED1 price control period we have reduced our business carbon footprint (BCF) by 20.5%; this represents a 4.61% reduction on the previous year's figure and

places us ahead of the target we set ourselves for 2018/19 (2% for each year of the period). We are constantly looking for ways to reduce our BCF and are working with experts in this field to set ourselves more challenging longer-term targets. Section 2.4 provides more information.

- During the 2018/19 regulatory year 86.8% of our office and depot waste was diverted from landfill and either recycled or used for energy recovery – exceeding our existing target of 70% diversion from landfill. A new target of 90% diversion from landfill has been set as part of the GAP (see above) and will apply from 2019/20 onwards. For more information, please see section 2.5.
- 2018/19 was a positive year for UK Power Networks in terms of raising awareness among our employees of the impact our business has on the environment and improving communication with them on environmental issues. We prepared a short animation for staff which demonstrates how to apply control measures to lessen our impact on the environment in common scenarios experienced across our network, such as refuelling operations. We also launched a waste recycling campaign, ‘Talking Rubbish’, which involves visiting office depots throughout our operating area and holding ‘waste surgeries’ to discuss all matters associated with waste management and recycling. Section 2.5 provides more information.
- We continue to replace existing transformers with EcoDesign specification units which reduce fixed and variable energy losses. In 2018/19 we replaced a total of 1,048 distribution transformers, which reduced losses by 4,291.1 MWh per annum. We also replaced 21 primary and grid transformers, further reducing losses by 2,810.2 MWh per annum. In addition, as a result of a collaboration with a transformer manufacturer to develop a pole-mounted amorphous steel transformer, we installed 14 of these units on our networks, collectively delivering an energy loss reduction of 15.5 MWh per annum for their entire lifespan. 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 (BAU) activities. For more information, please see section 2.4.3.
- Our programme of work to tackle theft in conveyance led to 233 cases being resolved across our three licence areas in 2018/19. We also continued our work with other distributors and suppliers to promote more effective electricity theft reduction efforts across the industry. In particular, we showcased our approach to theft in conveyance at the UK Revenue Protection Association Conference in June 2018 and were active in an industry forum, involving suppliers and distributors, to share ideas and best practice. We are also assisting with the drafting of comprehensive new theft guidelines to help parties better understand how to effectively tackle these difficult situations. The guidelines are due to be published by the end of 2019. Section 2.4.3.2 provides more information.
- In 2018/19 we continued to invest in ensuring that customer supplies are protected from flood risk, to achieve our commitment of protecting 78 substations from the effects of flooding during the RIIO-ED1 period. During the year we successfully flood protected 16 substations serving in excess of 330,000 customers, bringing the total number of mitigations so far in RIIO-ED1 to 40. We also carried out 25 detailed flood risk assessments and worked with multiple specialist companies to develop further capability in dynamic flood risk analysis and response across all three of our licence areas. For more information, please see section 2.5.
- We are committed to being an enabler of the low carbon transition. Our comprehensive innovation strategy informed by stakeholders, our DSO and flexibility roadmap 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 low carbon system that addresses our customers’ evolving needs. We have concentrated on developing our DSO capabilities and supporting the EV and heat agendas. In 2018/19 we increased our focus on EVs as there are clear policies driving the uptake; whilst on heat, we are engaging with stakeholders to understand where our role will be critical in supporting the transition. Section 3 explains how our smart grid and innovation portfolios are establishing us as the leading DNO in low carbon readiness.
- Despite considerable effort and resources being deployed to the target for cable fluid losses during the year, a number of significant leaks occurred on circuits, some of which were difficult to access for location and repair due to network constraints. We remain focused on reducing cable fluid leakage, targeting the poorest performing circuits on our network. In addition to leak repairs, significant cable replacement projects have taken place in 2018/19 to remove poorly performing fluid filled circuits from the network. Going forward, we will continue to look for new ways to improve our performance to ensure we consistently achieve our oil leakage targets in all three of our licence areas. Section 2.3 provides 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 0.08% of the SF₆ in service in 2018/19, the best annual performance by a DNO group in this area. We continue to aim to minimise the leakage of SF₆ in order to reduce the impact on the environment. For more information, please see Section 2.4.2.
- In 2018/19 we reviewed and finalised our smart metering stakeholder engagement plan. This includes focused sessions on smart metering-related topics and the incorporation of smart metering into our wider engagement activities, so that our stakeholders have an appropriate context of how smart metering enables our Business Plan. We also developed and submitted for approval our Smart Meters Data Privacy Plan (DPP), completed in consultation with the ENA, BEIS, Ofgem, the Information Commissioner's Office and Citizens Advice. We 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 – with high levels of customer and supplier satisfaction being recorded. Please see section 3.3.8 for more information.
- We continue to work closely with stakeholders to identify schemes that would benefit from the undergrounding of overhead lines to improve visual amenity. Though no undergrounding schemes were completed in the 2018/19 regulatory year, work was undertaken on schemes at South Walsham Marshes, Burnham Overy and Potter Heigham in EPN; these are due to be completed in the next regulatory year. Section 2.2 provides further detail.

Links to our [RIIO-ED1 Business Plan](#) are provided throughout this report and our RIIO-ED1 targets are listed in section 1.3 below.

We very much hope that our stakeholders will find this report of interest and look forward to providing a further update on UK Power Networks' performance in 2019/20.

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 of England and South East 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.

We are also firmly committed to being an enabler of the low carbon transition, developing our future capabilities as a DSO to deliver a secure, reliable low carbon energy system that addresses our customers' 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 2018/19 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
- Managing and preventing waste
- Reducing noise pollution from our assets and promoting biodiversity
- Protecting our substations from flood risk
- 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

In each of these areas 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. 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.

We have Environment Agency permits to operate three waste transfer stations and seven waste oil storage facilities. Electrical insulating oil which is removed during routine maintenance is reprocessed and reused, thereby reducing demand for new oil to be extracted. Through training and compliance 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 Chief Executive Officer. 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 Directorate 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.

2.2 Visual amenity

UK Power Networks is a member of a long-established Steering Group which facilitates the undergrounding of nominated schemes to remove overhead lines within AONB and National Parks in the EPN and SPN licence areas, observing funding criteria specified by Ofgem. The group consists of landscape experts (members of AONB and National Park organisations) acting as stakeholder representatives, and is chaired and facilitated by Natural England who has a national remit to advise on the management of designated landscapes. The group meets every three months.

UK Power Networks holds the position of a non-voting member in this group, providing technical support and guidance for scheme assessments as well as costings for completing the work. The level of support we provide varies from scheme to scheme but will always include the provision of a route for the new cable network and the estimated cost of carrying out the work. Voting arrangements have been expanded so as to enable Steering Group members to vote on schemes outside of their respective DNO areas, and schemes are passed by an overall voting majority. The necessary majority is determined by the Chair at the start of the voting process.

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 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.

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

Projects are assessed against a range of scoring criteria before they can be 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 biodiversity or heritage) are taken into account. 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 £200k per kilometre. However, some schemes, through the technicalities of delivering the work, may represent a value greater than the upper limit and the Steering Group has the discretion to exceed the cap should the scheme warrant it.

Scores, feedback and supporting evidence are recorded. Throughout the scoring process the Steering Group members debate whether all relevant factors have been taken into account and any related issues resolved. A related issue could be whether or not the removal of the overhead line is being carried out in conjunction with other work, such as improvements to facilities to increase visitor numbers to a heritage site.

Table 1 shows 47 schemes that are in progress. Some of these schemes involve lines at different voltages. For such schemes the benefits increase as the removal of only one section would further highlight the impact of the remaining lines on the landscape. This encourages the Steering Group to identify schemes which focus on larger areas, where exposure to the benefits can be afforded to as many stakeholders as possible.

Scheme	Protected Landscape	Licence Area
Ludham Marshes	Broads	EPN
South Walsham Marshes	Broads	EPN
Potter Heigham	Broads	EPN
Share Marshes	Broads	EPN
Beccles Marshes	Broads	EPN
Dunstable Downs	Chilterns	EPN
Latimer	Chilterns	EPN
Stoke by Nayland	Dedham Vale	EPN
Flatford	Dedham Vale	EPN
Bayfield	Norfolk Coast	EPN
Burnham Overy	Norfolk Coast	EPN
Blakeney/Morston	Norfolk Coast	EPN
Cley Phase 1	Norfolk Coast	EPN
Shingle Street	Suffolk Coast & Heaths	EPN
Shotley North	Suffolk Coast & Heaths	EPN
Shotley South	Suffolk Coast & Heaths	EPN

Scheme	Protected Landscape	Licence Area
Blyth	Suffolk Coast & Heaths	EPN
Felixstowe	Suffolk Coast & Heaths	EPN
Orford	Suffolk Coast & Heaths	EPN
Bedgebury Pinetum	High Weald	SPN
Moat Farm	High Weald	SPN
Newenden	High Weald	SPN
Sheffield Park	High Weald	SPN
Royal Military Canal	Kent Downs	SPN
Bodsham	Kent Downs	SPN
Elham Valley	Kent Downs	SPN
Preston Hill	Kent Downs	SPN
Birling Phase 2	Kent Downs	SPN
Olantigh Park	Kent Downs	SPN
Lees Court	Kent Downs	SPN
Ranscombe Farm	Kent Downs	SPN
Ightham Mote Phase 2	Kent Downs	SPN
Birling	Kent Downs	SPN
Charleston	South Downs	SPN
Firle Beacon	South Downs	SPN
Malling Hill	South Downs	SPN
Alciston	South Downs	SPN
Deans Farm	South Downs	SPN
Swanborough	South Downs	SPN
Littlington South	South Downs	SPN
Telscombe	South Downs	SPN
Littlington North	South Downs	SPN
Hurtwood	Surrey Hills	SPN
Winterfold	Surrey Hills	SPN
Raikes Farm	Surrey Hills	SPN
Abinger Hammer Phase 2	Surrey Hills	SPN
Pains Hill	Surrey Hills	SPN

Table 1 – Undergrounding 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. 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 2018/19 regulatory year are shown in the RIGs worksheet *E1 – Visual Amenity* (please see the Annexes and Appendices). Though no undergrounding schemes were completed in the 2018/19 regulatory year, work was undertaken on the schemes at South Walsham Marshes, Burnham Overy and Potter Heigham in EPN; these are due to be completed in the next regulatory year. No direct work was undertaken on schemes in SPN in 2018/19 as negotiations were ongoing with landowners.

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. In our [RIIO-ED1 Business Plan](#) we committed to reduce oil leakage from these assets by 2% per annum for the duration of the RIIO-ED1 price control period (April 2015-March 2023). This section provides information about our strategy for reducing oil leakage from FFCs on our network, a summary of 2018/19 performance and details of the work we have undertaken both independently and with key stakeholders.

Key reasons to reduce cable fluid loss include:

- Compliance with environmental legislation and the Fluid Filled Cable agreement between the Environment Agency and the ENA
- 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. If a cable leaks to an extent that would be considered an environmental incident, we have thorough procedures in place to report such instances to the Environment Agency and deal with them promptly and effectively to minimise the amount of fluid lost.

2.3.1 2018/19 performance

Cable fluid loss is measured by the total amount of fluid used to top up cables less any fluid recovered. A summary of 2018/19 cable fluid loss is provided in Table 2 below; this has been extracted from the RIGs worksheet *E2 – Environmental Reporting* for each of our licensees. For more information, please see the Annexes and Appendices.

Licensee	Average annual cable fluid losses – DPCR5 ¹	Cable fluid losses – 2018/19 ²	Difference (volume)	Difference (%)
EPN	54,239 litres	57,703 litres	3,464	+6%
LPN	126,623 litres	89,649 litres	-36,974	-29%
SPN	54,298 litres	74,132 litres	19,834	+37%
Total	235,160 litres	221,484 litres	-13,676	-6%

Table 2 – Comparison of cable fluid lost in 2018/19 to historical performance in DPCR5

In 2018/19 a total of 221,484 litres of cable fluid were lost in our three licence areas – this represents a 6% reduction compared to average performance in the DPCR5 period.

The target for cable fluid losses, based on our commitment to reduce losses by 2% year on year within RIIO-ED1, was 190,930 litres and hence the target for 2018/19 was not achieved.

Despite considerable effort and resources being deployed to this activity during the year, a number of significant leaks occurred on circuits, some of which were difficult to access for location and repair due to network constraints.

- 14,600 litres of fluid were lost from the Watford South to Rickmansworth 132kV circuit in EPN. An outage was taken at the earliest possible opportunity, but was not possible immediately.
- 11,200 litres of fluid were lost from the Deptford to Bengeworth Road 132kV circuit in LPN where access to conduct repair work in the public highway was restricted. Some temporary repair work was carried out whilst the circuit was replaced.
- 12,000 litres of fluid were lost in SPN following a number of significant leaks. The affected cable circuits were: Three Bridges to Crawley Industrial East 33kV, Croydon to Norbury 33kV and Dartford to Ruxley 33kV.

In addition to leak repairs, significant cable replacement projects have taken place in 2018/19 to remove poorly performing fluid filled circuits from the network. The cables have been replaced with modern solid cable.

¹ The data in this column represents the average amount of cable fluid lost and not captured 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.

- St John's Wood to Aberdeen Place 132kV in LPN
- Deptford to Bengeworth Road 132kV in LPN
- Beddington to Sutton 33kV in SPN

Going forward, we will continue to look for new ways to improve our performance to ensure we consistently achieve our oil leakage targets in all three of our licence areas.

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 2018/19 regulatory year is provided below.

- **Self-Healing Cables**

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 and started in November 2017.

As stated in our [2017/18 Environment Report](#), 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 move the technology readiness level, i.e. closer to commercialisation.

In 2018/19 the project made excellent progress. The self-healing fluid formulation has been further refined, its manufacture scaled to industrial volumes and the purification process significantly improved. The fluid cable test rigs are operational and cable thermal ageing is well advanced. In addition, UK Power Networks and Northern Powergrid have conducted reference leak testing using T3788 and self-healing fluid cable additive and carried out containment leak repair testing. Both sets of test results demonstrate that the additive retains its self-healing capabilities even after extensive testing under high temperatures and pressures.

During the year both DNO groups nominated circuits and sourced around 33 cable samples at the lengths required for cable rig testing. Samples of unused FFC were obtained from one of UK Power Networks' stores and from sections extracted from recently decommissioned circuits.

The selection of circuits for field trials is progressing. A particularly suitable one has been located in a substation in our EPN licence area. It is contained entirely within the grounds of the site and so can be used as a more highly controlled test site that will allow voltage testing. This also avoids the need for approvals to be sought from local authorities for road closures or landowners for site access. It is possible to carry out voltage testing on the cable which will demonstrate the safety of the self-healing fluid prior to its introduction into an energised circuit. Methods to deploy the self-healing fluid are also being considered in regard to using existing cable servicing assets with additional fluid delivery control.

Circuit trials will be carried out according to plans developed by the DNOs and designed to ensure that their management and operations teams are satisfied with the performance of the self-healing fluid. Following completion of these trials, if successful, it is anticipated that this technology will be appropriately deployed in a controlled manner to suitable oil-filled circuits.

If the project is successful, we anticipate that it will provide benefits from reduced cable fluid loss from 2021 onwards.

- **Pressurised Cable Active Control & Monitoring**

This project reviews the operating systems for FFCs so that cables can be operated at lower pressures without the risk of customer interruptions. The project is registered under the NIA project NIA-UKPN-0012. It started in September 2015 and concluded in 2019.

Last year we reported that the first active pressure control unit (APCU) prototype and test rig had been designed and developed. The initial APCU design incorporates the various functions and safety features identified during the feasibility stage of the project. A fully contained unit measures fluid flow rates and pressure within the FFC and uses this data to operate a variable pressure valve, thereby reducing leakage.

Since last year, the testing and implementation of five units on to live network circuits has been successfully completed and the APCU is operating as designed. The trials on live network circuits have been completed. The five units on the network are currently operating well and are maintaining a constant cable pressure. In order to gather sufficient data, these were observed under various weather and load conditions on the network. As a further enhancement, APCU on FFC cable systems with more than one tank position has been developed. Further testing to assess the operation of the twin feed APCU at different levels on a circuit profile was completed as planned. It was concluded that the APCU can work on twin feed systems, provided the correct pressure settings are applied.

The project has proved that the APCU is effective and safe for installation on the network. The control system actively controls and maintains the oil pressure contained within an FFC system and absorbs the fluctuations within the pressure tank, thereby reducing unnecessary mechanical strain on the FFC. It is hoped this will have the added benefit of slowing or potentially stopping leaks from FFCs. This innovation project is providing benefits from reduced cable fluid and further deployment in areas of need are being carried out as part of a BAU roll-out of this technology.

Through the NIA funding incentive, the learning from these projects is available for 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* worksheet (please see the Annexes and Appendices). It is therefore not possible to compare or analyse the costs and volumes included in 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 and manage cable leaks across our network. Our Environment team has worked with staff in our asset management and operational functions to provide proactive knowledge sharing sessions at Environment Agency local offices. This is helping to ensure that both our organisations have an improved knowledge and understanding of the management of cable leaks.

During 2018/19 we continued to work with key stakeholders to share best practice and work to target the poorest performing circuits on our network. This work 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 the 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 (see section 2.3.2)
- Discussing individual poor performing circuits with local stakeholders including the Canal and River Trust and local authorities (as required), enabling UK Power Networks to understand and take account of stakeholders' views

In summary, UK Power Networks has successfully reduced cable fluid losses by 6% in the fourth year of RIIO-ED1 (2018/19) when compared to average loss during DPCR5. It is anticipated that by 2019/20 the plans outlined above will reduce cable fluid loss in line with the 2% year-on-year commitment made in our [RIIO-ED1 Business Plan](#).

2.4 Carbon impact and climate change

2.4.1 Our business carbon footprint

This section describes our 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. We are pleased to report a reduction of 20.5% (see Figure 3) – significantly ahead of this target. This also represents a 4.61% reduction on the previous year's figures. We are constantly looking for ways to reduce our BCF and are currently working with experts in this field to set ourselves more challenging longer-term targets.

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 March 2019. Bringing contracts in-house in EPN has reduced our BCF overall but also increased EPN's share of the headcount from 37% in 2014/15 to 44% this year, and proportionally decreased the share of the other two DNOs. EPN's much smaller reduction (shown in Figure 3) is due to the methodology we have used. If we apportioned based on geographical area, as opposed to headcount, LPN would only be allocated 2% of the shared footprint, creating an even greater anomaly.

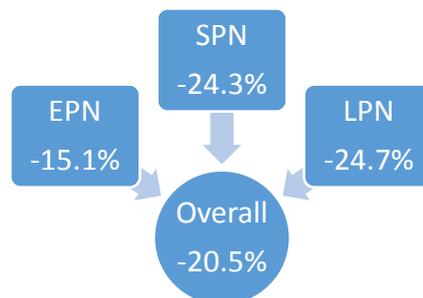


Figure 3 – 2018/19 BCF reduction by DNO

Our results for the 2018/19 regulatory year are shown in the RIGs worksheet *E3 – Business Carbon Footprint* (please see the Annexes and Appendices). In all calculations of our BCF we have used the [government-issued carbon conversion factors](#) published on 8 June 2018 and in effect in March 2019.

2.4.1.1. Our BCF reporting process

Distribution losses account for more than 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 2018/19 the largest elements of our BCF were operational transport (45%) and building and substation energy usage (26%), followed by temporary generation (19%), business travel (7%) and fugitive (SF₆) emissions (3%).

Table 3 shows our overall BCF excluding distribution losses for the regulatory years 2014/15 (our baseline measurement year as set by Ofgem) and 2018/19. Details of the individual components of our BCF excluding losses are also reported below.

Licensee	2014/15 (tCO ₂ e)	2018/19 (tCO ₂ e)	% change
EPN	32,539.49	27,622.02	-15.1%
LPN	19,776.50	14,899.48	-24.7%
SPN	25,025.12	18,932.47	-24.3%
Total	77,341.11	61,453.97	-20.5%

Table 3 – Our 2014/15 and 2018/19 BCF excluding 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 (£250k 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. This approach is favoured over geographical apportionment as the LPN licence area only accounts for around 2% of the total land area, which would result in an unrealistically small value.

Our entire BCF reporting process is audited by our Risk & Assurance team. Aspects are also examined annually 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 12% (from 38% to 26%) 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, which has fallen by nearly 40% since 2012 and by 20% since just last year. Our challenge going forward is that nearly two-thirds of our BCF (operational transport and temporary generation) are based on diesel. The carbon intensity of diesel is not likely 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, and we have been trialling these in the LPN licence area.

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. During the 2018/19 regulatory year 99.23% 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 27,299.74 tCO₂e in 2018/19. This represents an 11.8% 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)	2018/19 – our fleet (tCO ₂ e)	2018/19 – contractor (tCO ₂ e)	2018/19 – combined (tCO ₂ e)	% change
EPN	1,228	44.1%	11,450.84	7,537.09	4,504.60	12,041.70	+5.2%
LPN	809	29.1%	9,284.47	4,965.40	2,967.61	7,933.01	-14.6%
SPN	747	26.8%	10,212.92	4,584.86	2,740.18	7,325.04	-28.3%
Total	2,784	100%	30,948.23	17,087.35	10,212.39	27,299.74	-11.8%

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. The overall reduction in tCO₂e is due to a combination of energy efficiency measures and lower carbon intensity of the energy used.

Licensee	2014/2015 – total (tCO ₂ e)	2018/2019 – total (tCO ₂ e)	% change
EPN	13,574.67	8,267.77	-39.1%
LPN	6,942.63	4,284.52	-38.3%
SPN	6,648.78	3,583.26	-46.1%
Total	27,166.08	16,135.55	-40.6%

Table 5 – tCO₂e resulting from 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. This was particularly evident in 2018/19 when we experienced extremes of cold, heat and windy intervals with thunderstorms. The LPN network is least affected by bad weather as it is almost entirely underground.

Licensee	2014/15 – total (tCO ₂ e)	2018/19 – UK Power Networks (tCO ₂ e)	2018/19 – contractor (tCO ₂ e)	2018/19 – combined (tCO ₂ e)	% change
EPN	4,321.55	4,315.39	208.35	4,523.75	+4.7%
LPN	1,717.71	796.11	137.26	933.37	-45.7%
SPN	6,328.58	6,033.07	126.74	6,159.82	-2.7%
Total	12,367.84	11,144.57	472.35	11,616.94	-6.1%

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). Only usage of company car fuel cards is recorded by licensee and so the remaining total business mileage is apportioned based on the number of indirect staff employed in each region. 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 unknown vehicle average 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, as an alternative to business travel. As Table 7 demonstrates, although EPN is showing an increase, partly due to a rise in its apportionment, our overall business mileage figures are lower than our 2014/15 baseline.

Licensee	Indirect staff	% of staff	2014/15 – total (tCO ₂ e)	2018/19 – UK Power Networks (tCO ₂ e)	2018/19 – contractor (tCO ₂ e)	2018/19 – combined (tCO ₂ e)	% change
EPN	948	38%	1,651.60	1,761.41	59.08	1,820.49	+10.2%
LPN	774	31%	1,339.13	1,102.04	38.92	1,140.97	-14.8%
SPN	773	31%	1,473.05	1,311.31	35.94	1,347.25	-8.5%
Total	2,496	100%	4,463.78	4,174.76	133.95	4,308.71	-3.5%

Table 7– Business mileage summary showing the levels of tCO₂e emitted by UK Power Networks' 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 2018/19.

Licensee	2014/15 – total (tCO ₂ e)	2018/19 – total (tCO ₂ e)	% change
EPN	1,540.83	968.32	-37%
LPN	492.56	607.62	+23%
SPN	361.80	517.10	+43%
Total	2,395.19	2,093.04	-13%

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 any other sources.

Our results for the 2018/19 regulatory year are shown in our RIGs worksheet *E3 – Business Carbon Footprint* (please see the Annexes and Appendices). Overall losses performance is presented in Table 9 and Table 10 below, which is due in part to a reduction in the carbon intensity of electricity lost. The figures were correct at the time of submitting our E4 figures (31 July 2019) but may be subject to further updates given the standard reconciliation cycle in the settlements process.

Licensee	2014/15 – total (tCO ₂ e)	2018/19 – total (tCO ₂ e)	% change
EPN	1,178,315.84	603,788.31	-49%
LPN	913,866.74	503,864.60	-45%
SPN	663,791.18	379,313.80	-43%
Total	2,755,973.76	1,486,966.71	-46%

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

Licensee	2014/15 (tCO ₂ e)	2018/19 (tCO ₂ e)	% change
EPN	1,210,855.33	631,410.33	-48%
LPN	933,663.24	518,764.08	-44%
SPN	688,816.30	398,246.27	-42%
Total	2,833,334.87	1,548,420.68	-45%

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 regions. Where SF₆ leaks occur we act in strict accordance with the EU F-gas Regulations to ensure they are rectified without undue delay.

In 2018/19 we comfortably exceeded the 0.2% target for leakage of SF₆. The overall UK Power Networks position was 0.08% as a proportion of SF₆ in service, the best annual performance by a DNO group in this area.

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 assets on our network is 114,042kg across our three licence areas; please see the corresponding breakdown in Table 11.

Licensee	Installed capacity (kg)
EPN	42,962
LPN	46,881
SPN	24,199
Total	114,042

Table 11 – Installed SF₆ capacity per licensee

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, non-SF₆ technologies including options such as alternative gases and 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 (which is subject to space constraints), offering advantages at installation due to the compact nature of this type of switchgear. Where alternatives can be used in such circumstances, the transition will be managed in a safe and cost-effective manner.

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 2,580kg from current levels by the end of RIIO-ED1³. It should be noted that this trajectory is likely to change due to our plan to trial SF₆ alternatives potentially 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. System development is considered later in the project life cycle and hence system development decisions do not directly impact the trajectory of UK Power Networks' SF₆ bank.

The figures presented in the RIGs worksheet *E2 – Environmental Reporting* (please see the Annexes and Appendices) demonstrate that over the last year our three licensees comfortably met the SF₆ leakage target set out in our [RIIO-ED1 Business Plan](#). We addressed performance in EPN by replacing the leaking SF₆ current transformers at Wymondley Main. Going forward, we are prioritising SF₆ reduction projects and the implementation of enhanced measures to expedite the delivery of leak mitigation where leak rates are significant and could adversely affect performance against our leak rate target, to ensure we continue to meet our RIIO-ED1 Business Plan commitment in our three licence areas.

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 constitutes an on-site refurbishment or factory refurbishment. 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, a replacement will be considered.

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

SF₆ must be treated with care, in a manner compliant with the EU F-gas Regulations. 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

³ 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) and a prediction of the scope of works that will be completed for switchgear projects currently in our RIIO-ED1 plan.

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 July 2019 we successfully completed the replacement of the remaining six of 18 132kV Reyrolle NEI SF₆ filled current transformers at Wymondley Main in EPN. These substantially contributed to EPN's overall performance in 2017/18; 34kg of SF₆ were emitted, accounting for 37% of the SF₆ leaks in EPN that year. An expedited programme of work was undertaken to replace the current transformers and resolve the issue.

Our 2019/20 plans include investment targeted at the most significant contributors to SF₆ leaks on our 33kV and 132kV switchgear, at sites such as City Road in LPN and Southern Cross in SPN.

Our stakeholders

Key stakeholders in this area are the parties 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.

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.

The quantity of SF₆ topped up is recorded automatically during the completion of top-up work orders. As previously stated, these work orders are created automatically when a low SF₆ gas alarm is detected. SF₆ leakage figures are held on UK Power Networks' asset register and are reported to the senior management team in our Asset Management Directorate 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).

Looking ahead: our future strategy

We are focused on continued high performance in this area and the assessment and introduction of SF₆ alternative technology when available and economically viable, such as Green Gas for Grid (g3). This will be accomplished by maintaining contact 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.

In addition, as part of the ENA SF₆ Working Group, UK Power Networks is currently working on the development of an SF₆ technology matrix which will identify alternative technologies to SF₆ at all voltage levels. This will include a workshop with manufacturers to learn about their current capabilities and future plans for manufacturing SF₆-free GIS switchgear – enhancing our understanding of how readily alternative technologies can be adopted by UK Power Networks and the associated costs and benefits.

We keep abreast of all innovations related to SF₆ as an insulation medium, including the exploration of SF₆ alternatives. Alstom and National Grid have worked collectively 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 2018/19 regulatory year are shown in the RIGs worksheet *E2 – Environmental Reporting* (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 losses⁴. 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. They 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. Fixed losses are independent of the energy being transferred across the network and relate to losses associated with the energy required to energise transformers. The level of technical losses within a system will depend on a number of factors. For a typical distribution network, around 30% of technical losses will be due to fixed losses and around 70% will be due to variable losses, although there will be regional variations in this ratio.

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 of the reduction technique. Conversely, 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.

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), commissioned Imperial College London, Princeton University and others to undertake a variety of holistic and specific studies. This process started in early 2016, through our [LDR tranche 1](#) activities, and continues through the current [LDR tranche 2](#) period, from early 2018

⁴ 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.

to early 2020. For the benefit of our stakeholders we continue to publish reports and other material of interest that our research produces on our losses website⁵, which also contains interactive explanations for the various losses types and causes.

Where the cost can be justified by the benefit, we have taken approaches developed in LDR tranche 1 and embedded them into our BAU 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 these data quality and data availability challenges, we have developed robust CBAs that justified upsizing LV and HV mains cables during the 2018/19 regulatory year. 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 Technical Losses Task Group (TLTG) in April 2019 to ensure it was widely accepted.

Table 12 shows a summary of total losses on our networks from data that has been developed from the RIGs worksheet *E3 – BCF* (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.

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Total losses (tCO₂e)						
EPN	1,112,211	1,178,316	1,034,381	1,016,939	838,822	603,788
LPN	839,961	913,887	880,009	779,598	644,058	503,865
SPN	611,716	663,791	559,249	541,021	489,723	379,314
Total losses (GWh)						
EPN	2,699	2,860	2,238	2,468	2,386	2,133
LPN	2,038	2,218	1,904	1,892	1,832	1,780
SPN	1,485	1,611	1,210	1,313	1,393	1,340
Total units distributed (GWh)						
EPN	33,794	32,882	32,721	33,295	33,106	32,994
LPN	28,006	27,632	27,442	27,266	27,012	26,864
SPN	20,508	19,713	19,413	19,468	19,373	19,379
Total losses (%)						
EPN	7.99%	8.70%	6.84%	7.41%	7.21%	6.46%
LPN	7.28%	8.03%	6.94%	6.94%	6.78%	6.63%
SPN	7.24%	8.17%	6.23%	6.74%	7.19%	6.91%

Table 12 – Summary of losses

Table 13 shows the losses performance reported through the RIGs worksheet *E4 – Losses Snapshot* for the regulatory year 2018/19 (please 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	250.3	297.5	179.7
HV cables	357.8	325.5	197.0
Distribution ground-mounted transformers	455.0	1,154.5	198.0
Distribution pole-mounted transformers	68.1	0	27.1
Amorphous steel pole-mounted transformers	13.0	0	2.5
Total	1,144.2	1,777.5	604.3

Table 13 – Summary of losses performance

⁵ <https://www.ukpowernetworks.co.uk/losses/index.html>

Based on the realised benefits reported in the 2018/19 RIGs worksheet *E4 – Losses Snapshot* (please see the Annexes and Appendices), a total of 3,526.0 MWh of CBA-justified improvements were made over the 12-month period. This equates to 998.1 tCO₂e in the year.

Table 13 above contains new categories for HV cables and amorphous steel transformers. As indicated earlier, these new categories evolved from research and new business cases that we have compiled under Ofgem's Losses Discretionary Reward initiative.

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 and are substantially more efficient than older specification transformers. Replacement in this example therefore reduces losses, but as the transformer specification is a mandatory requirement, the losses benefits are not included in the *E4 – Losses Snapshot* worksheet. Table 14 below 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	1,791.3	1,483.5	1,016.3
Primary and Grid transformers	784.3	1,019.2	1,006.8
Regional totals	2,575.6	2,502.7	2,023.1

Table 14 – Losses reduced through the adoption of more efficient transformers not supported by CBAs focused on losses

The regional totals in Table 14 above add up to 7101.4 MWh, which equates to 2,010.2 tCO₂e.

Adding all figures together, we estimate that losses on our networks were reduced by 10,627 MWh per annum as a result of all the work UK Power Networks has undertaken. Of this 3,526.0 MWh per annum was explicitly driven by losses considerations.

Activities undertaken in this regulatory reporting year

Current programmes to manage distribution losses

The following activities are CBA-justified and are embedded in our BAU activities to reduce losses:

HV cables – We are installing larger cross-section 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 will 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 at the ENA TLTG to ensure that our approach is robust.

Through earlier changes in our [11kV Network Design](#) policy there has been a significant shift in the cable sizes being upsized. In total, 880.3 MWh will be saved every year going forward by upsizing main line conductors in the 2018/19 regulatory year. This is reported in the *E4 – Losses Snapshot* worksheet.

LV cables – We are also installing larger cross-section conductors in 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.

Through earlier changes in our [LV Network Design](#) policy there has been a significant shift in the larger cable sizes being installed. In total, 727.4 MWh per annum is saved every year going

forward through upsized main line LV conductors. This is reported in the *E4 – Losses Snapshot* worksheet.

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 256 sites where the CBA demonstrated a positive NPV, yielding improvements of approximately 1,902.8 MWh per annum. This is reported in the *E4 – Losses Snapshot* worksheet.

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 technical losses. During the 2018/19 regulatory year, we installed 14 of these units on our networks, collectively delivering an energy loss reduction of 15.5 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 entirely avoidable with sufficient investment and in LDR tranche 2 we are continuing to validate the Princeton University findings and further develop our understanding of this newly identified source of losses.

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

Replacement of distribution and power transformers – We continue to replace existing transformers with EcoDesign specification units which reduce fixed and variable energy losses. This year we replaced a total of 1,048 distribution transformers, which reduced losses by 4,291.1 MWh per annum. In addition, we replaced 21 primary and grid transformers, further reducing losses by 2,810.2 MWh per annum. (These loss reductions were not declared in our E4 tables because the investment was not based purely on energy loss improvement only.)

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.

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 BAU activities. For example, we propose to trial 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 that our transition from DNO to DSO is likely to have on network losses. We will also investigate how we can exploit smart meter data to identify technical and non-technical losses.

We seek to identify how mechanisms such as active network management (ANM), demand side response, distributed generation, energy storage, and a range of low carbon technologies can be used to manage network losses. Generally, these technologies are being developed to maximise network utilisation, which has network and societal benefits; but they will as a side-effect increase technical losses. However, these mechanisms may be used infrequently for their primary purpose, and we are therefore exploring whether they can be used to minimise network losses for the remainder of the time.

We also intend to keep abreast of new technologies coming to market which may be used to minimise losses. While the exact nature of these technologies is not yet fully understood, it is likely they will

enable us to undertake our current focus more efficiently. Technological developments may also highlight new areas we can focus on to target losses.

Summary of losses activities and benefits during this regulatory reporting year

Table 15 provides a summary of the costs and benefits from our CBA-justified losses activities and has been developed from the *E4 – Losses Snapshot* worksheet (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.

The annual reduction in losses is due to installing larger cross-sectional area HV and LV cables and the replacement of existing distribution transformers with larger and lower loss units. This figure is subject to replacement programmes and we will continue to add new business cases as we establish new and durable CBAs to support the various activities.

Programme/ project title	Regulatory reporting year (2018/19)			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	0.368	727.4	205.9	4,894
HV cable	0.524	880.3	249.2	880.3
Distribution transformers	0.339	1,902.8	538.6	3,666.4
Amorphous steel transformers	0.002	15.5	4.4	15.5
Totals	1.233	3,526.0	998.1	9,456.1

Table 15 – Summary of losses costs and benefits from activities in RIIO-ED1 (technical losses)

Table 16 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* worksheet (please see the Annexes and Appendices).

Programme/project title	Description of unit	Volumes in regulatory reporting year (2018/19)	Forecast volumes for following regulatory year (2019/20)
LV cable	km	114.6	100-200
HV cable	km	148.2	100-200
Distribution transformers	ea	256	200-300
Amorphous steel transformers	ea	14	20-100
Primary and Grid transformers	ea	N/A	N/A

Table 16 – 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 the under-recording or non-recording of electricity consumption. Responsibility lies primarily with electricity suppliers who must ensure that consumption is correctly recorded within industry settlement systems. Suppliers must accurately read meters, set the appropriate energisation status against each metering point and detect, investigate and resolve situations where customers tamper with or bypass 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.

Tackling theft in conveyance is an important part of a distributor's responsibilities. UK Power Networks has both a licence obligation and a broader legal, social and moral imperative to investigate and resolve such instances. Ceasing ongoing theft is clearly important but our operations also identify and remedy the dangerous situations often associated with unauthorised connections. Our investigators will

frequently 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 families, neighbours and the wider general public.

As shown in Table 18 below, our programme of work led to 233 cases of theft in conveyance being resolved across our three licence areas in 2018/19, while a further 136 cases investigated during the year remained 'in progress'. With this latter group, UK Power Networks continued to work with property owners to facilitate appropriate connection arrangements including, where necessary, delivering service upgrades; other sites simply awaited the customer's chosen supplier carrying out metering point registration actions. Our operations in 2018/19 included a number of significant sites including major office-flat conversions, a cement works, a supermarket, agricultural hostels and a residential care home. These helped drive our best performance to date in terms of estimated reduced losses.

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, however our policy makes such provision and we may take this step as a last resort to avoid the indefinite continuation of instances of theft.

In 2018/19 UK Power Networks continued to work with other distributors and suppliers to promote more effective electricity theft reduction efforts across the industry. We showcased our approach to theft in conveyance at the UK Revenue Protection Association Conference in June 2018 and provided a training and motivational session to Crimestoppers staff who operate the Stay Energy Safe tip-off service. In addition, UK Power Networks has been active in an industry forum which brings together suppliers and distributors to share ideas and best practice and we are also assisting with the drafting of comprehensive new theft guidelines to help parties better understand how to effectively tackle these difficult situations. The guidelines are due to be published by the end of 2019.

Table 17 and Table 18 summarise key figures in respect of non-technical losses activities. Table 17 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 (2018/19)			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	0.26	7,385	2,090	14,311

Table 17 – Summary of losses costs and benefits from resolved theft in conveyance cases in RIIO-ED1

Programme/project title	Description of unit	Volumes in 2018/19 Reporting Year ⁶
Countering Theft in Conveyance	Resolved theft in conveyance cases	233
	'In progress' cases	136

Table 18 – Summary of theft in conveyance losses activities in the 2018/19 regulatory reporting year

⁶ 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.

2.5 Other environment-related activities

Green Action Plan

As part of our vision of being the most socially and environmentally responsible DNO, in March 2019 we launched our Green Action Plan (GAP), which includes a new set of company-wide short-term environmental targets to challenge and stretch our RIIO-ED1 commitments.

Since 1970 more than half of UK species have declined and 15% are under threat of extinction⁷. Air pollution is an urgent public health issue on a similar scale to heart disease, smoking and obesity, estimated to cause 40,000 early deaths every year in the UK⁸. The Environment Agency recently advised that within 25 years, England will not have enough water to meet demand⁹. These are just a few of the facts that explain the urgency of taking action.

Sustainability typically considers three elements: people, planet and profit. The GAP aims to create a structure and roadmap for UK Power Networks to achieve its aspirations on the environmental aspect of sustainability, and details initiatives and opportunities to deliver tangible outcomes over a two-year period.

We have a number of environmental initiatives under way. The GAP aims to create a robust plan and roadmap through proposing:

1. Stretch targets to our existing objectives and stretch opportunities to existing initiatives over the short, medium and long term. The opportunities have been proposed as a result of a benefits-led decision-making process to ensure that effort is focused on achieving UK Power Networks' goal
2. New opportunities against the stretch targets as a result of a gap analysis carried out to promote best practice and make the most of the opportunities that exist within UK Power Networks

The GAP is built on three pillars:

1. Minimising our environmental impact
2. Supporting the global low carbon transition – fighting climate change
3. Leading by example – setting a standard for other DNOs to follow

As a result of establishing this plan we have identified six new areas, with newly set targets associated to biodiversity, energy, noise, pollution, water and waste.

- Biodiversity – by 2021 we aim to increase the biodiversity value by up to 30% at 100 of our sites to actively contribute towards minimising species decline and promoting net-gain.
- Energy – by 2021 we aim to reduce the energy use in our top six buildings by 10%, which will in turn reduce our CO₂ footprint and mitigate climate change. Furthermore, we have changed our BCF target to 20% reduction by 2021 from 16% by 2023.
- Noise – by 2021 we will proactively contact 100% of all local authorities to review their development plans (where produced) within UK Power Networks' footprint. This will in turn help us to identify and highlight future potential noise nuisance.
- Pollution – by 2030 we aim to decrease nitrogen oxide (NO_x) emissions from our fleet and generators by 33% to limit air pollution.
- Water – by 2021 we aim to reduce our water consumption by 10-15% in our top six buildings.
- Waste – by 2021 we aim to divert more than 90% of our waste from landfill and recycle more than 80% of our waste from our top six sites.

We look forward to updating stakeholders on our performance against these additional measures next year.

⁷ <https://www.rspb.org.uk/globalassets/downloads/documents/conservation-projects/state-of-nature/state-of-nature-uk-report-2016.pdf>

⁸ <https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution>

⁹ <https://www.bbc.co.uk/news/uk-47620228>

Office and depot waste

The graph in Figure 4 presents a breakdown of our office and depot waste during the 2018/19 regulatory year. In total, we generated 2,935 tonnes of office and depot waste. 142.1 tonnes (4.8%) ended up in landfill (marked in red on the graph). 2,548.4 tonnes (86.8%) were diverted from landfill and either recycled or used for energy recovery (marked in green). This is well ahead of our existing target of 70% diversion from landfill and a new target of 90% diversion from landfill has been set as part of our GAP, which will apply from 2019/20 onwards. The remaining 244.5 tonnes of waste (8.3%), marked in blue, are 'unassigned', which means we do not have details of their final destination once they have been sent to a transfer station.

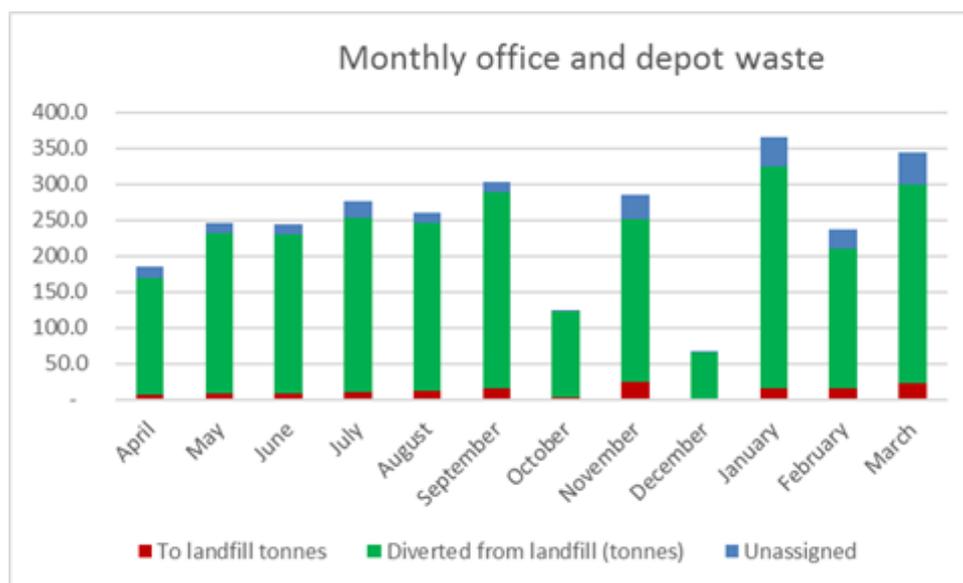


Figure 4 – Breakdown of our office and depot waste in 2018/19 (tonnes)

Noise pollution 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 or complaints 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. Airborne noise can be blocked by a physical barrier – typically a metal screen with insulation, although UK Power Networks was the first to trial a new design developed by Sonobex (please see our [2017/18 Environment Report](#)). 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.

We continue to engage with local authority Planners and Environmental Health Officers, often because of a noise complaint or about potential development adjacent to our substations. Over the years it has become apparent that local authorities face challenges with low frequency noise and the application of methods to determine whether a noise complaint is justified, or the appropriate conditions to include in planning permission.

We are committed to an open dialogue with local authorities and apply the principles of the National Planning Policy Framework and recognised standards during such interactions. We aim to engage with every local authority in our operating area and offer to add location details for our primary and grid

substations to their mapping systems, or try to load their development plans onto our own mapping system in an attempt to proactively engage before any planning decisions are made. As part of this process we are overlaying our main substations onto individual local authority development plans. This identifies sites that may require further acoustic investigation to enable us to advise local authorities on appropriate planning conditions for future developments (Figure 5 shows an example).

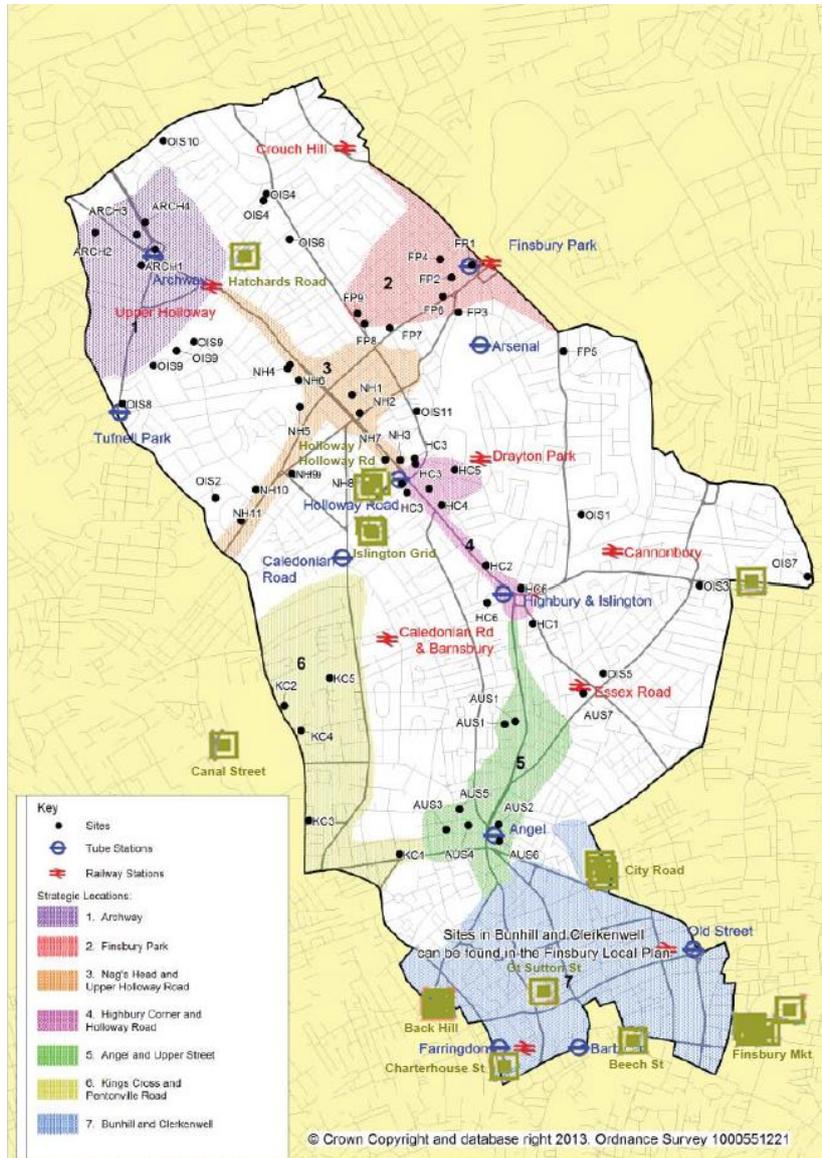


Figure 5 – UK Power Networks' substations overlaid onto the London Borough of Islington's development plan

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.

In 2018/19 UK Power Networks received 26 enquiries and complaints about noise (see Table 19) – fewer than in the previous two years. We have looked for trends but found no identifiable reason for this fluctuation. These were mainly linked to substation transformer noise. During the year we installed mitigation schemes at four 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)¹⁰.

¹⁰ 'Procedure for the assessment of low frequency noise complaints' can be viewed here: http://usir.salford.ac.uk/id/eprint/493/1/NANR45-procedure_rev1_23_12_2011.pdf

Our 2018/19 results are reported in our RIGs worksheet *E2 – Environmental Reporting* (please see the Annexes and Appendices).

Year	EPN	LPN	SPN
2016/17	19	9	14
2017/18	14	6	15
2018/19	12	7	7

Table 19 – Volumes of noise complaints/enquiries reported by UK Power Networks over the last three years

Environmental awareness practices and campaigns

2018/19 was a positive year for UK Power Networks with a renewed focus on raising awareness among our employees of the impact our business has on the environment and improving communication with them on environmental issues. We prepared an animation (see Figure 6) to highlight the Source-Pathway-Receptor pollution model. The Source-Pathway-Receptor model shows how breaking the pathway between a source of pollution and a receptor can prevent environmental harm. The video demonstrates how to apply control measures to lessen our impact on the environment in common scenarios experienced across our network, such as refuelling operations. This was cascaded to all employees during our environmental focus month and remains available via our intranet.

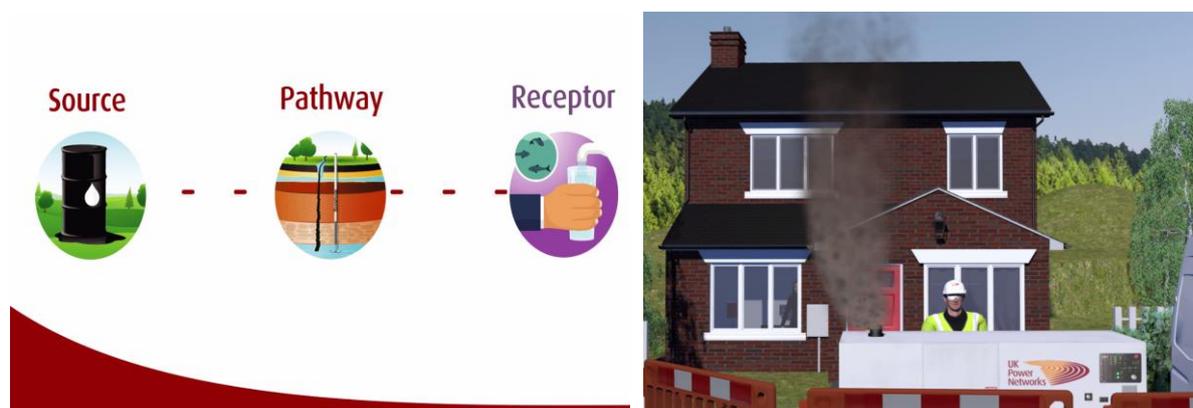


Figure 6 – Extracts from our animation on the Source-Pathway-Receptor pollution model

The video can be viewed [here](#).

UK Power Networks' Waste Campaign

It is part of our vision to be the most socially and environmentally responsible DNO. Accordingly, we have launched a waste recycling campaign, 'Talking Rubbish', which involves visiting office depots throughout our operating area and holding 'waste surgeries' to discuss all matters related to waste management and recycling. Employees are encouraged to visit the surgeries to learn about waste recycling and opportunities to reduce our waste. Our waste contractor, Viridor, also assists in providing expert feedback to answer any waste management-related questions.

During the 2018/19 regulatory year we delivered four waste surgeries; these were held at our Bidder Street, Bury St Edmunds, Fore Hamlet 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. Figure 7 shows staff participating at one of the surgeries.



Figure 7 – UK Power Networks staff participating at a waste surgery

As part of our GAP a further six key offices have been identified to improve waste management with the aim of reducing and meeting the new and challenging office depot waste targets of diverting 90% of waste from landfill.

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 2018/19 a further 60 employees attended this course, taking the total number to 227 to the end of March 2019.

Environmental reporting – Civil Sanctions

We report on any cautions, notices, warnings, penalties, prosecutions and reportable environmental incidents. Our 2018/19 results are reported in our RIGs worksheet *E2 – Environmental Reporting* (please see the Annexes and Appendices).

Figure 8 and Figure 9 provide a breakdown of civil sanctions by subject category and type. The majority related to actual or potential pollution which we reported to the Environment Agency. The next most significant subject was waste; primarily fly-tipping and littering which local authorities required us to remove from substations or, more commonly, the surrounding area. All of these were investigated, and four out of five were rejected because the affected land was not owned or controlled by UK Power Networks, an issue we try to address when liaising with local authorities.

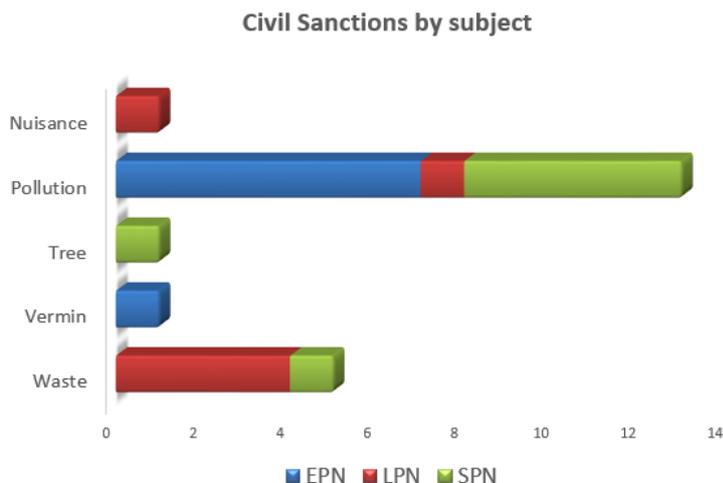


Figure 8 – Civil Sanctions by subject

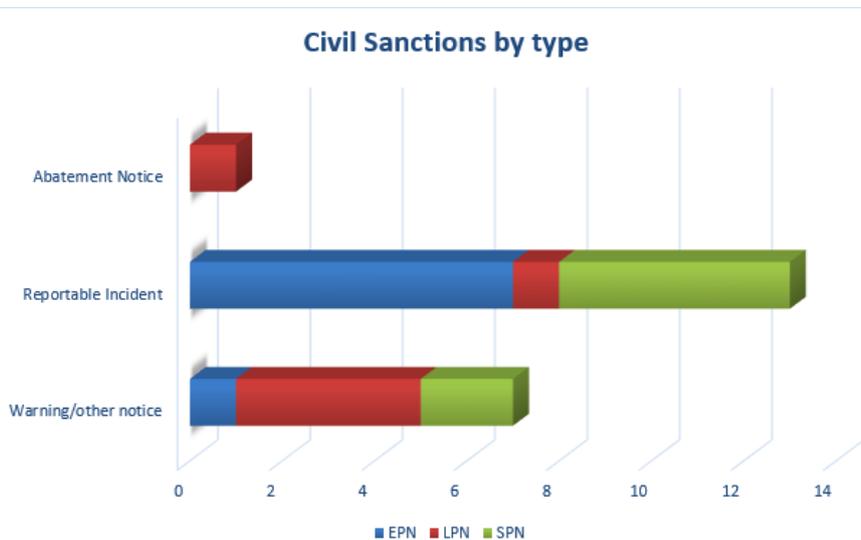


Figure 9 – Civil Sanctions by type

Streetworks waste classification trial

The Environment Agency (EA) has been concerned that waste from utility excavations is being misclassified and disposed of incorrectly as non-hazardous waste. As a result they issued a temporary Regularity Position Statement (RPS211) which details certain requirements businesses must meet if they wish to classify excavated waste as non-hazardous. The RPS211 is scheduled to be withdrawn in April 2020.

The EA is actively pursuing the industry for a solution, and Street Works UK has established a working group of utilities and contractors (including UK Power Networks) to undertake a study to design a protocol for the appropriate assessment and classification of excavated utilities waste. This would enable Street Works UK members to comply with their legal obligations, without the requirement to test each excavation.

UK Power Networks was invited to join the protocol trial study and has agreed to contribute to the development of the methodology. The study has required UK Power Networks to sample a percentage of excavated waste from a variety of jobs and areas within existing contractual arrangements and provide this data to help build a picture of the nature, composition and properties of waste encountered across various environments. UK Power Networks' Streetworks team has arranged for the training of

personnel, the sampling, delivery and testing of a number of samples and is in the process of reviewing the first set of initial results. The results will be shared with Street Works UK for its assessment and use in devising the new sampling protocol.

The trial study aims to take place over six months with the aim of designing a risk based approach to classifying utilities excavation waste. It is expected to conclude in November 2019.

Use of waste plastics in asphalt

In the pursuit of innovative ways to reduce environmental impact, UK Power Networks is currently engaged in a partnership with its roads reinstatement contractor as well as Surrey County Council to trial the use of pelletized waste plastic, which will replace part of the oil based bitumen binder in a standard asphalt mix. The plastic pellets are derived from household waste such as bottles, bags and packaging. The reuse of waste plastics not only reduces the amount that would otherwise be sent for incineration or to landfill – it also reduces the need to extract raw materials for the manufacture of bitumen (and subsequently reduces carbon emissions). Although this material has already been used in various parts of the country, the trial is to establish that the material is compliant as a substitute component of the asphalt mix and that it is also suitable for hand lay reinstatements.



Figure 10 – Trial of the use of pelletized waste plastic in an asphalt mix

UK Power Networks' road reinstatement contractor has recently completed the first trials of laying the new asphalt mix as hand lay reinstatements. This was undertaken under the supervision of Surrey County Council and UK Power Networks to ensure compliance with the relevant highway and engineering standards. Full testing of the reinstatement will be carried out to examine the physical properties of the finished product and quarterly site visits have been planned for up to three years after reinstatement. Initial feedback from the reinstatement team indicates that the material is easier to work with and handled better than the standard asphalt mix.

Biodiversity initiative

Loss of species in the UK and globally is a great cause for concern and we have committed to identify 100 of our larger sites with potential for biodiversity net gain. Working closely with expert ecologists at RSK ADAS and our Wildlife Trust partners, we aim to increase biodiversity potential at those sites by 20-30% by 2021. Initial surveys will assess the range of habitats, plants and animals already present and establish a baseline to enable ecologists to identify appropriate targeted measures to maximise the beneficial habitat available (see Figure 11). These measures might include the installation of bird or bat boxes, changes to vegetation management regimes and sowing wildflowers to provide nectar for pollinating insects. Once the changes are implemented, we can re-assess the biodiversity potential of each site. Nature will need time to grow into the newly improved sites and this project is an investment in the future which will deliver benefits over the medium to long term for wildlife and local communities.



Figure 11 – A Wildlife Trust Ecologist surveying habitat at a UK Power Networks substation

Reusable water bottles for field employees

In August 2018 UK Power Networks issued field employees with reusable water bottles to replace single use plastic bottles. Over the last year we have reduced the number of single use plastic bottles issued by Stores by over 200,000. All employees are being encouraged to replace single use plastic water bottles with reusable aluminium or plastic bottles filled with water from company taps, which provide safe drinking water.

Flood preparedness

In 2018/19 we continued to invest in ensuring that customer supplies are protected from flood risk, to achieve our commitment of protecting 78 substations from the effects 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 2018/19 we successfully flood protected 16 substations serving in excess of 330,000 customers, bringing the total number of mitigations so far in RIIO-ED1 to 40. 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 to ensure mitigations are future-proof.

Investment has also taken the form of research, monitoring and ongoing analysis of flood risk across our operating area. In 2018/19 we carried out 25 detailed flood risk assessments and also worked with multiple specialist companies 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 river and tidal flooding, we ensure that supplies and critical assets are flood protected. 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 can cause devastation to critical subterranean substation assets. We work closely with water infrastructure owners and implement flood protection measures where required.

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 re-connected at minimal inconvenience following flooding of critical equipment through automation. 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 BAU 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 a greater clearance from ground level and building designs have been adapted to ensure additional resilience from flooding. Our flood protection programme is supported by two key documents: our policy and design guidance document [EDS 07-0106 – Substation Flood Protection](#) which is available for use by internal and external parties, and the industry best practice document [ETR 138 – Resilience to Flooding of Grid and Primary Substations](#). UK Power Networks was an active participant in the recently approved update of the latter document to ensure consistency in its approach and compliance to the best practice document.

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 business. UK Power Networks was an active and willing participant in a number of public meetings, forums and consultations in 2018/19, including proposals at Byfleet, Surrey and The Fens, Cambridgeshire.

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.

We record and report our 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 RIGs worksheets *CV16* and *M1* (Flood Mitigation) for our three licensees.

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

3.1 Introduction

We are committed to being an enabler of the low carbon transition. This section explains how our smart grid and innovation portfolios are establishing UK Power Networks as the leading DNO in low carbon readiness. Our comprehensive innovation strategy informed by stakeholders, our DSO and flexibility roadmap and our EV readiness programme are examples of how our business activities are guided by our strategic focus to provide a secure, reliable and low carbon system that addresses our customers' evolving needs.

3.1.1 Policy shaping the industry

The 2050 Climate Change Act targets require the UK to reduce carbon emissions by 80% compared to 1990. The underpinning principle is that the UK should target near-zero emissions from power generation, transport and building energy use by 2050. The government has accepted the fifth Carbon Budget proposals from the Committee on Climate Change. In May 2019 the Committee on Climate Change (CCC) published its Net Zero report¹¹, which sets a path for the UK to be the first country to legislate ending its contribution to global warming. The report highlights the need to strengthen policies around low carbon electricity, energy efficiency in buildings and low carbon heating and electric vehicles (EVs), among others. It also states that policy and regulatory frameworks should encourage flexibility (e.g. demand response, storage and interconnection).

There are key relevant findings from this report that reinforce the actions and strategies we have in place:

- By 2035 at the latest, all new cars and vans should be electric (or use a low carbon alternative such as hydrogen). If possible, an earlier switchover (e.g. 2030) is desirable by reducing costs for motorists and improving air quality.
- The government must continue to support strengthening of the charging infrastructure, including for drivers without access to off-street parking. By 2030 at least 1,200 rapid chargers near major roads and 27,000 chargers around local towns and regions are likely to be required to meet current service levels.
- It will be important to make anticipatory investments to upgrade electricity networks and/or to re-open the allowed investment partway through the 2023-28 price control period (RIIO-ED2) to ensure timely upgrades.
- Many electricity networks will need to be upgraded in a timely manner and future-proofed to limit costs and enable a rapid uptake of EVs and heat pumps; the CCC therefore recommends that relatively large least regret network expansions are made when required.
- Stronger progress is needed on heat pump deployment with the UK trailing behind other nations; a particular focus is needed on new-build properties and those off the gas grid.

Policy is defining the speed at which networks are having to react. In 2010 the incentives introduced on renewables drove an enormous uptake of new generation connections, to which UK Power Networks adapted and responded. Now the carbon targets are being brought forward. The CCC has indicated that low carbon generation supply will need to quadruple by 2050 in order to meet the net zero targets.

¹¹ <https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf>

This means that the strategic work we are doing is ever more important in preparing us for the challenges of decarbonising the energy system.

The targets will drive more renewable connections, the development of storage technologies to maximise the use of that clean energy, the need to continue energy efficiency measures and deployment of more low carbon heat technologies, all while accelerating the uptake of electric transport. All of these trends imply having the right infrastructure in place and the smart solutions to maximise the use of that infrastructure.

Examples of how the low carbon technologies industries are developing include:

- **EV infrastructure needs across Europe** – The UK, France, the Netherlands, Germany and Norway hold approximately 84% of Europe's 0.14 million EV charge points and 76% of Europe's 1.25 million EVs¹². The two most advanced countries with regards to EV uptake are Norway and the Netherlands. The Netherlands has the best EV to charge point ratio in Europe as well as the most public chargers. This information serves as a benchmark for how the EV charging infrastructure is developing in the UK
- **Heat policy in the UK** – In December 2018 the UK government published the report [Clean Growth – Transforming Heating, Overview of Current Evidence](#). In this report the Department for Business, Energy and Industrial Strategy (BEIS) highlights the substantial contribution heat makes to greenhouse gas emissions, as natural gas remains the main source of heating, and the importance it has in achieving the Industrial Strategy and Clean Growth Targets. This means that whatever the road to decarbonising energy, nearly 24 million homes across the country will need to change their heating source. In 2017 13% of heat was provided by electricity, compared to 67% from natural gas. Among other initiatives, the government plans to achieve:
 - A reduction in heat demand by building a market for energy efficiency for owner-occupiers
 - Substantial growth in low carbon heating in the short term, including heat networks and low carbon heating solutions. The latter is supported by the Renewable Heat Incentive (RHI), which plans to invest £4.5 billion between 2016 and 2021 to deploy heat pumps, biomass boilers and solar water heaters, among other technologies

Across generation, storage, transport and heat, one of the key challenges we face is uncertainty. For example, the volume of EVs on our networks will continue to grow; in London we expect to see up to 4 million EVs by 2030. The challenge for network operators is understanding where and when the uptake of new technologies will connect and how it will impact the network. Our innovation strategy supporting system flexibility, storage and ANM will help manage the increase in demand on the electricity system.

To address these challenges, we have concentrated on developing our DSO capabilities and supporting the EV and heat agendas. This year, we have increased our focus on EVs as there are clear policies driving the uptake; whilst on heat, we are engaging with stakeholders to understand where our role will be critical in supporting the transition.

3.1.2 The role of DNOs and UK Power Networks' areas of focus

Networks are at the centre of the decarbonising agenda and UK Power Networks is committed to showing leadership in this space. We understand, based on some of the challenges raised above and the political and technological context, that we have a key role to play as enablers in decarbonising the energy system at the lowest cost to consumers. Electrifying heat and transport will be an important part of the solution and understanding the impact of those technologies, and where they are best applied, will be critical to helping government meet its ambitious targets. We will provide a supporting role by ensuring there is sufficient capacity to meet future demand from technologies such as EVs or to connect renewable generation.

Our approach is based on two key areas of work which are underpinned by stakeholder engagement:

¹² European Alternative Fuels Observatory – <https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats>

1. Innovation enabling the low carbon transition
2. Defined DSO strategy and road map

Innovation enabling the low carbon transition

In 2017 we consolidated our EV strategy and we have worked arduously to prepare for the electrification of transport. Our 2018 EVolution strategic EV Readiness project provided a solid foundation to establish the key areas of focus, enabling us to identify areas that need to undergo change to deliver the required outcomes for the business to facilitate EV uptake. Initiatives undertaken as part of EVolution cemented our position as the leader among network operators in preparing for the EV uptake.

Our EV strategy is focused on three 'pillars':

1. Having the best-in-class EV uptake forecasting models and monitoring strategy
2. Deploying smart solutions as a first resort
3. Investing strategically in network upgrades

We have continued to grow our innovation portfolio to tackle the low carbon challenges and developed a cross-company EV readiness programme to position us for the EV challenge.

- In 2018 we undertook a project named Recharge the Future with the aim of delivering the most sophisticated EV forecasting tool in the industry. The objective of the tool was to reduce uncertainties associated with EV load growth, enabling efficient planning of interventions, informing reinforcement spending and reducing the risk of firm capacity shortfalls. This is now the most comprehensive analysis of EV charging behavior to date, encompassing all major international EV trials.
- We have improved our data gathering and cemented key stakeholder relationships within government and across the industry to inform our investment models.
- We delivered new geospatial data on LV network risk for an EV customer segment (taxis) – Black Cab Green.
- We developed a position on smart charging with the industry and set a roadmap for how to enable a market to provide smart charging services through our project SmartCAR, and outlined smart charger functionalities and specifications. This has led to stronger industry collaboration, bringing in energy suppliers and charge point operators to design the customer proposition of smart charging. It has also provided a better understanding of the benefits of first market led smart charging in our leading project, Shift.
- We are taking a leading role in discussions across the industry (e.g. the OLEV EV energy taskforce, the London Mayor's EV taskforce) and have developed EV charge point guides for fleets and local authorities.
- We co-chaired Work Package 4 (Accessible Data for Decision Making) of the EV energy taskforce, providing responses to types of data required by different stakeholders, data hosting, collection, accessibility and ownership.
- We partnered in a consortium of industry experts which won six IUK bids for EV Innovation projects and secured funding for the world's largest EV fleet project with key organisations including Hitachi, Royal Mail, Centrica and Uber.

One of the key enablers of a smart charging network and optimised infrastructure deployment is data. As a result of the work we are leading with the EV energy taskforce, UK Power Networks fully supports the five data recommendations:

1. Digitalisation of the energy system – government involvement with an aim to support the principles of new data needs, continuous improvement and digitalisation strategies
2. Maximising the value of data – data should be presumed to be open, with requirements to make it discoverable, searchable and understandable with common structures, interfaces and standards, making sure it is secure and resilient
3. Visibility of data – a Data Catalogue should be established to provide visibility through standardised metadata
4. Coordination of asset registration – coordinate registration of energy assets, simplifying the experience for consumers through a user-friendly interface improving reliability and efficiency of data collection

5. Visibility of infrastructure and assets – a unified Digital System Map of the Energy System should be established to increase visibility of the energy system infrastructure and assets, enable optimisation of investment and inform the creation of new markets

In addition, we have started to form our thinking around the environmental impact of decarbonising heat and the role that UK Power Networks will need to play in this transition. This includes understanding the role of hydrogen and decarbonising gas, working closely with small and medium enterprises (SME) to support them in their transition, as well as understanding how new technologies can help us manage the increasing loads.

DSO strategy and road map

In 2017 UK Power Networks launched its forward-looking Distribution System Operation (DSO) strategy setting out how it is enabling the energy transition whilst continuing to deliver great service and keeping costs down. The strategy was very well received, with an approval rating of over 90% from our stakeholders. 2019 has been a key delivery year for our DSO strategy, with a particular focus in the areas of flexibility, key enabling investments such as active network management, and visibility of the low voltage network.

Flexibility is a rapidly emerging new market for generators, including renewables, to sell services to electricity networks. It saves customers money by using distributed energy resources (DER) to offer additional capacity on the network at peak times instead of the traditional method of building new infrastructure.

UK Power Networks was the first DNO to announce a long-term commitment to flexibility through its Flexibility Roadmap in summer 2018. The Flexibility Roadmap was based on three key principles:

1. Introducing competition in network needs by committing to market all load-related reinforcement requirements for the higher voltage levels
2. Ensuring the flexibility process is transparent and neutrally facilitated by UK Power Networks
3. Improving accessibility to distribution flexibility for all market participants

During the winter of 2018/19 we ran our second flexibility tender, covering 28 flexibility zones and a total capacity requirement of 94.8MW. Across the 28 locations, serving 0.5 million of our customers, the total funding pot was £12 million and it was published as a way to help flexibility providers understand the potential revenue opportunity. As a result UK Power Networks successfully contracted a total of 18.1MW of power from four companies across seven different locations to install or recruit new flexible capacity with a total value of more than £450k. The technologies involved are a mix of energy storage, demand side response, renewable energy and other generators. Specifically, UK Power Networks contracted with almost 100 assets, with batteries and DSR comprising 56% of the total capacity.

In May this year we unveiled plans to create the world's most advanced electricity network control system. We are investing £15 million in ANM – including a new intelligent software platform that will be integrated into the heart of our control system.

The new advanced automated control system will enable DER – mostly renewable energy, like wind and solar – to connect to the network cheaper and faster, which is enough to power more than a quarter of a million homes. The ANM system processes vast amounts of data to be able to run the South East of England's increasingly dynamic network both safely and more efficiently. By having the most complete view possible of everything that is happening on the network at any given moment, the system will autonomously make complex decisions to optimise the flow of available power. The benefits include reducing the need for building or upgrading existing infrastructure, speeding up new connections, enabling new markets and flexibility services, thereby reducing costs.

Finally, we have been developing our low voltage monitoring programme to ensure visibility of the network at street level. We are prioritising the top 600 locations where we believe EV constraints might occur. To date, we have completed the initial procurement of the units and site surveys and expect to have deployed monitors at these locations by March 2020.

3.1.3 Low carbon technology uptake

Low carbon technologies and distributed generation

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 20 are for the 2018/19 regulatory year and are reported in our RIGs worksheet *E7 – LCTs* (please see the Annexes and Appendices). For that year the reported figures were: 4,937 units of PV, 192 units of non-PV generation, 6,171 EV fast and rapid charge points and 1,796 EV slow charge points. For the purposes of this table, the fast chargers category includes 7kW and higher.

Technology type	EPN	LPN	SPN	Total
Heat pumps	947	10	199	1,156
EV slow charge	459	922	415	1,796
EV fast charge	3,151	959	2,061	6,171
PVs (G83)	2,904	430	1,603	4,937
DG (non G83)	102	12	78	192
Total DG	3,006	442	1,681	5,129

Table 20 – Total low carbon technologies reported in 2018/19

Heat pumps

Figure 12 and Figure 13 show how the uptake of heat pumps has evolved in recent years. In the absence of any new policy supporting the roll-out of heat pumps we expect this slightly decreasing trend to continue in the 2019/20 regulatory year.

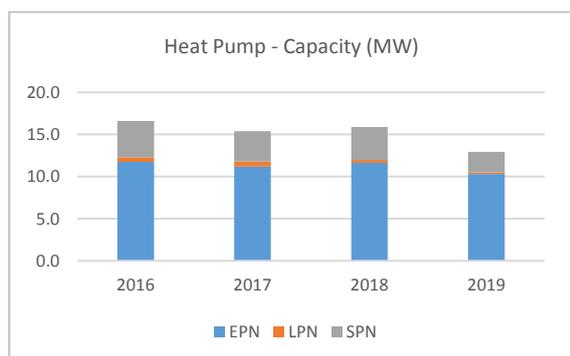


Figure 12 – Heat pumps – capacity installed

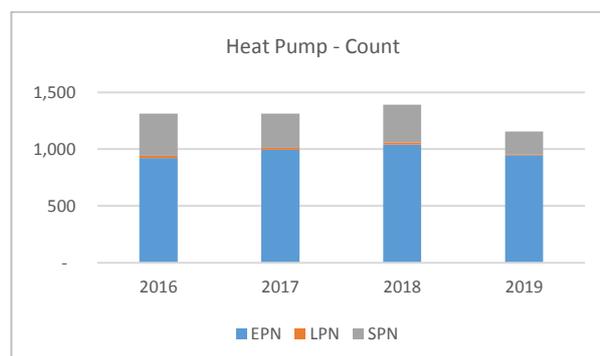


Figure 13 – Number of heat pumps installed

Since the inception of the RHI, 19,124 non-domestic installations have been put in place. There were 221 UK installations in Q4 2018¹³, the lowest quarterly amount since the creation of the scheme, following the trend of declining numbers of installations but a greater average capacity per installation. Average capacity in Q4 2018 was 0.75MW, the second highest capacity per installation in the history of the scheme. The peak month was September 2018 with 1.01MW per installation.

The data from the RHI database informs our data on heat pumps. In our original business plan we forecast that over 35,000 heat pumps would connect in 2018/19; the actual figure was 1,156, 17% less than in 2017/18. As we highlighted in previous years, the assumption was that in 2016 the Zero Carbon Homes policy would have been implemented, kick-starting heat pump deployment. The CCC has highlighted that the 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; however, until these proposals become policy, we do not expect to see significant growth in heat pump installations. Any forecast we now make on heat pump uptake is subject to the targets set by government.

¹³ Cornwall Insights – Non-Domestic RHI Quarterly Report Q4 2018

Small-scale generation

Figure 14 and Figure 15 show how the uptake of small-scale generation has slowed in recent years. While the Smart Export Guarantee will come into effect in January 2020, the Feed-in Tariff scheme closed in March 2019. This leaves a nine-month period where neither is available for new small-scale generation. We expect this to result in a further decline in the number and capacity of small-scale generation connecting to our networks.

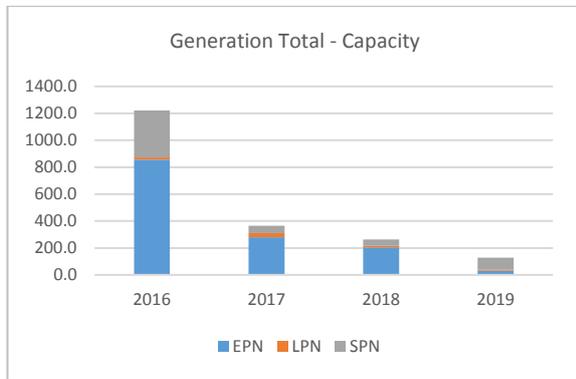


Figure 14 – Generation capacity installed (MW)

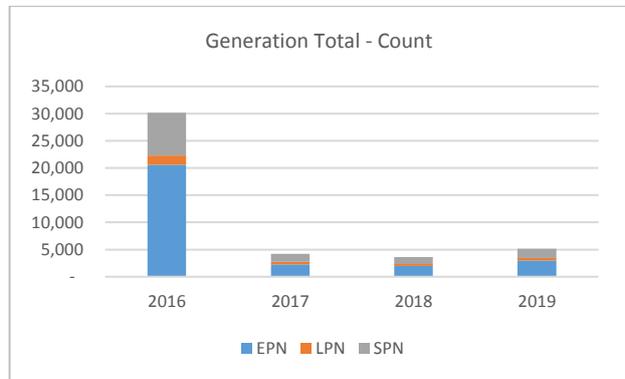


Figure 15 – Number of generation connections per year

In 2015 we expected over 33,000 PV units to connect to the secondary network in 2018/19, whereas 4,936 units actually connected. We highlighted in previous years that changes in both the Feed-in Tariff and Renewables Obligation schemes would result in lower volumes. We have seen a significant reduction since 2015/16 – reflecting those changes – although the number of installations is notably higher than last year, likely due to consumers attempting to utilise the Feed-in Tariff before it was discontinued in March 2019. The fall in distributed generation is particularly evident in the small-scale generation market where volumes have decreased by 88% since 2015/16. We expect no significant increases in volumes in the next regulatory year as the tariff rates associated with the Smart Export Guarantee for all suppliers may not be known until 1 January 2020.

EV charge points

Figure 16 and Figure 17 show how the uptake of EVs has increased in recent years. As EVs become more popular we expect the increased demand for public and private charging to result in a continuation of the current upward trend in the installation of charge points in our three licence areas.

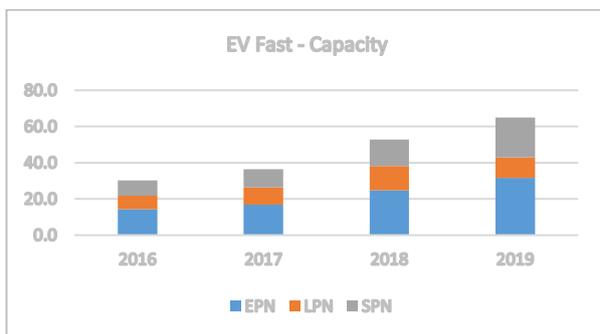


Figure 16 – EV charge point capacity installed (MW)

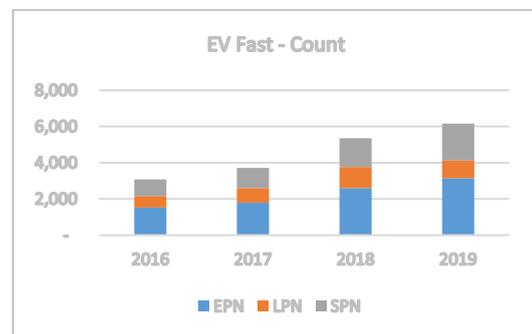


Figure 17 – Number of EV charge points installed

UK public charge point installations continue to increase. As of March 2019 there were over 20,500 public charge points across 7,200 locations in the UK, including 4,900 charge points in Greater London. This implies an additional 150MW of load on our networks, with high confidence this acceleration is set to continue. We estimate there are more than 19,000 home and workplace charge points across our three licence areas.

The number of public charge points across the UK increased by 44% in the 12 months to February 2019, with approximately 52% being installed across UK Power Networks’ licence areas. Figure 18 and Figure 19 show the spread of charge points and EVs by network area across the UK. The columns in red represent UK Power Networks’ three licence areas.

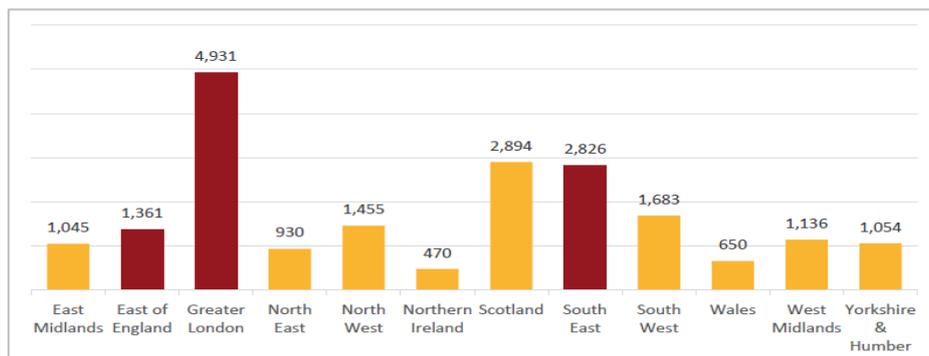


Figure 18 – Existing UK charge points by area. Source: Zap-Map - www.zap-map.com/statistics/



Figure 19 – Percentage increase in number of charge points since November 2018, number installed labelled, Source: Zap-Map

In 2015/16 we predicted that over 34,000 charge points would connect in 2018/19, whereas our records show that 7,967 actually connected, 17% more than in 2017/18. However, the volume of EVs registered in 2018/19 is thought to be approximately 18,000, an increase of approximately 87% on the 2015/16 value of 9,500. This growth is being driven by a focus on air quality in urban areas, as demonstrated by the introduction of London’s Ultra Low Emission Zone, as well as the increasing popularity of EVs. Furthermore, the standardisation of installing and connecting charge points is expected to streamline the process, allowing charge points to be installed at a greater rate than seen historically. Consequently, we expect the number of EV charge points to increase in the next regulatory year.

UK EV registrations now represent 2.3% of annual new vehicle registrations, up from 2% at the same time last year. February 2019 EV sales accounted for 2.6% of total UK sales, compared to 1.9% the previous year. Annual UK plug-in vehicle sales grew by 22% in 2018, taking total historical UK sales to 202,000 as of February 2019.

3.2 Progress of the innovation strategy

Last year we reported significant changes to our Innovation Strategy (available [here](#)). As shown in Figure 20 below, our focus areas continue to be:

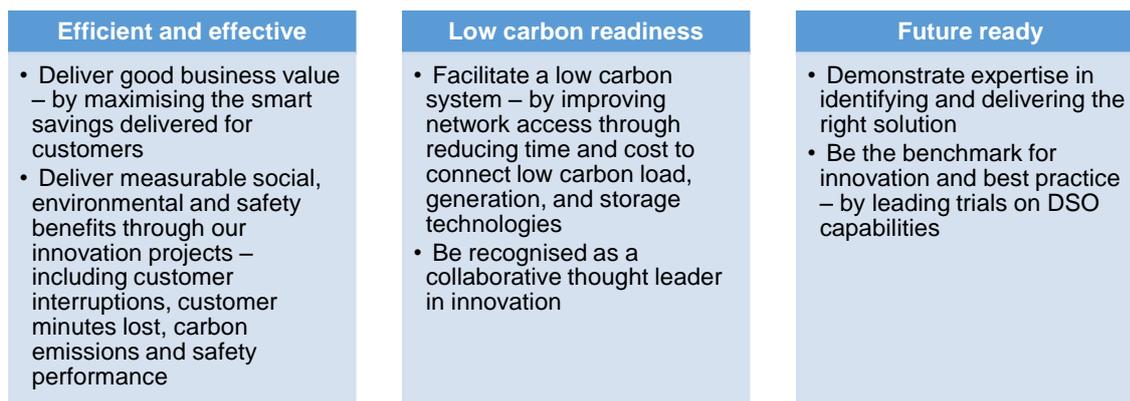


Figure 20 – Focus areas of our Innovation Strategy

This year we have continued to deliver on that vision and have also focused on providing value to our customers and across the business, delivering true impact and securing industry credibility in the outputs of innovation. The innovation strategy per se has not changed, as it continues to deliver results for the business and our customers. The value of our Innovation Strategy is evidenced by 30 solutions deployed into our business, delivering benefits of over £182 million. The strategy continues to be implemented as our colleagues across the company provide new ideas to help solve our challenges.

3.2.1 New ideas

At UK Power Networks we are wired to innovation, keen to work with anyone who has an idea that benefits our customers, whether it is one person with some intellectual property or a multinational company. Over the last five years we have collaborated with over 100 companies, of which 30% are SMEs. In our wider work around EVs alone we have worked with 64 companies.

Non-exhaustive examples of our collaborations include the following:

- We worked with one company (GridON) who came as a start-up company of four people with a lab bench prototype to successfully prove a first-of-its-kind-in-the-world fault current limiter on the 11kV electricity network.
- A sole trader company responded to our LV phase imbalance challenge with an idea to better balance LV phase load, which we supported in development and will trial on our network in 2019, pending successful testing.
- We were the first DNO to work with Piclo, a two person start-up company with initial funding from BEIS. They are now the biggest flexibility platform in the UK and provide their matchmaking service to all DNOs in Great Britain.

Being open to innovation, we welcome ideas at any time. Last year we received 130 ideas from outside our organisation. We reviewed them all, supporting development or giving constructive feedback. Stakeholders have advised us that this approach works better for SMEs, who often cannot wait for an annual call to submit their ideas.

We are aware of the challenges SMEs face when dealing with corporate utilities and we continue to collaborate with the Energy Innovation Centre (EIC) specifically to support SMEs in responding to network challenges and to develop SME proposals to network operators. We regularly put out specific calls for innovation through the EIC, advertising the challenges we face and asking the SME community to propose solutions that will help us provide a better service to our customers or keep the cost of delivering their electricity as low as possible. In 2018/19 we held six calls for ideas through the EIC, the ENA NIC call and publishing our own innovation requirements.

Additionally, once a year we make a call for larger demonstration projects that we could support to bid into the Network Innovation Competition (NIC).

3.2.2 Innovation framework going forward

At UK Power Networks we understand that we need to be able to measure the benefits of any innovation funding from our customers in a consistent way across our three networks. Electricity distribution companies are the only network operators with a requirement to report in a regulatory table (E6) the benefits of ED1 innovation. We have worked closely with the majority of gas and electricity network operator members of the EIC to propose a framework for the next price control, RII0-2. Ofgem has welcomed the collaboration displayed by those networks and is interested in how we might use such a framework to report against commitments and company innovation strategies, considering the business plans and in line with the Customer Engagement Groups (CEGs).

The objective of this framework is to propose how to:

- Improve reporting
- Build on the EIC's Innovation Measurement Framework
- Consider stakeholder feedback and lessons learned from existing projects
- Define how it can be implemented
- Allow the network operators to develop their innovation plans, influenced by stakeholders and governed by the CEG

The framework could measure collaboration and knowledge sharing across networks. One of the key measures of risk for innovation projects is the TRL (Technology Readiness Level), which should also provide transparency of the type of innovation being deployed. The framework could include outcome measures with supporting indicators as a balanced scorecard to assess network company performance. For example:

- The number of external parties involved in the trial
- The percentage of annual revenue spent on innovation projects
- The annual average number of innovation ideas
- The percentage of mature innovation deployed as BAU

The analysis for this work highlighted that there are many activities and data around innovation projects that are not captured and shared efficiently with stakeholders. We look forward to continuing the discussion with our fellow network operators and Ofgem to ensure the best innovation governance, in the interest of consumers, for the next price control.

The framework is outlined in Figure 21. It consists of key outcome measures based more around outputs delivered and seven supporting secondary indicators. The collective set of measures acts as a balanced scorecard to assess network company performance.

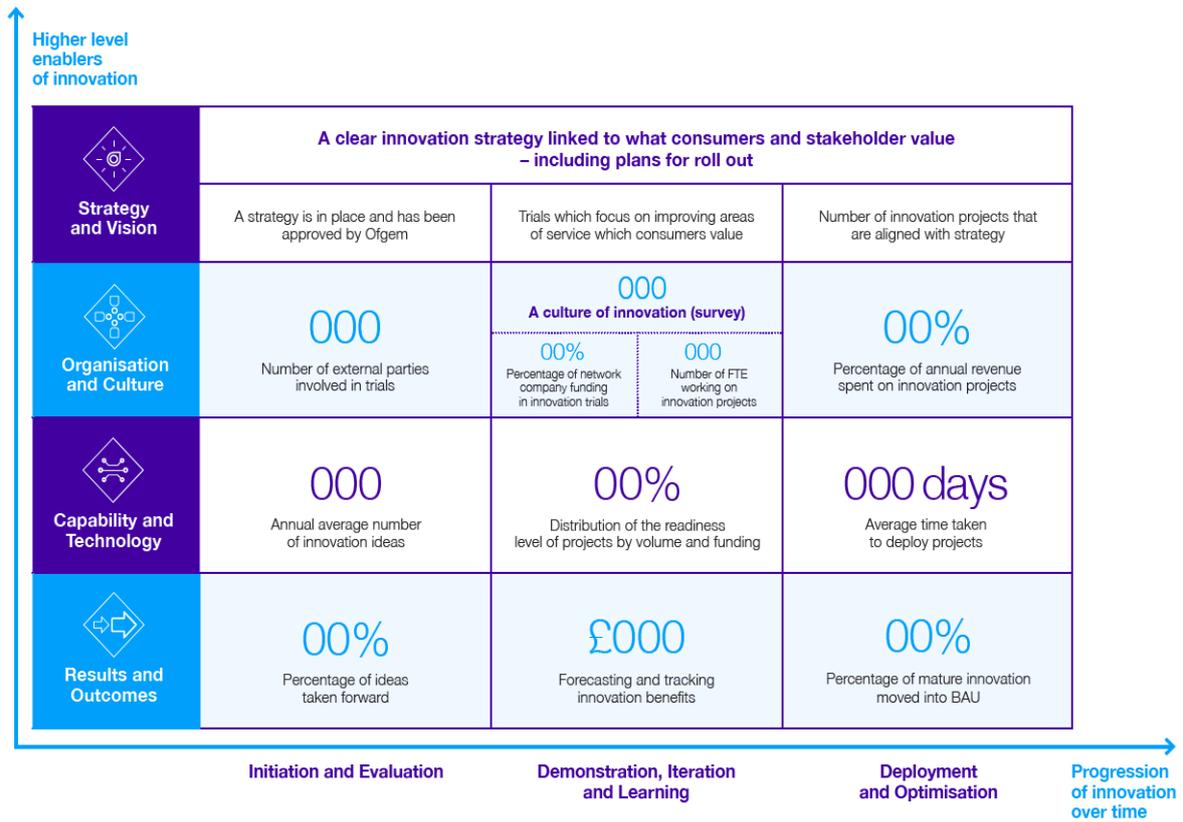


Figure 21 – Innovation framework proposal for ED2

3.2.3 Innovation portfolio

Of the 39 ongoing innovation projects 32 have been funded under the NIA, three have been funded as NIC projects and four have received funding from other sources. We have mapped all of our projects to our three Innovation Strategy pillars and against our business focus areas, as shown in Figure 22.

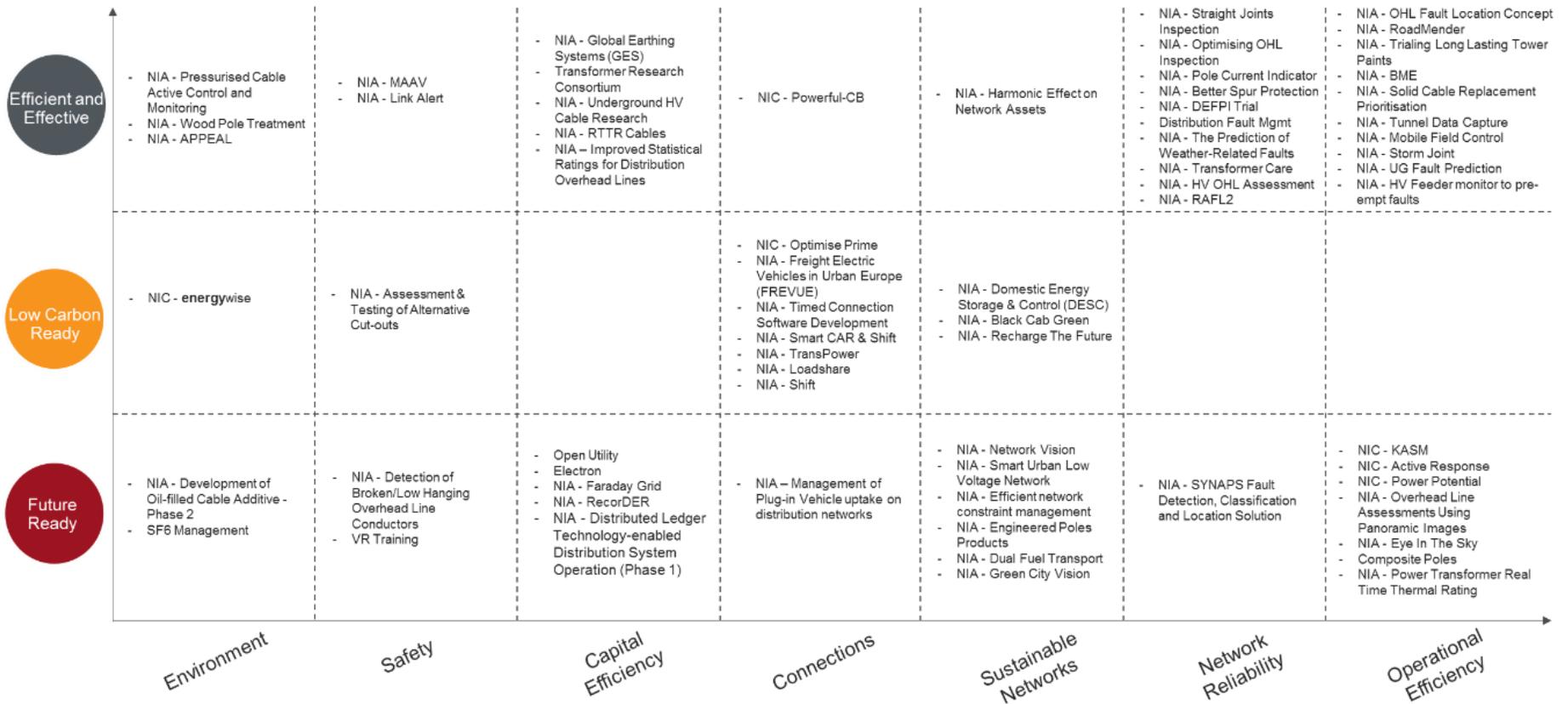


Figure 22 – Our innovation portfolio mapped to our three Innovation Strategy pillars and against our business focus areas

Our 2018/19 NIA Annual Summary can be found [here](#). This lists all ongoing NIA funded projects, detailing how they align to our innovation themes and hence our overall strategy. Further information about UK Power Networks' expenditure under the NIA can be found on our [website](#) or on the [Smarter Networks Portal](#).

Our LCNF Tier Two and NIC projects are larger, covering multiple innovation themes. Table 21 provides further information about each of these projects, including the licensee conducting the trials, the planned year of completion and 2018/19 expenditure. For further information about our Tier 2 and NIC projects, please visit our [website](#).

Project	Licence area where trialled	Start date	Planned end date	Total budget	2018/19 expenditure	Funding mechanism
Optimise Prime	EPN, LPN and SPN	January 2019	February 2022	£18,449,810	£35,461	NIC
Active Response	EPN and LPN	January 2018	November 2021	£17,023,824	£3,585,851	NIC
TDI 2.0	SPN	January 2017	December 2019	NGESO led	NGESO led	NIC
Powerful CB	LPN	January 2017	April 2020	£5,301,041	£476,798	NIC
energywise	LPN	January 2014	August 2018	£4,246,417	£509,806	LCNF Tier 2

Table 21 – Summary of our LCNF Tier 2 and NIC projects

3.3 Roll-out of smart grids and innovation into BAU

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 in our [2017/18 Environment Report](#) (see page 53 of that document).

We now have 30 BAU smart solutions deployed, 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 and deployment of load blinding relays.
2. **Improve asset lifecycle** – These solutions are derived from our Efficient and Effective innovation portfolio. 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 to help 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, our contingency analysis tools that help us plan outages and the Mobile Asset Assessment Vehicle (MAAV) that helps us assess the voltage of the network on the go.
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 cutting practices more efficiently.
5. **Improve safety** – These solutions are focused on improving safety for our employees and anyone who comes near our assets. They include 3D laser surveying and a new condensed aerosol fire suppression system.
6. **Improve environment impact** – These solutions are focused on reducing the impact 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.

In total, our 30 BAU solutions have delivered over £182 million of savings since 2015. This year alone we have saved £33.6 million by deploying smart solutions.

3.3.1 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 BAU. The process is described in our [2017/18 Environment Report](#) (see section 3.3 of that document).

This year we have added seven solutions to the 22 already deployed to BAU. Four of these were NIA projects that closed down and were deployed to BAU in 2018/19; one of them comes from an NIC project, Kent Active System Management (KASM); and two are fast-follow solutions from other network operators. Further detail and a CBA assessment for these solutions can be found in the Annexes and Appendices. Table 22 describes these solutions, which innovation project they originate from and the key assumptions and calculations made for the achieved benefits.

Solution	Description	Innovation project/ source of solution	Benefit calculation
1. OHL Assessment Tool	<p>The OHL assessment tool is a device for assessing the condition of overhead tower conductors, in particular Aluminium Conductor Steel Reinforced (ACSR). The chosen device is Kinectrics' LineVue. Without this solution, decisions for replacing OHL conductors at 132kV, 66kV and 33kV would have to be based on age.</p>	<p>NIA Project: Optimising overhead line conductor inspection & condition assessment</p>	<ul style="list-style-type: none"> Investment costs: cost of purchasing LineVue units Baseline totex: circuit replacement cost from NAMP for the circuits that need to be replaced Evaluation totex: baseline totex differed by two years
2. Kent Active System Management (KASM)	<p>The software solution allows the network to be run closer to its design limits by having better visibility of network constraints and the future status of distributed generators (wind and PV) in a time range from 24 hours to five days ahead. It reduces the amount of renewable electricity output that needs to be curtailed during network outages.</p>	<p>NIC project: The KASM project delivered a new Contingency Analysis and DG output forecasting software to demonstrate improved operation and planning of the East Kent 132kV distribution network.</p>	<ul style="list-style-type: none"> Savings: volume unit varies depending on the number of outages with curtailment Most are recorded during the summer period More renewable export means reduction of network CO₂ emissions Counterfactual based on conservative assumptions for outages and unnecessary curtailment
3. Overhead Line Assessment using panoramic images	<p>The OHL pole supports and their associated spans are inspected periodically to check their condition and to identify any potential or existing safety risks. These inspections are mainly carried out by foot patrol and in certain circumstances by helicopter.</p> <p>This solution is an interface in our existing GIS platform, the Geospatial Analytics Web Application (GSA), to enable users to search for a pole using its unique ID, to view the available image(s) from Google Street View for the pole and to carry out and record desktop safety inspections.</p>	<p>NIA project: Overhead Line Assessments Using Panoramic Images – Proof of concept using Google Street View images to carry out safety inspections on overhead line assets, as an alternative to foot patrols and helicopter patrols. This involved a review of Google Street View coverage of UK Power Networks' pole positions and use of a third party to capture sample 360-degree (panoramic) images similar to Google Street View Images.</p>	<ul style="list-style-type: none"> 700,000 wood pole supports for OHLs across UK Power Networks The baseline cost is that all safety patrols not carried out by helicopter are carried out via foot patrol (unit cost included in the RIGs table <i>CV30 – Inspections</i>) The evaluation case is a desktop assessment based on the average hourly rate for an inspector and assuming 10 inspections are made per hour

Solution	Description	Innovation project/ source of solution	Benefit calculation
4. PORT Lite	<p>This IT solution identifies fault location. It checks the following alarms:</p> <ul style="list-style-type: none"> • Circuit breaker fault • Busbar protection • HiHi Feeder current • Feeder fault passage indicators • Safety checks • ‘Man on site’ dressing • Fire protection alarms • Busbar dead section status <p>The PORT then:</p> <ul style="list-style-type: none"> • Triggers on bus-bar dead section • Traces upstream and merges multiple triggers • Checks for ‘person on site’, busbar protection, fire protection, circuit breaker fail, HiHi and fault passage indicator alarms • Prioritises local supplies then customer numbers • Restores from upstream for a stuck or slow circuit breaker 	This is an existing smart solution adopted by the business.	<ul style="list-style-type: none"> • Total number of schemes <p>CI benefit</p> <ul style="list-style-type: none"> • 50% improvement on traditional restoration methods, based on anecdotal evidence obtained during implementation • We take all restoration stages that were less than three minutes from the initial interruption • PORT is being implemented on the EPN and SPN systems <p>CML benefit</p> <ul style="list-style-type: none"> • Conservative estimation as it is almost impossible to know what the duration of an outage would have been without the intervention of PORT • We take all restoration stages under three minutes (thus exempt from Ofgem IIS reporting and submission) and assume that if they had not been restored in that time they would have been off supply for four minutes
5. Pressurised Cable Active Control and Monitoring	This solution is a cost-efficient control system for cable pressure management. By reducing the leakage rate of pressurised cables, the health index of these cables would be improved without the need to replace the cables in the short term. This would mean enhanced asset lives and a lower level of intervention of asset replacement being needed, providing a customer benefit.	NIA project: Pressurised Cable Active Control and Monitoring – developing and installing a system using equipment to actively reduce cable pressures to the minimum operating pressure at all times.	<ul style="list-style-type: none"> • Volume assumed is one single Active Pressure Control Unit (APCU) installed in one hydraulic section of FFC network • Cost of rolling out: £100k per year • Benefits from avoiding leakage in the short term: operational expenditure for leak repairs (£175k per annum) • Benefits in the future from deferring the costly replacement of 3km of FFC, avoiding in the short term (estimated four years) capital expenditure of £3.9 million

Solution	Description	Innovation project/ source of solution	Benefit calculation
6. Directional Earth Fault Passage Indicators (DEFPI)	The devices were trialled on 56 circuits forming closed Directional Over-Current rings. During initial trials, a number of improvements were identified to ensure more consistent and accurate direction indications from the DEFPI units. A subsequent firmware upgrade has been developed for both types of unit and an additional trial phase planned to collect and assess additional evidence to demonstrate that the units provide correct direction indications consistently. Currently the indications are not being used by control engineers to direct operational staff to restore the maximum number of customers and reduce CMLs.	NIA project: Directional Earth Fault Passage Indicator Trial – develop devices that can confidently identify the direction of fault current on closed HV rings and correctly display on the control diagram to enable the correct isolation of faulty sections of HV circuits.	<ul style="list-style-type: none"> • 100 DEFPI units will be installed during 2019/20 <p>CI benefit</p> <ul style="list-style-type: none"> • Number of customers on a DOC closed ring affected by a fault multiplied by 50% to be restored by control engineer remote switching <p>CML reduction</p> <ul style="list-style-type: none"> • Number of switching operations carried out before victoring¹⁴ is carried out • Cost: actual time on site • Counterfactual cost: where victoring is carried out before half of the remaining customers are restored, repeated until the fault is located
7. Fire Pro Fire Suppression System	With condensed aerosol suppression systems, unlike gaseous agents, the total flooding effect is achieved without increasing the pressure in the protected area/volume. Fire extinguishing is accomplished by the interruption of the chemical chain reactions occurring in the flame and not by the depletion of oxygen and/or cooling, as suggested by the traditional triangle of fire.	This is an existing smart solution adopted by the business. UK Power Networks has been trialling new condensed aerosol suppression systems during RIIO-ED1; these have proved reliable, economic and easy to specify and install. As a result they are now the preferred suppression system for new substation installations.	<ul style="list-style-type: none"> • Fire Pro suppression agent system total installation cost is £15k versus £29k for a CO₂ flooding fire suppression system • During RIIO-ED1, UK Power Networks has installed 11 Fire Pro systems • One Very Serious Incident (VSI) saved per year (£8.4k) per licence area until the end of ED1 • Five VSIs resulted from the malfunction of conventional suppression systems in 2018/19

Table 22 – New smart solutions 2018/19 – description, project source and benefit calculation

¹⁴ Victoring is the process of fault location using a Victor test set.

3.3.2 Innovative solutions for connections

There are four solutions which support our connection customers:

1. Flexible DG Connections
2. Distribution Network Visibility (DNV) Application
3. Point of Connection (POC) Mast
4. Timed Connection

These are all described in our [2017/18 Environment Report](#) (see pages 59-61 of that document).

Table 23 presents the savings incurred by the above four solutions in RIIO-ED1 to date.

Innovative Solutions for Connections	RIIO-ED1 Savings
Flexible DG Connections	£72,600,365
Distribution Network Visibility (DNV) Application	£43,483
Point of Connection (POC) Mast	£477,846
Timed Connection	£1,680,000

Table 23 – RIIO-ED1 savings from innovative solutions for connections

3.3.3 Solutions being deployed

In our [2017/18 Environment Report](#) we described the solutions that are currently being deployed as BAU (not including the seven added this year) and the connecting customer benefits. These solutions are listed below and their descriptions can be found on page 55 of that document.

- **Increase Network Capacity/Optimise Utilisation**
 1. Power Transformer Real Time Thermal Rating (RTTR)
 2. LPN Interconnection
 3. Energy Storage
 4. Demand Side Response
 5. FUN-LV
 6. Load Blinding Relays
- **Improve Asset Life Cycle Management**
 1. Joint Shell
 2. Oil Regeneration
 3. Perfluorocarbon tracer (PFT) fluid filled cable leak location
 4. CNAIM Modelling
 5. Woodpecker filler
- **Improve Network Performance**
 1. LV Re-energising Devices
 2. Automated Power Restoration System (APRS)
 3. Mobile Asset Assessment Vehicle (MAAV)
- **Improve Vegetation Management**
 1. LIDAR Vegetation Management
- **Improve Safety**
 1. Public Safety
 2. 3D Laser Surveying
- **Improve Environmental Impact**
 1. Innovative Bunding

The projects shown in Table 24 are expected to close down in the 2019/20 regulatory year. We will assess which projects have successfully transitioned into BAU and can become part of our E6 solutions.

Project Name	Finish
NIA – Detection of Broken/Low Hanging Overhead Line Conductors	October 2019
NIA – Development of Oil-Filled Cable Additive Phase 2 (EIC)	December 2019
NIA – Distributed Ledger Technology Enabled DSO (EIC)	March 2020
NIA – Dual Fuel Transport	January 2020
NIA – Engineered Pole Products	January 2020
NIA – Green City	July 2019
NIA – LOADSHARE	January 2020
NIA – OHL Fault Location Concept and Directional Earth Fault Passage Indication	May 2019
NIA – Synaps Fault Detection (EIC)	September 2019
NIA – Timed Connection Software Development	November 2019

Table 24 – Projects expected to close down in the regulatory year 2019/20

3.3.4 Forecast of benefits for the next regulatory year

Looking ahead to 2019/20, across our portfolio of deployed innovative solutions we would expect that:

- Our innovative solutions for improving network performance, including APRS, PORT Lite and LV Re-energising devices, will continue to deliver benefits
- The MAAV solution benefits will increase significantly next year as increased scanning is deliverable
- Our innovative solutions for improving the asset life cycle, including CNAIM Modelling, will continue to provide benefits
- Our innovative solutions for improving network capacity and utilisation, including the LPN Interconnection, which designs the network with larger feeder groups than traditionally, will also continue to provide benefits
- Overall, benefits delivered to customers through reduced connection times and costs will continue if further developers connect their projects to FDG zones
- The seven solutions deployed by UK Power Networks this year will deliver similar financial benefits

Table 25 indicates the total benefits for this regulatory year as reported in the RIGs worksheet E6 (*Innovative Solutions*) and the forecast per solution for the next regulatory year.

	Benefits (£)	
	2018/19	2019/20
Smart Solutions		
Increase Network Capacity/Optimise Utilisation		
Power Transformer Real Time Thermal Rating (RTTR)		
LPN Interconnection	£2,855,288.85	£980,000.00
Energy Storage	£108,287.07	£35,000.00
Demand Side Response	-	-£77,000.00
FUN-LV	-	-
Load Blinding Relays	£10,430,000.00	
Improve Asset Life Cycle Management		
Joint Shell	£140,672.80	£154,000.00
Oil Regeneration	-	
Perfluorocarbon tracer (PFT) fluid filled cable leak location	£1,895,904.84	
CNAIM Modelling	£10,263,458.03	£12,292,000.00
Woodpecker filler	£135,076.00	£91,000.00
OHL Assessment Tool	-	£280,000.00
Recharge the Future	-	-
Improve Network Performance		
LV Re-energising Devices	£307,239.99	£784,000.00
Automated Power Restoration System (APRS)	£7,472,805.93	£6,020,000.00
Mobile Asset Assessment Vehicle (MAAV)	-£1,583,849.42	£259,000.00
KASM	-	£280,000.00

	Benefits (£)	
	2018/19	2019/20
Smart Solutions		
OHL Assessment Using Panoramic Images	-	-
Port-Lite	£689,241.48	£567,000.00
Pressurised Cable Active Control and Monitoring	£175,000.00	£735,000
Directional EFPI	-	£210,000.00
Improve Vegetation Management		
LIDAR Vegetation Management	-	-
Improve Safety		
Public Safety	-£315,000.00	-£140,000.00
3D Laser Surveying	-£28,533.50	£10,500.00
Fire Pro Fire Suppression System	£156,537.04	£11,900.00
Improve Environmental Impact		
Innovative Bunding	£21,143.00	£7,420.00
Improve Connection Performance		
Flexible DG Connections	-	-
Distribution Network Visibility (DNV) Application	£3,552.98	£14,000.00
Point of Connection (POC) Mast		
Timed Connection	£890,000.00	£490,000.00
Total	£33,616,825.09	£23,003,820.00

Table 25 – ED1 solutions and forecast financial benefits

3.3.5 Solutions that changed from last year

Last year we forecast £38.7 million of savings for 2018/19, based on the 22 E6 solutions reported in 2017/18. In 2018/19 these 22 E6 solutions delivered £32.6 million of financial savings. The variance between this figures is due to several factors:

- We had no new Flexible DG connections to our network as initially forecast – this could be a consequence of the change in government incentives or the ANM solution we are deploying.
- In 2018/19 the MAAV incurred high investment costs which will be compensated with an increase in savings in the following years.
- We had less Joint Shell installations than envisaged and did not complete the POC Mast as initially forecast, as this is linked to the number of 132kV connections, which was less than forecast.
- The LV Re-energising devices' benefits were forecast based on observed performance of feeders that had the devices installed and experienced transient faults. However, these devices have not offered benefits in feeders where there have been permanent faults, as the business case is driven by reduced customer minutes lost avoidance through reclosing the circuit when the transient fault has cleared.
- The Power Transformer Real Time Thermal Rating Solution did not deliver any financial benefits this year as the solution is undergoing a BAU handover.

3.3.6 Sharing our best practice with other DNOs

One of our most significant achievements this year was to share some of the solutions that are already demonstrating benefits for us and our customers with other DNOs. For example, we provided SSEN with a MAAV (see Figure 23) for two days so that they could test it and assess the benefits it might bring to their network performance. SSEN found this very useful as it helped inform the potential for a future MAAV trial. During those two days SSEN found energised structures that were investigated and repaired. In their words, “the loan of the MAAV from UKPN has allowed us to de-risk the potential for a future longer MAAV trial”.



Figure 23 – UK Power Networks' MAAV next to an SSEN van while being tested by SSEN

In addition, in July we delivered a presentation to ENWL's executive management team on a case study of this vehicle and the benefits it has provided so far (see Figure 24).



Figure 24 – UK Power Networks' MAAV team visit the executive management team at ENWL to present the MAAV case study

We are also evaluating some of the solutions adopted by our fellow DNOs to understand how we can similarly approach such technologies. One example is the infrared thermal imaging cameras (ITICs) used by SSEN. The ITICs are used to assist in LV underground cable fault location where they reduce CMLs and occasionally CIs if defects are located prior to a fault occurring. The energy released from the LV fault causes the ground temperature to rise relative to the ground around it. This can be identified with a thermal camera, unless the ground surface is heated by some other means, such as being in direct strong sunlight. We are working closely with our operational teams to optimise the data collection process for tracking the benefits of such devices.

Finally, in June we visited SSEN to run a joint inspection to understand how their HAYSYS Phase Identifier works. This technology is the result of their NIA project, Phase Identification Unite to Assist in Underground Fault Location. The tool provides several functions, including real-time outage management, by narrowing the fault location to keep more customers on supply and identifying the phase of a smart meter. It also supports our planned outage work and network design by defining ways to balance LV loads. Our Network Operations teams who manage faults are now using this solution by mapping properties by phase and only cutting supply to those affected.

3.3.7 Additional information, methodology and CBAs

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

3.3.8 Smart metering

Strategy for maximising the net benefits of smart metering

Great Britain's transition to smart meters is being led by energy suppliers who are required to take all reasonable steps to roll out smart meters to all of their domestic and small business customers by the end of 2020. Smart meters have the capability to record energisation status, voltage measurements and energy consumption and to communicate with energy suppliers and network operators.

The increasing uptake of solar panels, EVs, battery storage and other low carbon technologies is likely to place increased demands on the low voltage network. It is therefore essential that we manage our networks to cope with the increasing demand in an efficient, coordinated and economical way. Data obtained from smart meters can be used to provide a much clearer view of loads on the low voltage network which is currently not available from traditional meters. With better visibility of the demands on the low voltage network we will be able to enhance our practices and deliver the benefits set out in our [RIIO-ED1 Business Plan](#).

Our [RIIO-ED1 Business Plan](#) sets out three key areas in which benefits from smart metering data will be realised. These are shown in Table 26:

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 low voltage 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 low voltage 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 a capability to support expansion of low carbon technologies and time of use tariffs.</p> <p>There will be the ability to undertake ANM on the low voltage 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 26 – Key areas in which benefits from smart metering 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 in the context of Great Britain's smart meter roll-out, consulting with colleagues across the Cheung Kong Group (CKG) and other major utilities outside the UK. These discussions have informed our Smart Meter Benefits Realisation Strategy which is sponsored by our CEO. It is guided by three principles which reflect our ambition to fully embed smart metering data into our business as an enabler of our wider RIIO-ED1 and RIIO-ED2 business plans. These are set out below:

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 develop expertise and insight into our smart metering data from the earliest opportunity.
3. We will ensure that our investment in realising the benefits of smart metering aligns with our plans to transition to a DSO.

During the 2018/19 regulatory year we reviewed and finalised our smart metering stakeholder engagement plan. This includes focused sessions on smart metering-related topics and the incorporation of smart metering into our wider engagement activities, so that our stakeholders have an appropriate context 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 SMETS2 meters (and in due course similar data from the SMETS1 meters when they are fully adopted by the DCC), mindful of the requirements of our Smart Meters Data Privacy Plan (DPP), which is covered later in this section. We rely on two teams:

- Our Smart Meters Programme team, which is providing the technical solution that will deliver smart meter benefits to the business from the utilisation of power outage and restore alerts, energy consumption data and voltage measurements
- Our Smart Operations team, which is the business owner of the DCC adaptor that allows us to connect to 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 metering data within the business, to coach other functions on how best to embed smart metering data into their day-to-day activities to deliver business benefits

Smart meter installation volumes

Table 27 shows the volumes of cumulative SMETS1 and SMETS2 meter installations in our licence areas during the 2018/19 regulatory year¹⁵. Installation volumes during the year have increased from a 2017/18 installation rate of 21% to a meter population currently at 30.18% of UK Power Networks' customer base.

Licensee	2017/18 SMETS1 smart meter volumes	2017/18 SMETS2 smart meter volumes	2018/19 SMETS1 smart meter volumes	2018/19 SMETS2 smart meter volumes	Cumulative smart meter volumes	Percentage penetration of smart meters
EPN	319,226	3	288,298	60,407	1,156,011	31.8%
LPN	163,386	0	133,383	17,591	598,610	25.4%
SPN	208,797	12	162,357	31,508	750,583	32.6%
Total	691,409	15	584,038	109,506	2,505,204	30.2%

Table 27 – Smart meter installations

During the 2018/19 regulatory year there was a gradual decline in the SMETS1 meters installed and a gradual increase in SMETS2 meters installed in our areas, showing an overall small increase in installed smart meter volumes.

¹⁵ The installation volumes shown are dependent on information provided by suppliers and show actual installations, whereas the licensees' CV34 tables in the RIGs show smart meter interventions by DNOs.

Current status of IT and communications investments

Our DCC adaptor provides a landing point for smart meter data within our business that includes a strong security framework for our smart metering systems (in accordance with the Smart Energy Code security obligations). We work closely with the DCC adaptor vendor and other network operators who share the same DCC adaptor platform (Northern Power Grid and Scottish Power Energy Networks). Through this forum we operate collaboratively to coordinate our queries with the DCC to leverage each other's challenges related to infrastructure and data quality issues, sharing the successes when issues are resolved.

We remain committed to delivering changes to our IT systems that will allow us to realise benefits from the smart meter data. However, due to industry-wide data quality and DCC issues related to poor correlation between outage and restore alerts received, we have aligned the timelines of our change initiatives to the smart meter roll-out plans so as to avoid the risk of stranded investment from the changing requirements or programme delays outside our control. Delays to the programme and work to resolve data quality and challenges associated with the accuracy of power outage and restore alerts have resulted in additional costs that have included some changes to our IT systems, delaying the delivery of benefits to customers.

Actions taken in 2018/19 to maximise the value of smart meter data

Our Smart Meter Operations team has developed a collaborative working relationship with the DCC and the other DNOs to support the delivery of improvements within the DCC infrastructure and data communications systems. The work to leverage improvements has also included the testing of meters, timely delivery of power outage alerts, accuracy of the power outage and restore alerts and quality of voltage violation alerts.

During 2018/19 we developed our Smart Meters DPP that was submitted to Ofgem for review and approval. Our work to develop the DPP was completed in consultation with the ENA, BEIS, Ofgem, the Information Commissioner's Office and Citizens Advice.

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 – with high levels of customer and supplier satisfaction being recorded. Our approach to this work complies with all of the industry defined Smart Meter Intervention performance Service Level Agreements. Our Smart Meter Interventions teams perform 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 are now live and we are receiving data from SMETS2 smart meters. Testing of updates to the gateway application is ongoing. Once implemented, the updated system will also enable the receipt of SMETS1 smart meter data from the DCC from 2020 onwards.

We have not yet realised benefits from smart metering due to the small volume of SMETS2 meters installed so far. However, from supplier forecasts, the SMETS2 meter installation volumes will increase during the 2019/20 period, especially as the SMETS1 meter installation volumes decline. The relatively low meter volumes will provide a valuable period to develop an understanding of the realities of SMETS2 data and the functionality and performance of DCC and wider smart metering infrastructure.

Our plans for realising smart metering benefits in 2019/20 and in future years

The delay to the DCC national infrastructure has been followed by concerns about the quality of data being received from SMETS2 smart meters. These issues are currently being discussed at an industry

level between network operators, the DCC and BEIS to identify a resolution to address the data quality issues and improve the accuracy and timeliness of data received by the network operators.

These issues coupled with the low volumes of SMETS2 meter installation volumes have prompted us to further review our programme timescales for the delivery of benefits. A number of projects are under way that will enable smart meter outage data to be accessible and visible to our customer service and operational staff. These are explained below.

The integration of our SAP CRM solution with our DCC adaptor required a number of changes to our business processes; for example, our contact centre has delivered training to contact agents informing them of how smart metering customer journeys vary from traditional meters. Changes to our processes have included the use of SMETS1 meter information and are timed to complement the volume of SMETS2 meters within our three licence areas.

We are also working with our Customer Services staff to ensure that the opportunities we have identified for the use of smart metering data are embedded into our digital investment plan. Our digital strategy is guiding 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, our customers will be able to realise the benefits of smart meter data.

We aim to have the new functionality operational from Q4 2019, in line with our updated Smart Metering Benefits Roadmap which describes the technology and business changes required to realise our smart meter strategy and aligns with SMETS1 smart meter adoption into the DCC and the SMETS2 roll-out plans released by energy suppliers.

Due to programme delays experienced during 2018/19, we have updated our plans for 2019/20 to include providing greater visibility of information about outage start and stop times within our online fault maps, the ability to confirm smart meters as SMETS1 or SMETS2 specification, and a review of how best to use smart meter data to support the customers on our Priority Service Register.

During this period we expect to be able to use smart meter power outage alert notifications within our contact centre should a customer with a SMETS2 meter experience a fault, and voltage information to better understand network performance with a view to improving network reliability.

Our network modelling programme is scheduled for delivery during 2020/21 (we are currently refreshing our Network Modelling toolsets) and will provide an opportunity to leverage benefits from the use of smart metering data for network analysis. This capability will be available when Ofgem approves our DPP, which we submitted in Q1 2019. Our smart meters system will be developed to meet the requirements of the DPP for managing energy usage data to deliver benefits to customers and the business. We also propose to implement a capability for analysing smart meter data for active, reactive, import and export power that can support our management of network losses and planning decisions.

The above examples highlight our goals for 2019/20 and onwards, with key investments that will enable benefits to be realised from smart meter data once significant volumes of SMETS2 meters are installed. 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 metering benefits is dependent on the wider roll-out of SMETS2 compliant meters and establishing access to smart meter data, 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 28 for the 2018/19 regulatory year and reported in the RIGs worksheet *E5 – Smart Metering* (please see the Annexes and Appendices).

Source	Category	EPN	LPN	SPN	Total
C22/E5	Smart Meter Communication Licensee Costs	3.0	1.89	1.9	6.8
C22/E5	Smart Meter Information Technology Costs	0.77	0.48	0.48	1.73
CV34	Smart Meter Interventions – On-site/Physical Activities (including prior year restatement)	5.5	1.54	2.12	9.16
CV34	Smart Meter Interventions – Extra Scheduling & Call Centre	0.02	0.01	0.01	0.04
CV34	Smart Meter Interventions – Smart Meter Registration	-	-	-	-

Table 28 – Summary of 2018/19 smart metering-related expenditure in £ million

4 Annexes and Appendices

4.1 EPN

[Environment and Innovation Pack – tabs E1-E8 – 2018/19](#)

4.2 LPN

[Environment and Innovation Pack – tabs E1-E8 – 2018/19](#)

4.3 SPN

[Environment and Innovation Pack – tabs E1-E8 – 2018/19](#)

4.4 UK Power Networks

[Environment and Innovation Commentary – 2018/19](#)

[RIGs E6 CBA – 2018/19](#)

[Generic CBA RIIO-ED1 – GMTs – 2018/19](#)

[Generic CBA RIIO-ED1 – PMTs – 2018/19](#)

