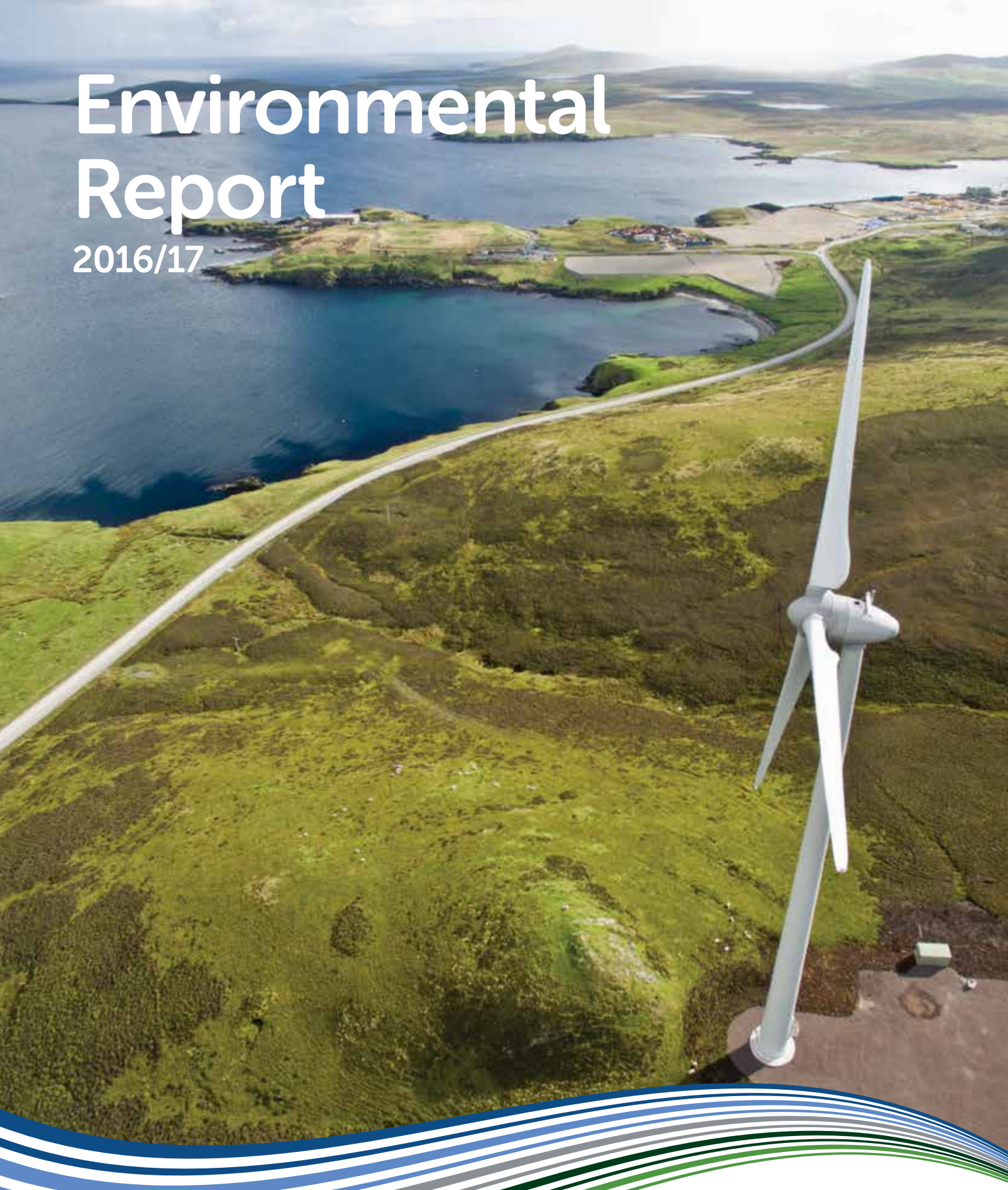
Environmental Report

2016/17



Scottish & Southern Electricity Networks

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1. Introduction

1.1 Executive Summary

The aim of this report is to inform stakeholders and members of the public on how we are performing against our RIIO-ED1 environmental targets and also details the additional environmental work that we are involved in. The second part of this report provides an overview of our latest innovation projects that are paving the way towards an ever smarter grid.

Through our business activities we have managed to reduce our total business carbon footprint for 2016/17 to 44,712 tonnes of CO_2 excluding network losses – a reduction of 22% on the figure reported for 2015/16. This improvement is mainly due to the result of reductions in emissions from fuel combustion and operational transport. Our emission reduction has been so significant that we have surpassed our RIIO-ED1 Business Carbon Footprint (BCF) target. Our RIIO-ED1commitments in this area are to:

- Reduce the energy consumption in our buildings by 15%
- Reduce the average mileage of vehicles by 10%
- Reduce rate of leakage of installed Sulphur hexafluoride (SF_6) by 15%

All of these commitments are over the course of the RIIO-ED1 period, 2015-2023.

Oil leakage from fluid filled cables is known to cause negative environmental impacts. As a result we plan to replace 21 kilometres of fluid-filled cable in our SHEPD network and 55km in our SEPD network over the RIIO-ED1 period. In 2016/17 we reduced the total km of oil filled cable by about 15km across both our networks.

Overhead lines especially those at higher voltage running through areas of outstanding natural beauty (AONB) are seen as unsightly by many. As a result, in 2016/17 we targeted our RIIO-ED1 funding for AONB and national parks on our High Voltage network by dismantling a total 6km of overhead line in the South Downs National Park and Chiltern AONB. We also plan to underground a further 16.75km of overhead line in such areas within our SEPD network and 22.35km within our SHEPD network over the next few years.

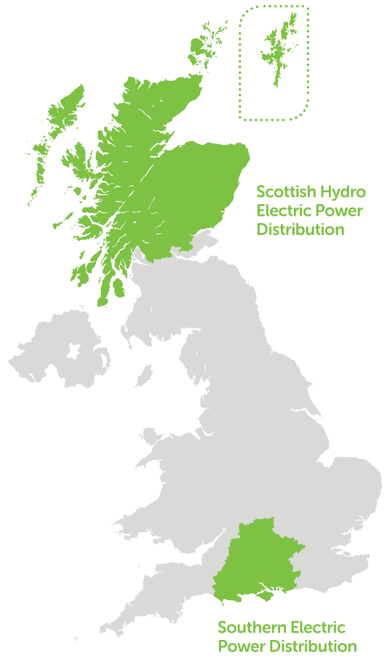
With respect to our losses strategy, we have achieved a significant losses reduction since 2009 and aim to maintain our focus to continue these reductions further in upcoming years. We have commenced the implementation of all the measures outlined in our Losses Strategy and these include:

- The installation of energy efficient transformers that deliver the enhanced losses performance
- Minimum sizing of cables and transformers to reduce losses
- Initiatives to reduce non-technical losses

We stated in our RIIO-ED1 Business Plan that our focus was on making innovation happen, delivering innovation and transferring it into business as usual (BaU). We are pleased to be able to say that we are achieving the key focus of our innovation strategy by successfully delivering novel technologies into BaU. This creates monetary savings for our customers as well as trialling a host of new technologies aimed at delivering future benefits for our customers, the environment and society.

One of the biggest challenges affecting us is the transition from Distribution Network Operator (DNO) to Distribution System Operator (DSO). This transition along with the development of new technologies and smart meter implementation will allow for greater network flexibility and pave the way towards a smarter network. We intend to publish further details of strategy for the transition to DSO later in 2017.

Our story in numbers (approximate)



Our network

1/3
Our two regions represent one third of the land mass of Great Britain

100
Over 100 subsea cables, powering island communities

550,000
Number of calls taken by local call centres in Perth and Portsmouth in 2015/16. Of these less than 1% were abandoned across our SEPD and SHEPD areas

4,000
Employees working from 85 depots and offices in the heart of the community

£1m
Awarded to local community projects through our Resilient Communities Fund

3.8m customers served by our networks

3.1m in southern England

770,000 in the north of Scotland

4,000+ SSEN employees working in engineering and customer service teams

85 depots located in the heart of the communities they serve

4 major office hubs at Reading, Portsmouth, Perth and Inverness

550,000 calls received from our customers last year

106,000 substations

490,000 vulnerable customers identified through our Priority Services Register

£1m contributed to local community projects through our Resilient Communities Fund

130,000km of overhead lines and underground cables Communities Fund

100+ subsea cables, powering island communities

1.2 Our Business/Who We Are

Our business explained

We are Scottish and Southern Electricity Networks (SSEN), responsible for maintaining and operating the electricity distribution networks across central southern England and north of the central belt in Scotland and maintaining the electricity transmission network north of the central belt in Scotland.

Our Networks business consists of two electricity distribution businesses, Scottish Hydro Electric Power Distribution plc (SHEPD) and Southern Electric Power Distribution plc (SEPD), and one electricity transmission business, Scottish Hydro Electric Transmission plc (SHE Transmission).

1.3 Purpose of the Report

The purpose of this Environmental Report is to provide stakeholders with a transparent and public account of SSEN's commitment to addressing environmental matters. This includes, but is not limited to, our role in the low carbon transition. It is intended to provide a holistic overview and clear rationale for our actions and details of actual benefits to customers and provide an important update on our continuing progress to meet our environmental targets, and show how stakeholders can shape this going forward in areas such as investment in Visual Amenity projects.

2. Managing Our Environmental Impact

2.1 Our Principles

SSEN are committed to reducing our impact on the environment and we aim to manage our activities according with the following high level principles:

- **Seek and then act on the views of our customers:** Our customers' views on the environment and the actions they expect us to take to manage our impact on the environment change by location and through time. Our approach is to work with our customers to understand their concerns and take actions where we can.
- **Look after our assets:** In particular, we ensure that they are maintained, refurbished and replaced as required, which has also allowed us to reduce our environmental impact.
- **Act in an environmentally conscious way:** We find innovative solutions to our problems and embed good environmental practice.
- **Promote our core value of sustainability:** We aim to achieve our sustainability targets that are set across the entire SSE umbrella company.

In January 2017, we published our company wide SSE plc sustainability report (**sse.com/media/474297/Sustainability-Report-2017_WEB.pdf**), which provides detailed information around SSE's key policies, management and performance in relation to its economic, social and environmental impacts. In terms of the Distribution networks, the report covers many areas where we have sustainably managed the environmental impacts of our activities. The areas covered in the report include the following:

- **Engaging with stakeholders:** SSEN established an independent Stakeholder Advisory Panel in 2016 to work alongside its Board to help scrutinise business performance and effectiveness in meeting its commitments under the RIIO-ED1 price control framework in which it operates. Amongst the material issues that SSEN identified was "Reducing carbon emissions" which is at the heart of this environment report.
- **Managing constraints on Distribution Networks (connections):** SSEN has created a team dedicated to connecting new generation customers onto the grid in areas which are typically constrained and have high connection costs. The team enable much faster connection times at reduced costs compared with traditional connection mechanisms.
- **A more flexible network:** To support a low carbon energy system, the electricity network needs to transition towards a more flexible system to ensure supply meets demand in the optimal way. To support the transition towards a flexible system, SSEN have undertaken a number of research projects in 2016/17, including The New Thames Valley Vision (NTVV), project which explored a number of innovative demand side management technologies, including network monitoring, battery storage and thermal storage The Shetland-based Northern Isles New Energy Solutions (NINES) project allowed SSEN to use large and small scale energy storage solutions and new monitoring and control systems, to deliver Active Network Management (ANM). The culmination of learnings from all these projects is now paving the way for the onset of the Distribution System Operator (DSO), which will act as an enabler for smart technology and distributed generation.
- **Preparing for a Low Carbon Future:** SSEN has been involved in the review of electric vehicles and their impact on the network through the 'My Electric Avenue' study. The results of this pilot showed that a third of circuits in the UK will require upgrading when there is a 40% to 70% uptake of electric vehicles on a specific low voltage network. The impact of charging has the potential to put pressure on the national grid and the distribution network. To mitigate this risk, an industry-wide solution is required that involves infrastructure upgrades, Demand Side Response or other smart technologies to protect the distribution network. SSEN is taking a leadership position through the Smart EV project (**www.eatechnology.com/projects/smart-ev**). This project aims to work with other Distribution Network Operators, National Grid, Department for Business Energy and Industrial Strategy (DBEIS) and Ofgem to develop an industry solution for managing future electric vehicle charging.

In addition, this report will provide an update on the following areas:

- Visual Amenity
- Oil Leakage
- Business Carbon Footprint
- Sulphur Hexafluoride Emissions (SF_6)
- Distribution Losses
- Other environment related activities such as flood mitigation, noise pollution, waste management
- Smart Grids and Innovation
- Smart Meters

2.2 Visual Amenity

Our distribution networks consist of overhead lines, substations and at a number of isolated locations, small power stations that provide back-up generation. We recognise that this equipment can have an adverse impact on visual amenity especially in sensitive environments such as Areas of Outstanding Natural Beauty (AONB), National Parks and National Scenic Areas (NSA). In particular, some can find overhead lines unsightly and consider the attractiveness of the landscape reduced by their presence. This might impact on individual well-being and also local economies if, for example, the main industry is tourism. The communities we serve are key stakeholders for our business and therefore this is an important issue for us.

Both SHEPD and SEPD are given defined funding by Ofgem for undergrounding of overhead lines in protected landscapes. The allocation of funding is influenced by stakeholder engagement completed in these local areas. Stakeholders have indicated that undergrounding of existing overhead lines was "important" or "very important" from a visual amenity perspective and supported SSEN's stakeholder led approach to address concerns in these areas.

Funding is specifically targeted at AONB, National Parks and NSA, and applicable for distribution voltages up to 132kV.

Our stakeholders indicated that we should include factors that they considered important to them, such as the historic environment and that these were considered as part of the scheme selection process. This is achieved by using a Visual Amenity Impact scoring model, developed in agreement with the AONB and National Park offices in our Region. Schemes are nominated to by these stakeholders, which are then considered and prioritised to ensure consistency in assessment across all SEPD and SHEPD areas.

The focus has primarily been on High Voltage (HV) and Extra High Voltage (EHV) overhead lines that have a high visual impact on the landscape and have a dominant impact for many viewers. We have therefore targeted our efforts on the worst affected areas identified using the scoring mechanism. Schemes are co-ordinated with other network investment and maintenance works where practicable to minimise disruption for stakeholders and reduce delivery costs.

We have a total of 15,508 km of overhead lines within designated areas at the year end of 2016/17 across both of our DNO areas. During 2016/17 two schemes to remove another 6km of line were concluded, with design and preparatory works ongoing for further future schemes with a total investment by SSEN in excess of £0.5m. Details of the schemes are provided in the Tables below.

Table 2.2a – Undergrounding schemes completed in Designated SEPD areas up to end 2016/17

Scheme	Designated Area	OHL km Removed	Completion Date
Hungerford	North Wessex Downs AONB	1.4	2015/16
North Lodge to Sunwood Farm, Buriton, Petersfield	South Downs National Park	0.8	2015/16
Thursley Common	Surrey Hills AONB	0.3	2015/16
Tichborne, Alresford	Southdowns National Park	3.5	2016/17
Turville Village	Chilterns AONB	2.5	2016/17

As presented in Tables 2.2b and 2.2c, there are altogether 16 visual amenity schemes in progress in SEPD and SHEPD licence areas. We will continue to engage with our stakeholders to ensure that ongoing and forthcoming projects achieve the best outcomes for landscape, biodiversity and communities.

Table 2.2b – SEPD Undergrounding schemes in progress

Scheme	Designated Area	OHL km Planned	Progress	Planned Completion Date
National Trust, Sherborne, Gloucestershire	Cotswolds AONB	1.4	Design	18/19
West Kennett, Gunsite Road & Silbury Hill	North Wessex Downs AONB	1.9	Design	18/19
Monkton Medieval Settlement, Chilgrove	South Downs National Park	1.75	Execution	17/18
Ulwell Gap, Godlingston Hill, Purbeck	Dorset AONB	3.3	Design	19/20
Woodyates PMT Martins Down	Cranbourne Chase	1.9	Design	18/19
Plush	Dorset AONB	0.2	Design	18/19
Bignor Park	South Downs National Park	1	Execution	17/18
Winterbourne Near Newbury	Winterbourne Near Newbury	1.5	Design	19/20
Valley of Stones Nature Reserve	Dorset AONB	4	Design	19/20

In the SHEPD area we conducted an extensive program of stakeholder consultation, giving the public, local authorities and charities the opportunity to nominate overhead line sections which they would like to be considered for undergrounding. Several of these schemes are design works which have been progressed in preparation for construction.

Table 2.2c – SHEPD Undergrounding of schemes in progress

Scheme	Designated Area	OHL km Planned	Progress	Planned Completion Date
Glen Tromie	Cairngorms National Park	8.0	Ongoing	17/18
Callendar	Loch Lomond & The Trossachs National Park	2.2	Completed	17/18
Balquidder	Loch Lomond & The Trossachs National Park	0.25	Ongoing	17/18
Kingussie	Cairngorms National Park	7.0	Ongoing	17/18
Blair Atholl	Cairngorms National Park	2.2	Ongoing	17/18
Loch Tummel	Cairngorms National Park	0.3	Design	18/19
Strathyre	Cairngorms National Park	2.4	Design	18/19

For further details on Visual Amenity, please see worksheet E1 – Visual Amenity linked to the Appendix to this report.

2.3 Oil Leakage

We have a responsibility to have regard for the environment in the communities in which we operate. An important element of this is that we must ensure that any oil contained in our assets does not cause damage to the surrounding area.

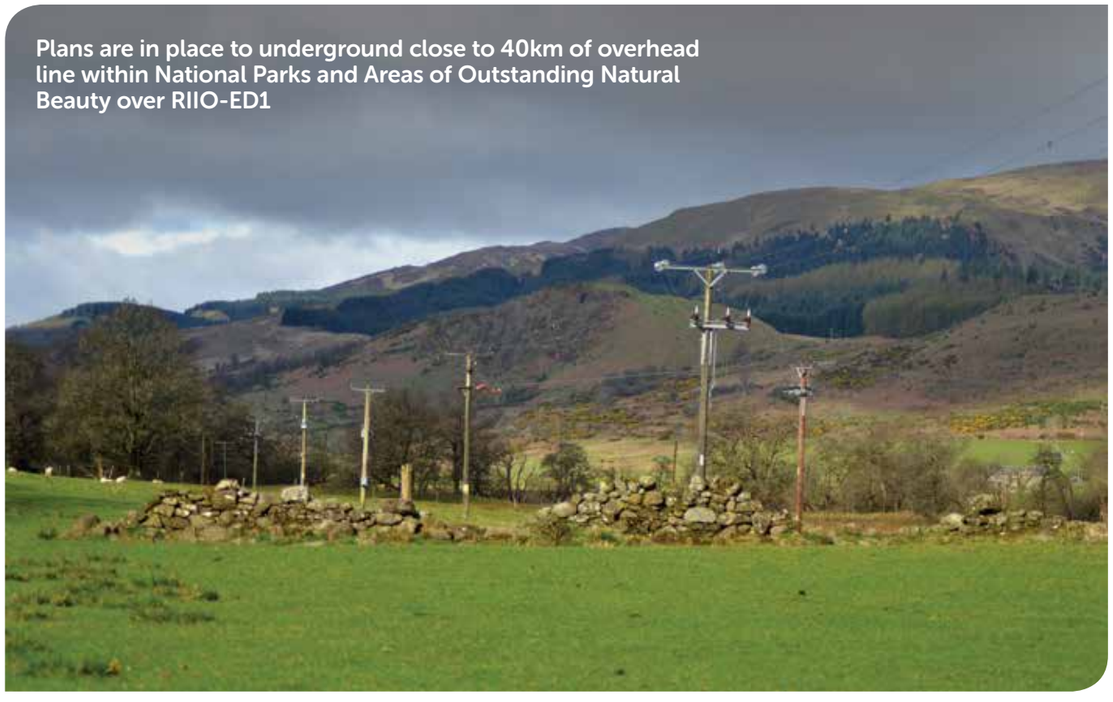
Oil is widely used as an insulating material or cooling medium across a wide variety of electrical equipment including fluid-filled cables (FFC) and some types of electrical switchgear and transformers. We have robust processes in place to maintain and operate these assets such that we ensure that any potential leakage is minimised. If there are any incidents then we are committed to a fast response and to addressing and resolving any issues to ensure that there is no adverse environmental impact.

However, oil filled cables can leak due to age, wear or potentially third party damage. If untreated a leak will not only cause potential environmental damage, but may result in equipment failure and disruption for our customers.

To mitigate the environmental impact and any associated |supply disruption, we employ a proactive leak location process. This process allows the circuit to remain in service while the |leak is being located by dosing the cable system with an inert fault detection fluid. This method of detection is capable of detecting more than one leak on the circuit at each operation. Once identified repairs will be done as well as any necessary remedial works. This process is built in to the routine maintenance process of our FFC assets.

In addition to our proactive oil leakage strategy, we also have a comprehensive range of specialist equipment to ensure that we can provide a robust response to any oil leakage event. We have also established service agreements with specialist contractors for support in the event of an incident.

Additionally, as part of our losses reduction strategy, where relevant we have prioritised the replacement of pre 1960 transformers with more energy efficient transformers that deliver enhanced losses performance and outperform the EU Transformer Eco Directive Tier 1. This also has the added benefit of significantly reducing the probability of oil leakage associated with the older less efficient transformers and improving our business carbon footprint.



Plans are in place to underground close to 40km of overhead line within National Parks and Areas of Outstanding Natural Beauty over RIIO-ED1

2.3.1 Oil Leakage performance in RIIO-ED1

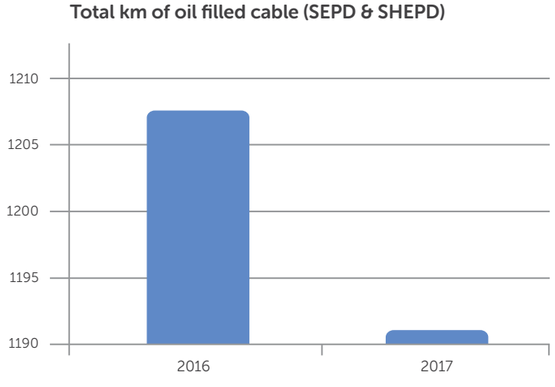
In our RIIO-ED1 business plan, we made a commitment to replace 21 kilometres of fluid-filled cable in our SHEPD area and 55km in SEPD. We committed to tagging our 25 worst performing circuits on an annual basis resulting in a reduction in our oil leakage of at least 15% relative to 2012/13.

Since the start of RIIO-ED1 SEPD has tagged (See glossary for definition) at least 28 fluid filled circuits to improve accuracy of leak location and expedite repairs. Where condition assessments have indicated cable sections to be close to end of life, projects have been initiated to consider replacing these assets with modern cable types which do not contain oil. We currently have projects underway to remove 13.2 km of oil filled cable within the SEPD region.

In 2016/17 SHEPD completed a project in Dundee that removed 4.876km of oil filled cable from our network. To ensure efficient investment for our customers, we continually monitor the environmental performance of our oil filled cable fleet.

Since this commitment was made, the oil leakage rate has decreased and stabilised across our fleet of cables, which makes the selection of the cables to be replaced to achieve maximum customer and environmental benefit more challenging. Figure 2.3a shows that the total km of oil filled cable on our network has decreased over the RIIO-ED1 period.

Figure 2.3a – Change in total length of oil filled cable over RIIO-ED1 period



We will continue to monitor the performance of our cables and will update our plans if the situation changes. With our annual process of tagging the 25 worst performing circuits and our planned capital replacement and refurbishment programmes targeting high priority circuits both in SHEPD and SEPD, it is expected that we will meet our commitment to reduce oil leakage by at least 15% relative to 2012/13 position.

2.3.2 SSEN Fluid Filled Cable industry engagement

We are also continuing to engage with other industry stakeholders to share best practices in order to reduce oil leakage. This involvement includes meetings with other DNOs to share best practices from BaU and ongoing innovative projects, as well as attending bi-annual meeting with the Environment Agency to review performance. We will continue this work for the remainder of ED1.

2.3.3 Oil Mitigation Schemes

SSEN reports the number of oil mitigation schemes affecting cables and substation plant such as transformers and circuit breakers and the costs associated with these to Ofgem on an annual basis as part of the E2 – Environmental Reporting requirement linked to this report in the Appendix.

In 2016/17, one oil pollution mitigation scheme associated with FFCs costing £45,000 was completed in the SEPD area whilst a total of £776,000 was spent on 20 oil pollution mitigation schemes for Transformers and Circuit breakers in the SEPD area.

For further details on Oil Leakage, please see worksheet E2 – Environmental Reporting linked to the Appendix of this report

2.4 Carbon Impact and Climate Change

2.4.1 Business Carbon Footprint (BCF)

This section details the total Green House Gas emissions produced by SHEPD and SEPD in the financial year 2016/17. The BCF is published as part of our company reporting obligations and also reported annually to Ofgem as part of our distribution licence requirements.

The BCF is an account of the impact that our operational activities have on the environment. We collate the data from across our business using the methodology described within international business carbon footprint standards, the Greenhouse Gas (GHG) reporting protocol and ISO14064-1. We convert our data using equivalent tonnes of carbon dioxide (tCO_2e) using conversion factors as provided by the

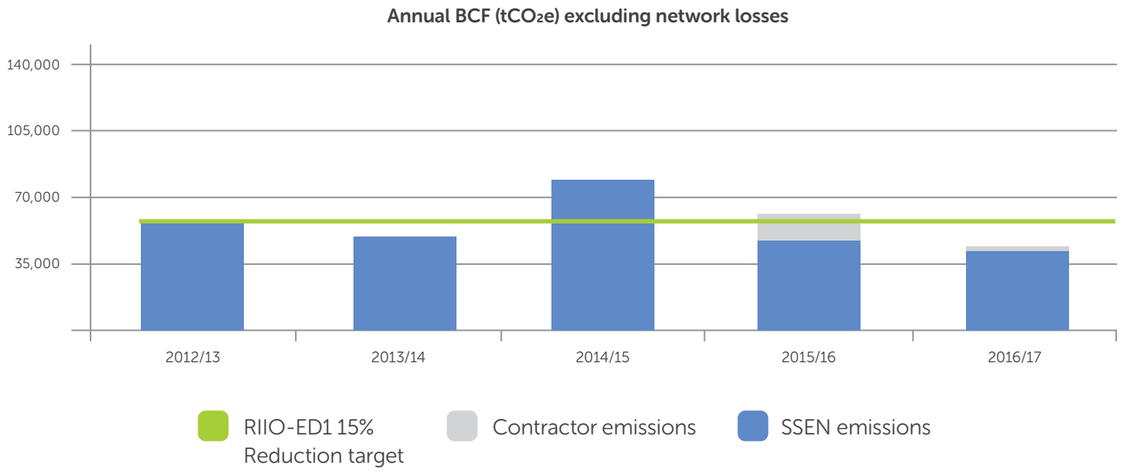
Department for Environment, Food & Rural Affairs (DEFRA) for annual reporting to Ofgem.

The purpose of this Business Carbon Footprint section is to provide a transparent account that our business activities have on the environment and our commitment to address these impacts. This report documents our energy usage from offices, substations, transport emissions (both operational and business), fuel combustion and the release of greenhouse gases such as SF_6. The reported data for operational transport (road) and fuel combustion also takes account of a number of our larger contractor emissions as required in Ofgem's regulatory reporting packs.

In 2016/17, the combined total greenhouse gas emissions for SEPD and SHEPD were 1M tCO_2e for the 2 licence areas. Of our carbon emissions, by far the largest contributor is electrical losses. This accounts for circa 93% of SHEPD's and circa 96% of SEPD's carbon emissions. The other activities that contribute froman SSEN perspective to our environmental footprint are sulphur hexafluoride (SF_6) and the emissions resulting from our vehicle fleet and buildings' energy usage.

Our target is to reduce the Business Carbon Footprint of our business activities by 15% during the RIIO-ED1 period, on a like-for-like basis, excluding exceptional events.

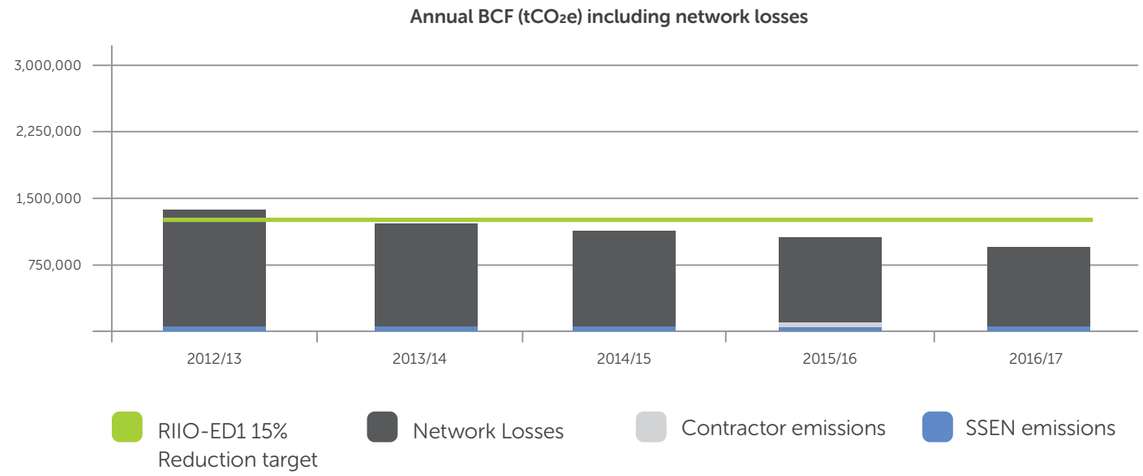
Figure 2.4a – Annual BCF excluding losses



As shown in Fig 2.4a above, our BCF (excluding losses) increased between 2013/14 and 2014/15. It then decreased by 27% in 2015/16. This data includes emissions associated with a number of our contractors for operational road emissions only in 2015/16 and 2016/17 when this information was reported separately in the Regulatory Reporting Pack (RRP).

Fig 2.4b shows the contribution that our network losses makes to our overall BCF in relation to our operational emissions and contractor emissions.

Figure 2.4b – Annual BCF including losses



Progress to achieve our RIIO-ED1 target has been reached in 2016/17 mainly due to significant efficiencies we have made in the area of operational transport by contractors. As shown in Fig 2.4a, the $tCO2_e$ related to operational transport by contractors in 2016/17 shows a downward trend from 2015/16. This is because there has been a shift away from using 'external' contractor in 2016/17, with a number of the core areas being brought into the Networks business where we were able to have overall control. This has led to an overall reduction in fuel consumption in this area, thus reducing CO_2e output. Losses tCO_2e has dropped significantly this year, but this largely is due to the DEFRA calculation methodology changing.

2.4.1.1 RIIO-ED1 Commitments

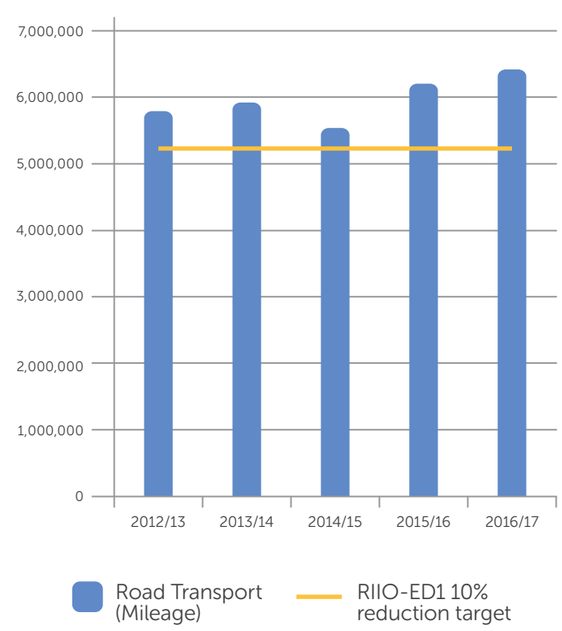
Our commitments by the end of the RIIO-ED1 period are to:

- Reduce the average mileage of SSEN vehicles by 10%
- Reduce Energy consumption in our buildings by 15%

2.4.1.2 Reducing the mileage of SSEN vehicles

One of the largest emissions is from our vehicle fleet for business transport. Our fleet uses low emission cars and runs on diesel, however, our continuing focus is on reducing vehicle numbers and hence the mileage from business road transport. Our commitment is to reduce the average mileage of SSEN vehicles by 10% during the RIIO-ED1 period. Figure 2.4c shows our progress at meeting this target.

Figure 2.4c – Annual vehicle mileage



As shown in Figure 2.4c above, our Annual vehicle mileage decreased between 2013/14 and 2014/15. It then increased by 2% from 15/16 and 8% from 2012/13 when targets were set.

Figure 2.4d – Annual vehicle emissions (tCO_2e)

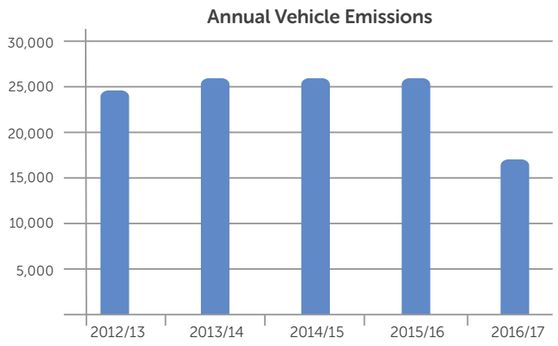


Figure 2.4d is a graph of emissions from business and operational road transport, which shows that we're moving in the right direction in terms of reducing our CO_2 emissions from road transport. Although we have not met our target of reducing average annual vehicle mileage by 10%, CO_2 emissions from all road transport in 2016/17 shows a reduction of 27% relative to 2012/13. This reduction is as a result of our increased use of diesel and hybrid power vehicles. We currently have one electric vehicle in our fleet. However, we continue to look at the possibilities of increasing our use of biodiesel, hybrid and electric vehicles. Implementation of LiDAR described in section 3.3.2. is thought to further reduce vehicle emissions through more efficient work scheduling.

2.4.1.3 Reducing energy consumption in our buildings

Similarly, on emissions from our buildings, we are part of an SSE company-wide target to reduce CO_2 from energy consumption by 15%. Company-wide refers to all SSE divisions e.g. Networks, Supply, Generation, etc. All energy reduction savings mentioned in this section therefore reflect savings from all SSE divisions. The initiative, 'War on Watts', which started in 2011/12 and focused on the behavioural side of energy use creates an energy efficient culture has been replaced by the 'Better Off' energy and water campaign which is also aimed at creating an energy efficient culture. The Better Off campaign was launched in September 2016 and relies on good communications between the Property Services energy efficiency team and all SSE staff.

We've set ourselves a target of reducing energy consumption by 18% by 2018 relative to a base year of 2011/12. A network of Energy Champions are helping to share the Better Off messages with colleagues and are a local source of advice on energy usage reduction measures.

Since 2011 under the series of resource efficiency behavioural awareness initiatives, we've invested over £10 million to install a number of energy efficiency technologies across our estate. Selected details on what we have done to drive savings on energy usage in our buildings are summarised below.

Our Daneshill Depot in Basingstoke has benefited from investment of around £80,000 in several carbon emission reduction projects since 2012. Projects have included the installation of LED lighting in the depot office building, stores and car park, new energy efficient storage heating, as well as wall and loft insulation. It is expected that the combined impact of these projects will be to save around 68 tonnes of carbon dioxide, whilst also reducing the site's electricity consumption by approximately 62%.

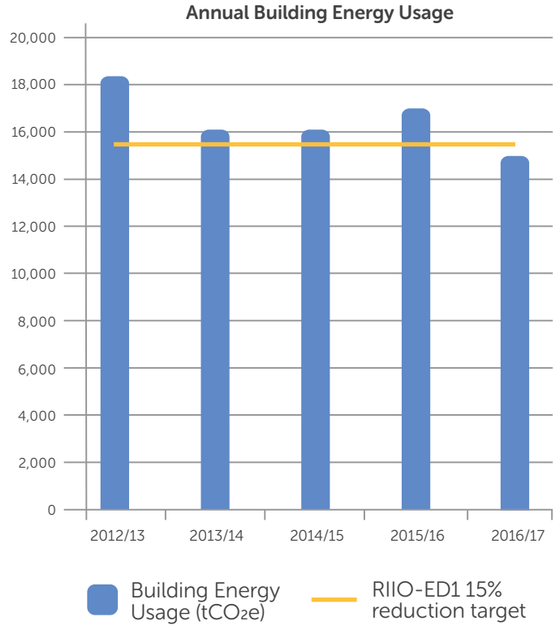
We have invested £750,000 in carbon saving initiatives at our data centres located north of Portsmouth during 2014/15. Projects have included the installation of new high efficiency turbo chillers with free cooling, an innovative adiabatic cooling system and solar photo-voltaic systems. The combined impact of these projects has seen the data centre sites electricity consumption reduce by over 9%, with a resulting CO_2 saving of 509 tonnes.

We have invested £1.5 million in a variety of carbon saving initiatives at our Penner Road, Customer Service Centre near Portsmouth in recent years. Since September 2013 projects have included the installation of internal lighting controls, a solar thermal system, a solar PV roof mounted system, a solar PV car charging station, and a new 24 hour turbo chiller. It is expected that the combined impact of these projects will be to save over 400 tonnes of CO_2 whilst also reducing the site's electricity consumption by approximately 36%.

We have invested over £150,000 in carbon saving projects during 2015/16 at our Slough Depot, in Berkshire. Projects have included the installation of a roof mounted solar PV system and the installation of LED lighting in the depot building. It is expected that the combined impact of these projects will be to save around 68 tonnes of CO_2 whilst also reducing the site's electricity consumption by approximately 30%.

Carbon reduction saving opportunity projects and awareness campaigns at our SSE Networks operational office and depot buildings have helped ensure that the carbon intensity of the business is ahead of its peers. Our latest reported buildings carbon intensity is 0.68 t/£m and this is well ahead of other similar networks businesses. Our Networks operational buildings have also been subject to recent refurbishments to target operational efficiency. Our depot buildings have targeted "A" or "B" rated EPC ratings and the latest depot building refurbishments have achieved A+ ratings.

Figure 2.4e – Annual building energy usage



As shown in figure 2.4e above, our Annual building energy usage decreased between 2012/12 and 2013/14 and remained flat in 2014/15. It then decreased further by 5% from 15/16 to 16/17. There has been a reduction of 18% from 2016/17 relative to 2012/13 when targets were set.

For further details on Business Carbon Footprint, please see worksheet E3 – BCF linked to the Appendix of this report.

2.4.2 Sulphur Hexafluoride (SF_6) Emissions

SF_6 is an extremely effective electrical insulator that is used in our circuit breakers, switchgear and other electrical equipment. It has significant advantages over alternative materials. It is non-flammable, a critical safety requirement in the high-voltage applications, and because of its excellent insulating properties it takes up less volume than alternatives such as oil. However, it is also a very potent greenhouse gas, one kg of SF_6 is equivalent to approximately 22,800kg of carbon dioxide.

The total capacity of SF_6 used in assets on our network is slightly less than 30,000kg across our two licence areas as presented in Table 2.4f opposite:

Figure 2.4f – Installed SF_6 capacity per Licensee

Licensee	Installed Capacity (kg)
SHEPD	5,716
SEPD	24,273
TOTAL	29,989

Emissions of SF_6 are calculated by combining the volume of SF_6 used in routine maintenance and the volume used during fault repair.

During routine substation inspections all SF_6 switchgear, plant and equipment are inspected and all gauges checked to ensure that SF_6 pressure is in the normal operating range. Low SF_6 gas levels are reported to the Network Management Centre, which will ensure prompt attention.

We take any leakage of SF_6 extremely seriously and have detailed policies and procedures in place to manage our relevant assets. We monitor plant leakage rates on a quarterly basis to quickly identify plant items that are becoming problematic and decide on an appropriate course of action for intervention to halt any leakage.

Topping up of SF_6 network assets is done to the BS EN 60376 specification standard. The quantity of SF_6 topped up is recorded in our asset management system upon the completion of the top-up work. There are detailed policies and procedures in place to manage the process.

We are actively following the progress made on more efficient, safer, insulation materials to replace SF_6 through National Grid's NIA project, as well as looking at techniques to reduce leakage from existing plant. Link to National Grid SF_6 project: **www.smarternetworks.org/Project.aspx?ProjectID=1724#project-details**

This is an area where we are actively ensuring that our procurement policies encourage the purchase of alternatives to SF_6. Depending on plant type, condition etc. this will be either a refurbishment or replacement solution.

In addition, through our innovation programme we have developed SF_6 leakage locating systems and effective interventions to reduce SF_6 once a leak is found. Link to our SF_6 leakage location project: **www.smarternetworks.org/Project.aspx?ProjectID=1520**

Figure 2.4g – Actual loss of SF_6 to bank

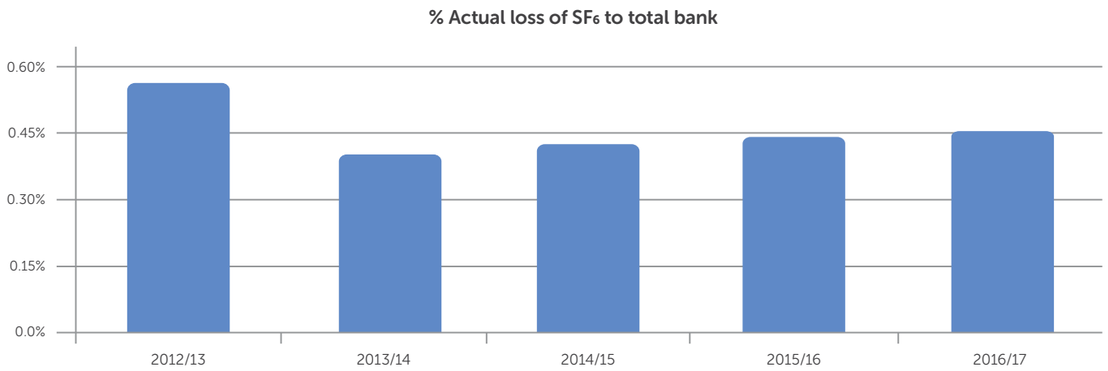
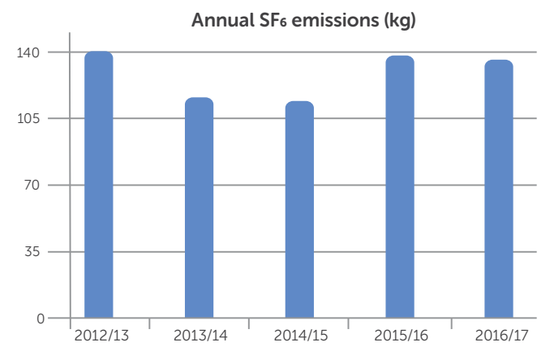


Figure 2.4g shows that our actual loss of SF_6 as a percentage of total banked SF_6 (refers to the total amount of SF_6 stored in plant) was 0.57%. Our SF_6 emitted as a percentage of total SF_6 banked decreased by 15% between 2012/13 and 2013/14 and remained relatively flat between 2013/14 and 2016/17. There has been a reduction of 12% from 2012/13 when targets were set to 2016/17. As shown in figure 2.4h above, our SF_6 emitted decreased by 17% between 2012/13 and 2013/14 and remained flat between 2013/14 and 2014/15. There has been an increase of 15% from 2014/15 to 2015/16 and a decrease of 2% between 2015/16 and 2016/17. The increase is due to old oil filled plant, prone to leakage, being replaced with SF_6 plant. This is reflected by an increase in banked SF_6 as shown in graph 2.4g.

Figure 2.4h – Annual SF_6 emissions



For further details on Business Carbon Footprint, please see worksheets E2 – Environmental Reporting and E3 – BCF linked to the Appendix of this report.

2.4.3 Distribution Losses

2.4.3.1 Overview

Distribution losses are an unavoidable consequence of transferring energy across the electricity network and they have a significant financial and environmental impact. These losses can either be technical (as electricity can turn to heat as it is transported) or non-technical (for instance, due to theft or measurement errors). Electricity losses have a significant financial and environmental impact upon consumers. The annual cost of distribution network losses is approximately £1 billion per annum across GB (2015 estimate).

2.4.3.2 Losses Strategy

Our Distribution Losses Strategy was updated in April 2017 and identifies our approach to ensuring that losses on our network are kept as low as reasonably practicable. Key measures identified include:

- Installing Primary & Grid transformers that outperformthe EU Eco Directive.
- Increasing the minimum size of new secondary transformers.
- Prioritising early replacement of pre 1960 secondary transformers.
- Increasing the minimum cable size to the next sizeup for new cables.
- Continuing to develop new methods of managing Non-Technical Losses.

Full details of our Losses Strategy can be found at:
www.ssen.co.uk/lossesstrategy

2.4.3.3 Losses Volume

The total amount of electrical losses on our network in 2016/17 was 2.36 GWh and is calculated by subtracting the number of energy units known to be delivered to customers from the number of units that originally entered our network. There are a wide range of factors which influence Distribution Losses which in combination make losses notoriously difficult to measure accurately. For example, today's domestic metering does not record when energy is used in between each reading, this means it is not possible to completely align measurements of energy entering and leaving our network. However, current assessment of the losses on our network has been estimated as shown in table 2.4i. Figure 2.4j shows the percentage losses in the networks in relation to total electricity distributed.

Table 2.4i – Total losses in the network

Year 2016/17	Total Distribution Losses MWh	Equivalent tCO_2e
SHEPD	545,901	266,591.7
SEPD	1,810,853	884,332.7

2.4.3.4 Losses Strategy in Action

SSEN have already commenced on the implementation of all of the measures outlined in our Losses Strategy, these include:

1 Energy Efficient Transformers
We have commenced on the installation of plant and equipment that delivers enhanced losses performance and outperforms the EU Transformer Eco Directive Tier 1. Where relevant this has included prioritising the replacement of pre 1960 transformers.

2 Minimum Sizing of Cables and Transformers
In general terms, increasing the diameter of conductors lowers losses. Therefore, we have put in place measures to increase the minimum size and rating of new cables and transformers. These measures relate to installation of equipment that affects both SSEN and external stakeholders such as Independent Connection Providers (ICPs). We have undertaken a detailed process of engagement with these key stakeholders to make them aware of the change, and have implemented the policy changes necessary to make these changes effective from 1st April 2016.

Figure 2.4j – Percentage of energy losses 2010–2017

3 Non-Technical Losses

For the non-technical losses it was necessary to estimate the number of MWhs that will now be correctly metered and billed following resolution by our Revenue Protection Teams. The Revenue Protection Team identified the number of properties / Meter Point Administration Number (MPANS) that have been rectified during the period. The number of MWhs was calculated using the average consumption per property type derived from the SHEPD or SEPD Common Distribution Charging Methodology as appropriate. We will continue to work with the Revenue Protection team to further develop our approach to identifying and reducing non-technical losses.

Each of the initiatives described above has been selected based on obtaining a positive result when performing a Cost Benefit Analysis (CBA) that values the lost energy at £48.42 per MWh. We will update the Losses strategy and associated CBAs on an annual basis to take account of any changes and to ensure that the anticipated benefits are realised. We will also assess the benefits from any new or innovative measures which become available since the previous update.

In addition to the Losses Strategy, SSEN also proposed a number of other loss reduction measures in our submission for Tranche 1 of the Losses Discretionary Reward. This sets out how we plan to transform our approach to managing losses by:

1 Understanding Where to intervene

- Building on our existing strategy by directly funding new pieces of analysis to better develop our understanding of losses and focus our actions.

- Improve preparation for the Smart Meter rollout by leveraging the learning and modelling techniques derived from our existing LCNF projects including SAVE and NTVV, mentioned in section 3.2.1.

- Initiating engagement with adjoining DNOs and upstream Transmission Operator/System Operator to ensure that networks operations are optimised across boundaries.

2 Understanding How to Intervene

- Engaging with wide range of key stakeholder including supply chain, other utilities and other energy market participants to raise awareness of losses and ensure a holistic approach to the management of losses.

- Sponsoring the creation of a new award category at the Energy Innovation Centre Awards 2017 for the best new approach to the management and understanding of network losses.

3 Intervening Effectively

- Investigating the creation of a dedicated 'Losses Team' to focus on the implementation of appropriate loss reduction actions on the network.

- Establishment of an SSEN Losses Steering Group chaired by our Director of Engineering and Investment to focus and support our programme of work.

- Leading the creation of a DNO Losses Forum to share best practise and develop a coordinated approach to the understanding and management of network losses.

We will continue to progress these initiatives through the remainder of the RIIO–ED1 period.

2.4.3.5 Losses Reporting Progress

For further details on losses, please see worksheet E4 – Losses Snapshot linked to the Appendix of this report.

Table 2.4k – Summary of SEPD Losses Costs and Benefits from Activities in RIIO-ED1

SEPD Programme/ Project Title	2016/17 Regulatory Reporting Year			RIIO-ED1
	Distribution Losses Justified Costs	Reduced Losses	Reduced Emissions Associated with Losses	Cumulative Reduced Losses to Data
	£m	MWh	tCO_2e	MWh
LV Cable Asset Replacement	0.01	14	7	14
LV Cable General Reinforcement	0.01	15	7	15
LV Cable Other	0.16	250	122	250
HV Cable Asset Replacement	0.00	3	2	3
HV Cable General Reinforcement	0.01	11	5	11
HV Cable Other	0.07	126	61	126
33kV Transformer (GM) Asset Replacement	0.95	1,400	683	2,625
33kV Transformer (GM) General Reinforcement	0.00	0	0	175
33kV Transformer (GM) Other	0.36	525	256	1,050
66kV Transformer Asset Replacement	0.00	0	0	263
66kV Transformer General Reinforcement	0.00	0	0	0
66kV Transformer Other	0.00	0	0	0
132kV Transformer Asset Replacement	0.74	526	257	1,052
132kV Transformer General Reinforcement	0.00	0	0	263
132kV Transformer Other	0.00	0	0	1,052
6.6/11kV Transformers – GMT Asset Replacement	0.00	133	65	162
DUOS recovery SEPD – domestic Other	N/A	28,052	13,689	35,885
DUOS recovery SEPD – non domestic Other	N/A	18,206	8,884	27,209

Table 2.4l – Summary of Amount of SEPD Losses Activities in Regulatory Reporting Year and Estimate for the Following Regulatory Year

SEPD Programme/Project Title	Description of Unit	Volumes in Regulatory Reporting Year	Forecast Volumes for Following Regulatory Year
LV Cable Asset Replacement	km	2	TBC
LV Cable General Reinforcement	km	3	TBC
LV Cable Other	km	41	TBC
HV Cable Asset Replacement	km	1	TBC
HV Cable General Reinforcement	km	2	TBC
HV Cable Other	km	27	TBC
33kV Transformer (GM) Asset Replacement	#	8	TBC
33kV Transformer (GM) General Reinforcement	#	0	TBC
33kV Transformer (GM) Other	#	3	TBC
66kV Transformer Asset Replacement	#	0	TBC
66kV Transformer General Reinforcement	#	0	TBC
66kV Transformer Other	#	0	TBC
132kV Transformer Asset Replacement	#	2	TBC
132kV Transformer General Reinforcement	#	0	TBC
132kV Transformer Other	#	0	TBC
6.6/11kV Transformers – GMT Asset Replacement	#	14	TBC
DUOS recovery SEPD – domestic Other	#	5,281	TBC
DUOS recovery SEPD – non domestic Other	#	642	TBC

Table 2.4m – Summary of SHEPD Losses Costs and Benefits from Activities in RIIO-ED1

SHEPD Programme/ Project Title	2016/17 Regulatory Reporting Year			RIIO-ED1
	Distribution Losses Justified Costs	Reduced Losses	Reduced Emissions Associated with Losses	Cumulative Reduced Losses to Data
	£m	MWh	tCO_2e	MWh
LV Cable Asset Replacement	0	6	3	6
LV Cable General Reinforcement	0	2	1	2
LV Cable Other	0	181	88	181
HV Cable Asset Replacement	2	4	2	4
HV Cable General Reinforcement	1	2	1	2
HV Cable Other	51	94	46	94
33kV Transformer (GM) Asset Replacement	1	1,048	511	2,096
33kV Transformer (GM) General Reinforcement	0	262	128	1,310
33kV Transformer (GM) Other	5	3,668	1,790	4,716
6.6/11kV Transformers – GMT Asset Replacement	0	10	5	29
DUOS recovery SHEPD – domestic Other	N/A	13,837	6,753	18,072
DUOS recovery SHEPD – non domestic Other	N/A	6,638	3,239	10,408

Table 2.4n – Summary of Amount of SHEPD Losses Activities in Regulatory Reporting Year and Estimate for the Following Regulatory Year

SHEPD Programme/ Project Title	Description of Unit	Volumes in Regulatory Reporting Year	Forecast Volumes for Following Regulatory Year
LV Cable Asset Replacement	km	1	TBC
LV Cable General Reinforcement	km	0	TBC
LV Cable Other	km	30	TBC
HV Cable Asset Replacement	km	1	TBC
HV Cable General Reinforcement	km	1	TBC
HV Cable Other	km	20	TBC
33kV Transformer (GM) Asset Replacement	#	8	TBC
33kV Transformer (GM) General Reinforcement	#	2	TBC
33kV Transformer (GM) Other	#	28	TBC
6.6/11kV Transformers – GMT Asset Replacement	#	1	TBC
DUOS recovery SHEPD – domestic Other	#	2,366	TBC
DUOS recovery SHEPD – non domestic Other	#	140	TBC

2.5 Other Environment-related Activities

2.5.1 Innovation

Environmental benefits are a common feature of many of the projects in our innovation portfolio, predominantly through the acceleration of the connection of new low carbon technologies and the resulting reduction in the carbon content of the energy we distribute. Some samples of our innovation projects that generate environmental benefits are detailed below.

2.5.1.1 Enhancing Wildlife & Biodiversity

Applied Integrated Vegetation Management (IVM) (NIA_SSEPD_0025): This project seeks to investigate potential improvements of efficiency, safety and environmental impact through the use of IVM. This is the practice of promoting desirable, stable, low-growing plant communities that will resist the invasion of tall-growing trees that are a major cause of supply interruptions through the use of appropriate, environmentally sound, and cost effective control methods. These methods can include a combination of chemical, biological, cultural, mechanical and/or manual treatments and will possibly remove the requirement of the DNO to revisit site and carry out costly and disruptive mulching. The purpose of this project is to investigate if using IVM can reduce the operational expenditure, number of re-visits, exposure to hazardous activities and impact on the environment compared to traditional techniques.

More details can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=1856**

2.5.1.2 Supporting the uptake of Low Carbon Technologies (LCTs)

Low Cost LV Substation Monitoring (NIA_SSEPD_0027): As more customers take advantage of low carbon technologies, it has the potential to create load growth and unexpected power flows on the LV network. Accurate and detailed loading information from monitoring devices can be used to target and mitigate network alterations. However, due to the high costs involved in substation monitoring it hasn't been economically feasible to undertake this. We are investing in the development of new low cost substation monitoring equipment with a number of partners. This is being developed and trialled as part of this NIA project to test whether it can be installed and operated to provide valuable current and voltage information, while at the same time providing net financial benefits.

If it proves to be successful we will be able to roll it out as a BaU technology to help make intelligent investment decisions. These decisions will enable the implementation of other smart technologies, which in turn will support the growth of solar panels and Electric Vehicles at a much lower cost relative to conventional reinforcement.

More details can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=1885**

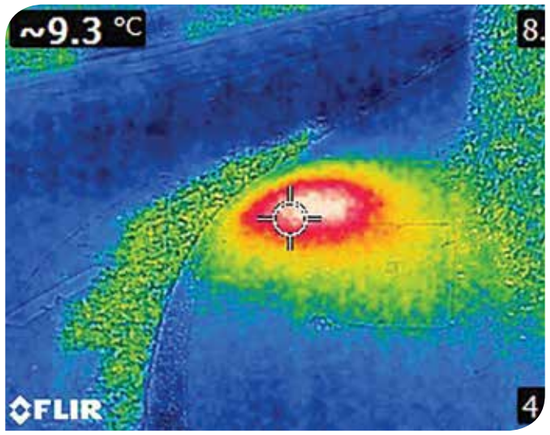
2.5.1.3 Reducing Noise & Air Pollution

Thermal Imaging of Underground Cables (TOUCAN) (NIA_SSEPD_0021): Thermal imaging cameras are currently being used within our Southern region and are in the process of being rolled out within our Scottish region. These cameras are able to detect underground network faults by accurately locating heat signatures from cable faults. The devices make no noise vs traditional sniffer devices and due to their ability to accurately pin point faults it means fewer noisy excavation activities are required with the additional benefit of reduced excavated waste material and backfill.

More details can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=1827**

Hybrid generators (IFI): Hybrid generators are able to operate in both battery and diesel mode causing significant fuel and carbon reductions vs traditional diesel generators. Traditional diesel generators are also noisy in nature. While running in battery mode the hybrid generator emits far less noise making it more attractive for night time operations.

More details can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=1537**



2.5.2 Environmental Employee Awareness

Sometimes environmental awareness is not sufficient in itself to create real environmental benefits. To build on the effectiveness of awareness campaigns, SSEN has implemented the following good practice guidelines:

- Do not pump polluted substances into watercourses
- Respect ecological exclusion areas
- Importance of designing, building and maintaining an efficient drainage
- Assess risks and plan construction when working on contaminated land
- Create archaeological exclusion areas, and respect the archaeological watching brief
- Segregate all waste to maximise recycling
- When driving on site, follow the designed route to protect wildlife and preserve scenery

- Build up stocks of turf, topsoil and subsoil separately and safely
- Always use the supplied fuelling points on sites, where spill kits are available
- Maintain any skilful reinstatements
- Always consider other land users prior to commencing work
- During the months of April to August, do not disturb breeding birds as they are protected by law

Within SSE, there is an internal group that actively promotes environmental saving activities. The 'Better Off' campaign encourages colleagues to switch off monitors, desktops, thin clients and laptops overnight or at the weekend rather than being left on standby. Additionally, household water and energy consumption advice is also offered to further reduce employee's environmental impacts outside of working hours.SSEN also operate two groups on the social networking platform 'Yammer', which allows colleagues to keep updated with new environmental awareness information about the networks sector. Finally, we offer 'Be the difference' volunteering where employees are able to raise funds for charity by partaking in a variety of activities including environmental clean-up days.

Environmental guidelines are in place to help protect our natural environment.

2.5.3 Adaptation/flood preparedness

During the second year of RIIO-ED1, SEPD and SHEPD invested £0.11m in site surveys across all flood risk sites in order to prioritise investment across the remainder of the price control period. This was in addition to expenditure of £1.24m on flood prevention measures at 31 sites across SEPD and SHEPD.

Flood defence surveys were carried out by contractors on all primary substations across both our regions. Along with further internal analysis it was identified that a number of sites were considered "at risk" to exceptional flooding events. Flood prevention measures were then implemented on these sites including levee building, door water proofing, air vent water proofing, cable sealing, installing water pumps, etc. The implemented measures now ensure that these sites are effectively protected against exceptional flooding events, preventing any reliability issues from occurring in the event of a flood.

Our Thatcham site is now zero to landfill

2.5.4 Waste/Landfill/Recycling

One of our key environmental standards to help achieve this goal is to apply the waste hierarchy to reduce, reuse and recycle our waste.

Our Logistics Operations team in Thatcham, which provides waste and recycling services to locations in the south, have reached a number of key milestones over the last 12 months, which not only support SSE's Environmental Policy but have also helped to generate substantial savings by reducing our use of third parties and reducing SSEN's carbon footprint.

The team's key focus has been on reusing, recycling or recovering waste to eliminate the need for landfill. They have achieved good performance in this area, however they faced a challenge as they had some waste that could not be recycled using the conventional waste management processes in place at the time.

To address this, the team ran a trial with a Waste Management Company to test the contents of their landfill containers for refuse-derived fuel (RDF) capability. RDF is a fuel produced by shredding and dehydrating solid waste with waste converter technology to produce electricity. The trial was successful and in August 2016 Thatcham became a zero to landfill site. The site used to send around 16 tonnes of waste to landfill every quarter, the equivalent of two blue whales!

The team is also actively promoting greater awareness and use of its waste collection service among the locations it serves, reducing their reliance on costly third party waste contractors which is expected to derive some efficiency savings.

Over the past 18 months, the Team has successfully implemented SSE's reduce, reuse and recycle waste hierarchy and also worked with various sites to generate savings and efficiencies and reduce SSEN's carbon footprint.

2.5.5 Contaminated Land Clean Up

In 16/17, there were 4 incidents of land contamination in the SEPD area. Initial risk assessments were undertaken to determine the extent of the contamination and to ascertain the risk mitigation works and/or clean up works required. The schemes cost a total of £11,000.

For further details on contaminated land clean up, please see worksheet E2 – Environmental Reporting linked to the Appendix of this report.

2.5.6 Noise Pollution

The noise complaints reported in 2016/17 for both SHEPD and SEPD included complaints related to substation noise. A total of 4 noise complaints were made in SHEPDs and 12 in SEPD's licence areas. A total of £0.970m was spent on rectifying a noise issue in Ealing Primary Substation and building a noise enclosure to deal with noise issues at Birdham substation in the SEPD licence area.

For further details on noise pollution, please see worksheet E2 – Environmental Reporting linked to the Appendix of this report.

2.5.7 Community Engagement

SSEN has implemented the Resilient Communities Fund which provides financial support for communities to prepare for extreme weather events. The fund originally ran over a 2-year period, awarding £1.25m in total to benefit communities in SSEN's electricity distribution network areas in the north of Scotland and central southern England. In 2016/17, due to the success of the fund, the decision was taken to extend it until 2023. In 2016/17, over £750,000 was awarded from the fund to support 111 community projects. Various flood prevention and preparedness projects were supported, including awards of around £13,000 to Edzell Flood Action Group to purchase flood barriers and around £19,000 to Salisbury City council for a flood resilience project.

More information regarding the Resilient Communities Fund is available here: **www.ssen.co.uk/Resiliencefund**

In 2016/17 SSEN's Resilient Communities Fund awarded over £750,000 in support of 111 community projects

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

3.1 Introduction

This section provides an overview of SSEN's innovation activities that are enabling a smooth transition towards a low carbon economy. Progress of our innovation projects that are aligned with our RIIO-ED1 strategy is displayed in this section along with details of benefits realised to date of technologies that have been successfully implemented into BaU. Progress on Smart Meter deployment and how we anticipate benefits from them is also covered here.

Forecasts suggest low carbon technology (LCT) uptake, such as electric vehicles (EVs), Photovoltaics (PVs) and increasingly energy storage, are set to increase in future years. On top of this electricity demand patterns are changing as consumers respond to economic stimuli and attempt to reduce their carbon footprints. Established patterns of supply and demand, with well understood diversity factors will change as consumers change their behaviour and adopt these new technologies. There is also the potential for new disruptive supply models to be introduced, driven by the roll out of smart meters. As such, DNOs face an increasingly uncertain set of future requirements which will require a much broader set of capabilities. Therefore, SSEN have a wide ranging Innovation portfolio to ensure we are well prepared for the future. Key areas for focus are described below.

Distribution System Operator (DSO): This is one of the largest and most complex challenges currently facing the industry. A large amount of effort is being invested within SSEN on projects that will allow DNOs to move from the traditional DNO model to the new DSO model. It is expected that the move to DSO will remove barriers to smart technologies, assist in the evolution of the smart grid and make energy markets more flexible to provide more scope for carbon and consumer benefits. SSEN have a number of key innovation projects which are helping to inform this transition, including our latest Network Innovation Competition bid – TRANSITION. SSEN are also fully engaged with the ENA led Open Networks project which is setting a Roadmap for transition to DSO across the whole industry. **www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview**

Electric Vehicles: Uptake of EVs is steadily rising as technological improvements to batteries improve vehicle range and prices become more attractive to consumers. SSEN is specifically working to:

- Understand the potential impact of EVs on different components of the network
- Develop an understanding of the technical and commercial solutions to meet these network challenges
- Engage with the EV community to ensure a mutual understanding of our requirements and needs. Specifically on engagement, we have significantly increased our interaction with the electric vehicles sector to include manufacturers, charging point suppliers, customer groups and relevant government agencies. We were also one of the founder members of the EV Working Group – this is a cross sector engagement group including organisations such as OLEV, the AA, Citizens Advice Bureau, charging companies and vehicle manufacturers. The Groups purpose is to smooth the transition toward the mass adoption of EVs. This work is being driven by our NIA project Smart EV – **www.eatechnology.com/projects/smart-ev**
- Put in place measures to help us to monitor the growth in EVs being connected to the network and in particular the impact of clustering.
- Appointed an EV Readiness Manager, who will be responsible for making sure that SSEN are well prepared for any challenges that may arise from the widespread adoption of EVs

Flexible Connections: Demand to connect small scale renewable generation quickly and on constrained networks is increasing. To meet this demand SSEN has:

- Standardised the technical specification for our flexible Active Network Management (ANM) connections
- Established and developed a specialised Active Solutions Team within our BaU function to provide customers with more flexible connection options and to continue to maintain and support these connections when they are complete
- Continued to support and deliver innovative projects to develop further flexible arrangements. This includes the ACCESS project on the Isle of Mull (**www.accessproject.org.uk**) where customers are using controllable demand to maximise the utilisation of distributed generation which would have been otherwise constrained.

Smart Meters: These continue to be rolled out across both our Scottish and Southern networks. As the volume of smart meters deployed grows, this will provide DNOs with the potential to receive additional information on networks

loading and also notification of supply interruptions. SSEN has established a specialised Smart Meter team with the objective of realising benefits from the roll out of smart meters to ensure we create benefits for our customers.

Innovation Deployment: SSEN is engaged in a number of large and small scale projects that are specifically designed to meet Ofgem's RIIO-ED1 outputs. The purpose of these projects is to ensure a broad range of benefits are realised for our customers. Examples of projects that are being rolled out into BaU include LiDAR that assists with our vegetation management programme and constraint managed zones (CMZ) that are able to defer the need for expensive capital investments.

Low Carbon Technologies (LCTs): The total uptake of LCTs has fallen this year compared with last year for both our networks. This is mainly due to a decline in the purchase of solar PV, as a result of changes in the subsidy regime. There has been an overall increase in the number of EV charging points on our network. In our Scottish region there has been a slight year-on-year reduction in the number of EV charging points, contrasted against an overall increase in our Southern region.

For further details on low carbon technologies, please see worksheet E7 – LCTs linked to the Appendix of this report.

3.2 Progress on our innovation strategy

We originally published our Innovation Strategy along with our RIIO ED1 business plan. This outlined our plans including our "top 20" innovations. We have made progress on many of these initiatives since then. Further details can be found in our Updated Innovation Strategy, the full document can be found at: **www.yourfutureenergynetwork.co.uk/wp-content/uploads/2016/04/Innovation-Stategy-update-ver-9.pdf**. An updated list of our top 20 innovations is shown in 3.2a.

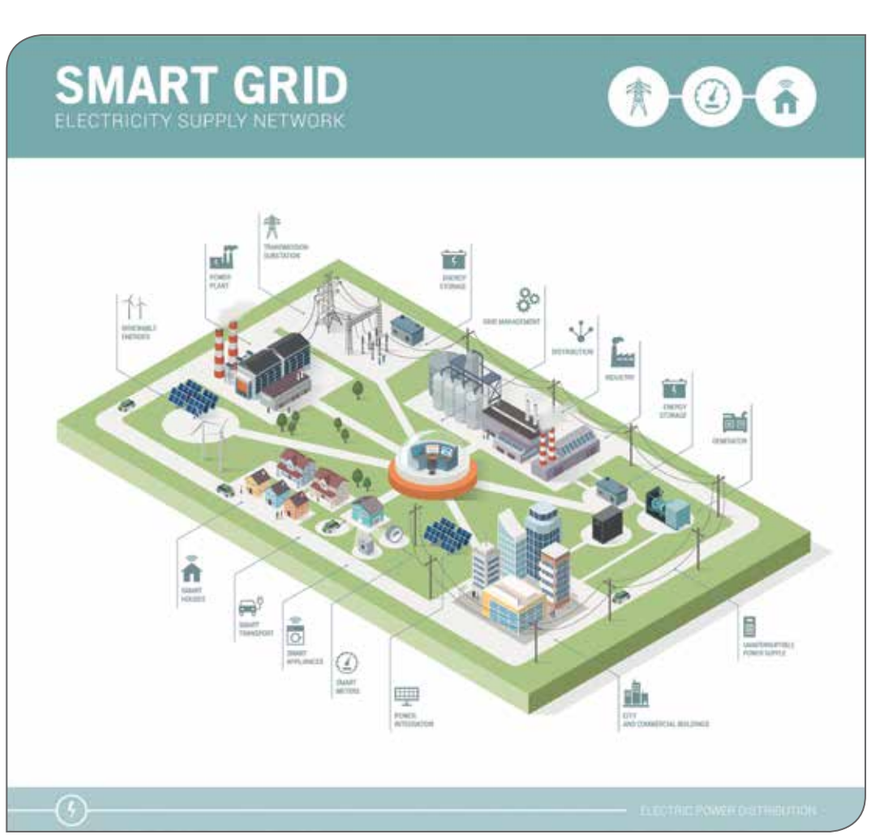


Table 3.2a – Top 20 innovations

RIIO ED1 Primary Output	Core Innovation for RIIO-ED1	2017/18 Update
Connections	Active network management – generator constraint management	Implemented into BaU
	Active network management – community demand management	Progressing as a live NIA project
	Demand-side management – thermal energy storage	In progress of being implemented into BaU in CMZ
	Dynamic circuit thermal rating	Fast following
	Fault current limiters	Fast following
	Local smart EV charging infrastructure	Progressing as a live NIA project
	LV solid-state voltage regulator and power conditioning	This project has been suspended
	Static synchronous compensators (STATCOMs)	Implemented into BaU & Progressing as an NIA project
Customer Service	Advanced distribution automation – network reconfiguration	In process of being implemented into BaU
	Weather impact and response modelling tools	Implemented into BaU
Environment	Bidirectional hybrid generation plant	Implemented into BaU
	Wood pole alternative	Progressing as a live NIA project
Reliability	Automated demand response with commercial customers	In progress of being implemented into BaU in CMZ
	Energy efficiency approaches	Progressing in SAVE NIC project and in CMZ
	LV network modelling	Considering BaU implementation following NTVV project completion
	LV network monitoring	Implemented in LV automation & losses activity & progressing as a live NIA project
Safety	Conductor sag/vibration monitoring	Progressing as a live NIA project
	Live line tree felling	Implemented into BaU
	Arc suppression coil and residual current compensation earthing	This project has been suspended
Social Obligations	Enhanced supply monitoring and support for vulnerable customers	Linked to roll out of smart metering

A more in depth breakdown of Active NIA projects can be found in the 2017 Annual NIA Summary Report located here www.ssen.co.uk/InnovationLibrary/Distribution

3.2.1 Large-Scale Innovation Projects

During 2016/17, SSEN had 5 large-scale innovation projects in its distribution business. Two of these projects have now concluded, NTVV and NiNES, where learnings were shared with the rest of the industry during the March 2017 Institute of Engineering Technology (IET) event. Further information on all these projects are detailed below.

The NiNES project has made it possible for increased renewable generation on Shetland.

3.2.1.1 Northern Isles New Energy Solutions (NINES)

Key activities
The NINES Project has helped SSEN to deliver a secure, affordable and reliable energy system for Shetland whilst increasing the use of renewable generation on the islands. In doing so, NINES implemented and trialled a range of technologies including:

Demand Side Management (DSM) using the next generation of storage and water heating. The aim was to deliver DSM into domestic homes, reducing peak electricity demand, thus enabling enhanced control of the current network and the ability to accommodate more renewable energy sources on to the grid.

A 1MW / 3MWh lead acid battery was also used to take or provide electricity according to generation and network characteristics.

An ANM was designed, developed and installed to manage the energy requirements of the lead acid battery and the next generation of space and water heaters with the aim of maximising the use of renewable energy thereby reducing the amount of fossil fuels required to meet the energy needs on Shetland.

Outcomes
The NINES Project has successfully deployed additional renewable generation, including wind and tidal, on a constrained Shetland network by making use of ANM, energy storage and demand side management. These innovative solutions reduce peak demand and thereby reduce the required generation capacity and output on Shetland. Full details of the outcomes of the project can be found at: **www.ninessmartgrid.co.uk**

Funding Stream
£18.6m project assisted in the development of the first phase of the Integrated Plan and informed the New Energy Solution for Shetland tendering process which has now concluded. £15.3m funded by electricity customers through adjustment to SSEN allowed revenue.

Start/End Date
2011-2017

3.2.1.2 New Thames Valley Vision (NTVV) (SSET203)

Key activities
Electricity demand patterns are changing as individuals, small businesses and larger companies increasingly act, either on their conscience or in response to economic stimuli, to reduce their carbon footprint. The options available to customers include: energy efficiency measures; the installation of solar thermal or PV panels and other small-scale renewable energy devices; an increased uptake of EVs; and adoption of heat pumps (HPs). The use of these disruptive network technologies poses challenges for the DNO who have a very limited view of their customers and individual usage.

With low carbon technologies now accelerating change on network, the current crude level of monitoring leaves the network exposed to stress as load factors vary; it also hides capacity that could be otherwise utilised. Without advanced monitoring and the smart use of data, the network would require significant capital investment to support the transition to a low carbon economy, whilst ensuring security and quality of supply to customers.

This five year project focused on the Low Voltage (LV) network with the aim to demonstrate how electricity distribution networks can better serve their customers by understanding, anticipating and supporting energy use as we move towards a low carbon economy. This is achieved through a mixture of analytics, technological and commercial solutions for network planning and operation. The £30m (£25m customer funded) project budget has been invested in developing and trialling technological solutions, commercial agreements, procedures, policies and training to create new learning for DNOs and other stakeholders on understanding, anticipating and supporting the requirements of our customers through the transition to a low carbon economy.

Adapting the principles applied to a supermarket loyalty scheme , the project has developed monitoring, modelling and forecasting capabilities to increase our understanding of future network usage. The valuable insight provided will enable informed decision to be made on future policies and investment to accommodate disruptive connected technologies. Application of the approaches trialled through NTVV will enable DNOs to avoid an estimated £900m of network reinforcement through the involvement of all customers groups and a comprehensive understanding of networks. The picture below shows the SSEN popup store that was used as part of the NTVV stakeholder engagement exercise.

Expected outcomes
NTVV has adopted an approach addressing three key elements:

Understand: Through the planned monitoring activities and the related modelling work, NTVV has identified the optimum level for network monitoring, minimising the costs for extensive installations.

Anticipate: In order to maintain the existing levels of supply quality and plan new network developments, there is a need to understand how different consumers on different parts of the network will use electricity in the future. NTVV is utilising sophisticated mathematical techniques to develop these models, providing the decision making support for constrained network zones.

Support: The project has enabled an understanding of the tools which will be required to provide the necessary level of flexibility for our network, including constraint managed zones where battery storage and demand side response will in the future play key roles; technologies developed through the project and necessary as the organisation transitions from a DNO to a DSO.

More information can be found here:
www.thamesvalleyvision.co.uk

Funding Stream
LCNF Tier 2
£30m project
(£22.8m Tier 2 funding)

Start/end date
2012–2017

3.2.1.3 Low Energy Automated Networks (LEAN) (SSET207/01)

Key activities
LEAN focusses on reducing transformer losses on primary substations. The key principal of the approach to be trialled is to switch off one of a number of transformers in a primary substation at times of low load, to avoid the fixed iron losses associated with that transformer. A second method, Alternative Network Topology, will be deployed where appropriate to further reduce losses and maintain network supply integrity.

Expected outcomes
LEAN builds on learning captured from SSEN previous LCNF Tier 1 and IFI projects and seeks to demonstrate new methods that can be applied to existing assets to reduce losses in the shorter term. Approximately 6% of electricity generated is lost each year in the GB distribution network, incurring costs in the region of £1bn to customers.

Funding Stream
LCNF Tier 2
£3.1m project

Start/end date
2014–2019

3.2.1.4 Solent Achieving Value from Efficiency (SAVE) (SSET206)

Key activities
The trials will consist of evaluating four energy efficiency measures on participants in the Solent region. The measures use combinations of technology, commercial rewards and engagement campaigns informed by energy consumption and demographic data, and include: light emitting diode (LED) installation, data-informed engagement campaign, DNO price signals direct to customers coupled with – data-informed engagement and community coaching. The methods have been chosen to allow an assessment of factors such as cost and effort required to implement.

Expected outcomes
To gain insight into the drivers of energy efficient behaviour for specific types of customers; identify the most effective channels to engage with different types of customers; gauge the effectiveness of different measures in eliciting energy efficient behaviour with customers; and determine the merits of DNOs interacting with customers on energy efficiency measures as opposed to suppliers or other parties. Initial trial interactions show minimal uptake of LED's and minimal response to both data informed engagement and data informed engagement + price signals (approx. 3% on each group). The next trial period will run significantly different/ more proactive interactions in attempt to boost these results. This project will establish a tool to identify the energy efficiency measures which are most cost effective in terms of managing a particular network constraint.

Funding Stream
LCNF Tier 2
£10.3m project
(£8.3m Tier 2 funding)

Start/end date
2014–2019

3.2.1.5 Distribution System Operator (DSO) Transition

Key Activities
The transition of Distribution Network Operators to Distribution System Operators is a major energy industry initiative that will transform the way our energy industry works, underpinning the delivery of a smart grid. It is a core component of Ofgem's future facing work to enable the energy system transition which is a culmination of work with the Department of Business, Energy & Industrial Strategy (BEIS), and forms part of the Government's Industrial Strategy. More details can be found here: **https://www.gov.uk/government/publications/upgrading-our-energy-system-smart-systems-and-flexibility-plan**

Government and Ofgem are calling for the industry to deliver a smarter, more flexible energy system by:

- Removing barriers to smart technologies, including storage
- Enabling smart homes and businesses
- Making markets work for flexibility

The infographic displayed in figure 3.2b illustrates that learnings gained from a broad range of SSEN projects will be utilised in the natural evolutionary transition towards a DSO.

The Smart Systems and Flexibility Plan envisages the development of a smart, flexible energy system that will reduce costs for consumers and industry, and support the growth of innovative new businesses.

Expected outcomes
Currently SSEN are focused on contributing to The Open Networks Project which is tasked with addressing the issue of DSO Transition. This project brings together 9 of UK and Ireland's electricity grid operators, respected academics, Non-Governmental Organisations (NGOs), Government departments and the energy regulator Ofgem. The objectives of the Open Networks Project for the first phase of work in 2017 are to:

1. Develop improved Transmission-Distribution processes around connections, planning, shared TSO/DSO services and operation.
2. Assess the gaps between the experience our customers currently receive and what they would like, and identify any further changes to close the gaps within the context of a 'level playing field' and common T & D approach.
3. Develop a more detailed view of the required transition from DNO to DSO including the impacts on existing organisation capability.
4. Consider the charging requirements of enduring electricity transmission/distribution systems.

Further information on Open Networks at
www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview

Funding Stream
The Open Networks project is being funded by the participating licensees outwith any of the various Ofgem Innovation funding mechanisms.

Start/End Date
January 2017–2030

3.2.1.6 Smart EV

Key Activities
At present there is no standardised method of controlling EV chargers and a number of manufacturers have developed proprietary systems. Left alone, this will lead to a multitude of system types with little commonality which would make adoption of Esprit-type charge control much more difficult in the future. Alongside this, messaging to customers is critical to ensure buy-in and facilitate acceptance of demand side response with regards to connection and control of PIVs. The project is collaborating with cross-industry organisations to try to find a supported option for standardising the communication with and control of EV charging on the distribution network, with a focus on avoiding and resolving faults as a result of demand increases from EV charging. There are several consultations being carried out to also gain widespread feedback on the options being investigated, as well as work to determine what customer messaging strategy is required to support this concept.

Expected outcomes
The project is looking to create an industry accepted standard for managing EV charging on distribution networks, as well as a customer messaging strategy and recommendations for its implementation to support the managed EV charging concept.

Funding Stream
Network Innovation Allowance
£430k project

Start/End Date
2016-2017 (Possible Extension)

Figure 3.2b – Illustration of SSEN projects and how their learnings are utilised for DSO development

3.3 Converting Innovations into Business as Usual

Prior to commencing any innovation project a robust Cost Benefit Analysis (CBA) process is undertaken to ensure that the proposed initiative has a positive business case. This will involve making a number of assumptions in order to predict the future benefits. During the trial period these assumptions will be tested, in order to give better information on how the initiative will perform on our network. This will include an ongoing assessment on the potential benefits. At the end of the innovation trial the business case will be thoroughly reviewed including a further robust CBA based on the learning gained through the innovation project. Only if this proves positive will we decide to implement it into BaU. In many cases further trials may be necessary to provide the level of confidence required to consider a transition to BaU. It should be noted that our experience has shown that the most successful BaU deployments have been derived from learning from across the SSEN Innovation portfolio and the learning from other DNOs' projects.

In order to monitor the progress of innovation trials performed by other DNOs various knowledge sharing workshops, conferences and strategic management meetings take place on a regular basis. This allows us to better understand how innovation is benefiting other DNOs and gain insight on effective deployment of the technology into BaU.

We are actively progressing the below solutions into BaU.

3.3.1 Constraint Managed Zones (CMZ)

We have developed the CMZ based on learning from both our own and other DNOs innovation portfolios. The CMZ is a new approach to managing constraints on the distribution network. With this approach we will procure a commercial service which will allow us to defer or avoid traditional network reinforcement. The CMZ project is being progressed as a BaU solution by SSEN.

CMZs have given us a simple commercial platform to allow the implementation of multiple smart interventions all of which have been tested as part of our, and others, innovation portfolios. We are currently undertaking a systematic analysis of our relevant ED1 reinforcement investments to allow us to recover the full value from CMZs in the remainder of the RIIO-ED1 period.

The key features of the CMZ:

- It utilises a market approach to procure constraint management services
- It is technologically agnostic
- It is open to a full range of market participants
- It is a Totex solution with a fixed decision cycle and associated optionality value
- It is replicable across a range of network scenarios
- It is compatible with flexible connections and other smart interventions

The sites we have identified for the initial CMZ deployment are sites where demand is forecast to overload the "firm" rating in the near future. By using a CMZ service to reduce demand in the event of an (N-1) scenario we can avoid or defer significant network investment as illustrated in figure 3.3a and 3.3b. We have undertaken two tender rounds and are now in the middle of a third again with a positive response from a supportive market place.

Figure 3.3a- Illustration of CMZ service configuration, for post-fault services

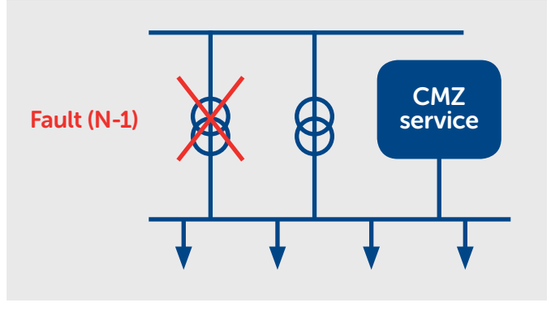
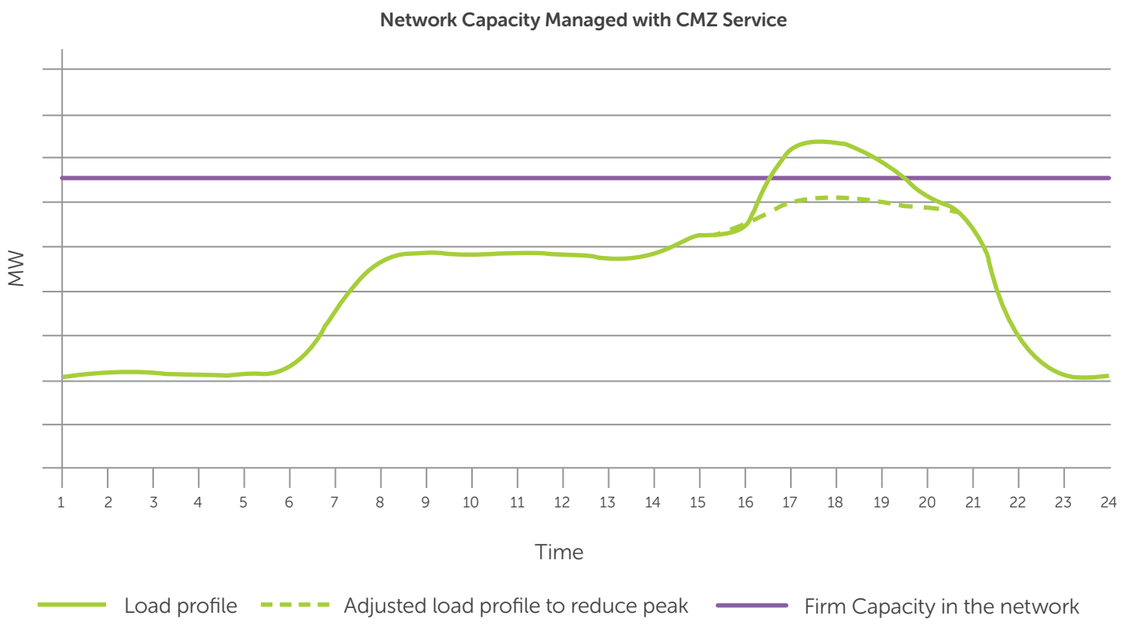


Figure 3.3b – Peak-lopping services re-shaping the load curve at the appropriate times



The Constraint Managed Zone is the natural culmination of a number of the innovation projects that we have delivered. Our projects of particular relevance are the Orkney Energy Storage Park LCNF Tier 1 project, the Orkney Active Network Management IFI project, the New Thames Valley Vision LCNF Tier 2 project and our DISCERN project which was part EU funded.

An additional value which comes from the CMZ is that it provides SSEN with a short term flexible option, allowing us the time to better understand how the use of the network will change with time.

The CMZ will have a fixed term contract at the end of the contract SSEN will have a number of options:

- Conventional reinforcement if required
- Do nothing – if forecast load growth does not materialise as anticipated
- Extend CMZ contract

This process ensures that we are constantly considering the most efficient and effective way of maintaining the integrity of the network.

3.3.2 LiDAR

SSEN has invested in state of the art LiDAR technology to map our overhead assets in both our Hydro and Southern network regions. This will provide key information in relation to vegetated spans and the heights of our overhead lines from ground and structures. From a tree cutting perspective, the data allows us to ensure we operate and maintain our network more efficiently, by targeting tree cutting at spans closest to our overhead lines. We have adjusted our tree cutting operational processes accordingly and intend to perform repeat LiDAR surveys of our networks in order to maximise benefits from this technology.

To date the LiDAR survey has captured 99% of our Southern network with the processed data on schedule to be made available to SSEN later in 2017.

LiDAR has captured around 50% of our Scottish network and we anticipate completion later this year (weather permitting) with data fully processed and made available to SSEN by May 2018.

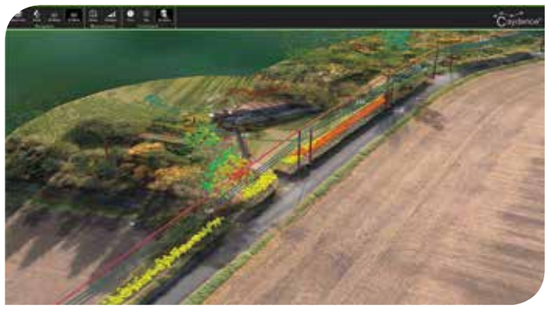
In order to maximise the benefits from the LiDAR survey data we have made significant changes to our Overhead line Inspection, Maintenance and our Tree cutting Policies and procedures.

Overhead line inspection: The changes allow us to maximise the efficiency of our inspection operations by moving a percentage of our assets from a 4 to an 8 year frequency.

Maintenance: The updated maintenance requirements ensure that any defect identified from either ground patrols or aerial surveys are validated and rectified based on risk priority basis.

Tree cutting: LiDAR data provides vegetation intrusion information per span that is far more accurate and quicker to obtain vs ground patrol tree surveying that was previously utilised. This allows us to move to a much more focussed dynamic tree cutting programme. We anticipate that this approach will increase our cutting efficiency and reduce the risk of non-compliant spans occurring.

Figure 3.3c – Example of LiDAR imagery courtesy of NM Group



3.3.3 Flexible Connections

We are committed to finding and developing flexible solutions for our customers to allow them to connect at an earlier stage. In some areas of our networks, the network is already at full capacity and it is not possible to connect any further generation without upgrading the existing network. In these cases, customers would typically be required to wait for the required reinforcement works to be completed before being able to connect to the network. However, there are a number of alternative options available to customers who are willing to consider a more flexible connection offering which, depending on the circumstance, may allow connection ahead of the required reinforcement works. We also offer flexibility in relation to payment options for connections.

Forming a consortium
In some cases, the costs of network reinforcement or new connection assets can be prohibitive to a project. One potential option available to developers in this circumstance is to share this cost with other developers wishing to connect to the same part of the network. This can be done by forming a consortium. To assist developers with identifying others that may be interested in forming a consortium, we are looking into developing an availability register as part of our Heat map tool, which can be accessed on our website.

Below are the flexible connection offers that we provide along with a brief description.

Timed connections
Our Southern network tends to have predictable load and generation patterns which enable us to determine when limitations in capacity may occur. We are therefore able to offer connections that are given an operating schedule with defined times and levels of capacity available to the customer. On our Scottish Hydro network we allow generators to connect without the requirement to wait for transmission reinforcement works to be carried out, where they are under 50kVa in size.

Intertrip
Some of our networks are constrained due to a single upstream asset requiring reinforcement, or a single limit being infringed under certain conditions. Through monitoring these conditions, further capacity can be released when these limits or assets are within normal operating parameters. In these circumstances, we may allow customers to connect on the basis that when the limit being monitored is breached, the customer's connection will be constrained off.

This alternative connection is suitable for all capacities and voltage levels, although there will be a maximum number of participants per area.

Active Network Management (ANM)
In areas where there are several, complex constraints affecting a number of customers over a long period of time, full ANM systems will be implemented. The ANM systems continually monitor all the limits on the network in real time and allocate the maximum amount of capacity available to customers in that area based on the date their connection was accepted.

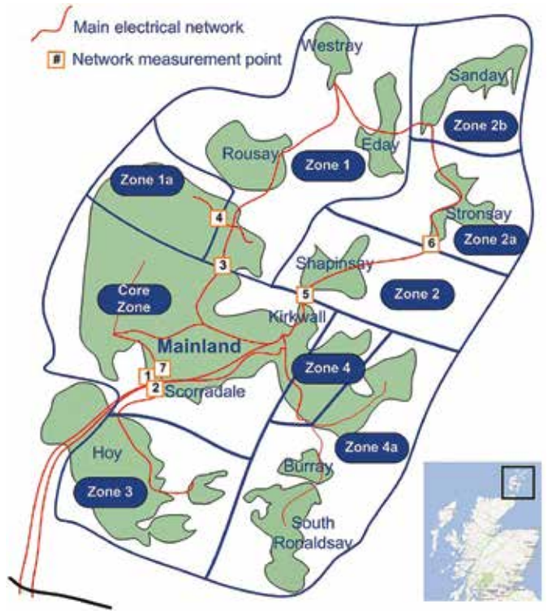
Orkney ANM System – operational but closed for further applications

Isle of Wight ANM System – operational and open for further applications

Shetland ANM – operational but closed for further applications

Western Isles ANM System – operational but closed for further applications

Further schemes are to be established following customer requests and then assessed on a case by case basis.



Single Generator Active Network Management (SGANM)
SGANM is a way of getting ANM functionality for a single generator connection. There are limitations to this option and we are currently only able to provide one such connection in any specific area.

Further schemes are to be established following customer requests and then assessed on a case by case basis.

Constraint Managed Zones (CMZ)
A CMZ is a geographic region served by an existing network where requirements related to network security are met through the use of load variation techniques, such as Demand Side Response, Energy Storage and stand-by generators. These techniques are CMZ Services provided to us by a CMZ Supplier.

Contractual flexibility
We consider flexibility in contractual terms in circumstances where a transitional solution may be available for a customer. Examples include situations where the local connection works can be completed early, but the full capacity is not available until reinforcement is complete. In this scenario we can include special conditions within the Connection Agreement which can allow the customer to export some of their full capacity, dependent upon what the current network can accommodate.

Export-limiting devices
We will consider applications for export-limiting devices on a case by case basis. Where approved by us, we would also require additional measures to be put in place to monitor power quality and ensure that the network operates within the required limits.

Application process
We are looking into reducing the time for quotes to be completed by 50% plus one day, this would mean as soon as we know there is reinforcement required on the network we would contact the customer and ask if they would like a Flexible connection, if they do then we would start the application process and get them to apply.

RIIO Commitment No88
We will work with local authorities and housing associations to anticipate where there are likely to be large volumes of new or low carbon technology connections to our network. This will allow us to apply innovative network solutions to minimise network reinforcement costs whilst also ensuring timely connections. We will defer network reinforcement on at least one circuit by working with a community to manage electricity consumption through energy efficiency and low carbon technologies by April 2018 – Currently held meetings with Perth & Kinross Council regarding Energy Storage and the possibility of using a flexible connection in over 80 schools.

Centralised ANM
Currently, ANM systems are deployed on physical IT server infrastructure which is often located near to the network connection and the flexible generation schemes they control. There is an opportunity to move towards more centralised architecture and system implementation enabling significant business benefits for the delivery and subsequent operation and maintenance of ANM. The centralisation of ANM systems (along with platform virtualisation) will increase the capacity and scalability of ANM technology solutions, reducing physical space and power requirements.

Centralised systems are easier to manage and less prone to environmental issues. Supportability is improved by removing (or significantly reducing) the requirement for remote maintenance work, as well as reducing (or removing) the requirement to travel to/attend site when technical issues arise. Over time, as the ANM virtualised production environment

scales up, the expectation is that the cost of delivering ANM solution designs, the cost of ANM systems implementation and the subsequent operating and support costs, would all reduce.

A tidal generator ready to be installed as part of the NiNES ANM scheme in Shetland.

The picture above shows a tidal generator in the docks ready to be installed as part of the NiNES ANM scheme in Shetland.

3.3.4 Summary of SSEN Innovations that are now BaU

Active Network Management (ANM)

ANM has been implemented in multiple locations across our Scottish and Southern Networks to help facilitate the connection of distributed generation. Prior to ANM the connection costs for new distributed generators was extremely high, due to large and expensive reinforcements being necessary. Time to connect was also very long as reinforcement projects often take several years to complete. For example, in order to connect new generation to the Western Isles additional capacity was required. The projected costs of traditional reinforcement required to create additional capacity was estimated at £20m and would take several years to complete the large scale capital investment project. This high cost acted as a barrier to entry for new generators wanting to connect to the network. However, implementing ANM has enabled 9MVA of additional capacity to be freed up on the Western Isles network without the need for this reinforcement. As a result generator(s) are able to connect at a far lower cost and at much faster timescales then was previously possible on the constrained network.

Benefits
£18.8M of costs avoided; 86,436 tCO_2e avoided for all ANM projects

This project was made possible from learnings derived from our original SHEPD Orkney ANM project. Information on this project is available here: **www.ssepd.co.uk/OrkneySmartGrid**

Bidoyng

Bidoyng is a smart fuse and fault location technology. Faults are often transient in nature, in that they occur briefly and do not cause any major damage to plant & equipment, meaning normal distribution operations can continue. However, they often cause fuses to blow, which means they need to be replaced before customers can have their power restored. Bidoyng smart fuses automatically switch fuses when one has blown meaning customers only experience a temporary loss of supply. It also means that SSEN do not incur any Customer Interruptions (CI) or Customer Minutes Lost (CML) fines as power can be restored within the 3 minute regulatory window. Kelvatec, the suppliers of the Bidoyng technology, also provide a fault location service, which helps our field staff locate underground cable faults quicker than would otherwise be possible.

Benefits
There has been an estimated benefit of £3.6m on fault repair costs and over 116,850 Customer Interruptions and 21,137,281 Customer Minutes Lost prevented.

The technology was implemented straight into BaU. More information can be found here: **http://www.kelvatek.com/bidoyng.php**

Live Line Tree Harvesting

SHEPD Live Line Tree Harvesting involves a specialised machine that is able to cut down trees adjacent to live overhead power lines. The machine is far more efficient than hand felling and also reduces the risk of injury to tree cutters as less hand felling is required. Before the live line tree harvester was utilised hand felling had to take place in a non-live environment requiring planned outages on the network and the need for mobile generators to provide temporary power to customers. These diesel generators are not only expensive to run but also release large quantities of CO_2. There is also a risk that the generator will trip causing a loss of power to potentially thousands of people. The live line harvester therefore offers significant improvement in safety and efficiency, while also reducing the environmental impact of tree cutting.

Benefits
There has been an estimated saving of £1.8m on tree cutting expenditure and 41,382 Customer Interruptions and 6,775,364 Customer Minutes Lost prevented.

This project has led to 1,138 tCO_2e avoided due to the reduced requirement to run diesel generation.

The original project was done as an IFI project. More information can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=545**

Bi Directional Hybrid Generator

The hybrid generator contains a battery which allows it to switch between battery and diesel generation modes. Running the generator on battery mode produces less noise, making it advantageous when in use around populated areas and at night time. On top of this the generators require less diesel, which saves fuel costs and reduces its environmental impact

Benefits
We estimate that approximately 30.1 tCO_2e have been avoided as a result of this project.

The original project was done as an IFI project. More information can be found here: **www.smarternetworks.org/Project.aspx?ProjectID=1537**

Thermal Imaging of Underground Cables (TOUCAN)

TOUCAN was an NIA project that investigated a technical method of using thermal imaging solutions as complementary tools in the context of locating underground cable faults in the power distribution network. When a cable fault occurs the repair operative uses conventional methods to locate the fault and pinpoint the excavation site. However, in a scenario where there is not enough precision, thermal imaging techniques will be employed to help locate the fault and confirm the primary excavation site. Rapid and accurate pinpointing of underground cable faults is a key factor in minimising supply interruption time and repair costs. If this method locates a fault from a residual heat signature it will reduce the number of bore holes for cable sniffers or reduce the amount of stress induced by cable thumping. The method could also eliminate false clues from the potential fault location data.

Benefits
Thermal imaging cameras have been implemented into BaU for 6 months and have now paid back their original investment. Continued savings are expected throughout the RIIO-ED1 period.

More information can be found here:
www.smarternetworks.org/Project.aspx?ProjectID=1827

Forestry Mulcher

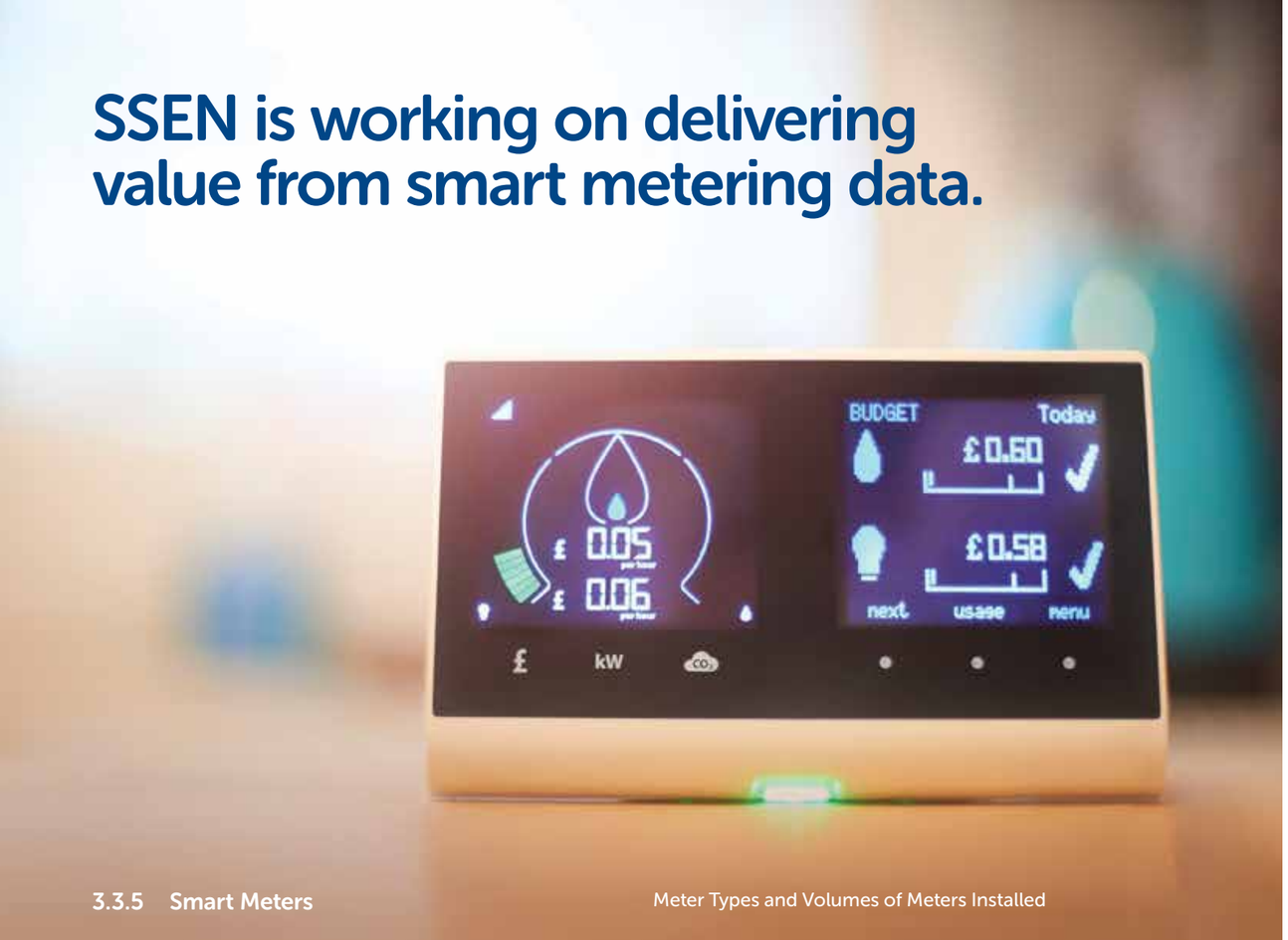
Forestry Mulcher was a NIA project that investigated the potential improvement of efficiency and safety through the use of remotely operated vehicles to carry out tasks associated with forestry mulching. Manoeuvrability and the size of traditional mulching machinery pose significant issues when working adjacent to a live network or at smaller sites. In normal circumstances where the proposed machinery will be used we would currently send four staff with a wood chipper where heavier machinery is not accessible. The remote controlled forestry mulcher which can tackle banks of a 45 degree angles, not only minimises the risks to operators over the conventional cutting systems, but also aims to reduce the amount of vegetation on embankments on railways and motorways. The machine allows for stump grinding and ease of transportation to inaccessible places to be possible.

Benefits
Approximately £100,000 in cost reductions have been achieved since this technology was deployed as BaU.

More information can be found here:
www.smarternetworks.org/Project.aspx?ProjectID=1812

The Cost Benefit Analysis models can be found in tables E6. Refer to the annexe for more details.

SSEN is working on delivering value from smart metering data.



3.3.5 Smart Meters

Throughout 2016/2017 Scottish and Southern Electricity Networks have been working towards completing the development and implementation of its Information Technology (IT) and communications infrastructure in preparation for the roll-out of smart meters. Due to the level of complexity associated with the governance, security and IT requirements for connection to the Data Communication Company (DCC)'s systems, SSEN created an internal programme to develop the necessary business processes and build new IT infrastructure to enable connection to the DCC and comply with the relevant code.

In our RIIO-ED1 business plan in March 2014 we identified that we would go live and connect to the DCC's systems in September 2015. There have been a number of changes to the GB Smart Meter Implementation Programme (SMIP) which have had a knock-on impact for delivery of a number of functionalities. We now expect that this will happen towards the end of 2017. It is anticipated that around 3.5 million smart meters will be connected to our networks and whilst is it expected that DNOs will have the means to communicate and gather information from the majority of smart meters we also believe that there will be a sizeable proportion of smart meters that we will not be able to communicate with or receive alerts from. Further information is provided in the following sections.

Meter Types and Volumes of Meters Installed

Specifications for two versions of Smart Meters have been developed by the SMIP; these are defined as SMETS1 and SMETS2 meters.

- SMETS1 meters provide a significant amount of smart functionality but currently they are not able to connect to the DCC's central communications and data infrastructure. Whilst there are future plans to connect these meters to the DCC, confirmation of how and when they will be connected and what functionality from these meters will be made available has yet to finalised and approved.

- SMETS2 meters provide additional functionality from that defined in SMETS1; they will be connected to parties including DNOs via the DCC's communications and data infrastructure. These meters will enable SSEN to gain access to the full range of alerts and service requests as defined by the SMIP.

Information relating to the volumes of smart meters installed during 2016/2017 is provided in Table 3.3d.

It should be noted that due to the level of uncertainty associated with the connection of SMETS1 meters to DCC systems, it is currently difficult to assess the impact that significant volumes of SMETS1 meter installations will have on our ability to deliver DNO smart meter related customer benefits.

Development of Information Technology and Communications Infrastructure

SSEN are developing systems to enable data from smart meters to be made available via connection to the DCC's infrastructure. In accordance with our business plan we are working towards connecting our IT infrastructure with the DCC and developing our own systems to manage and monitor alerts sent by smart meters directly into our existing outage management system (SIMS). Significant effort has gone into ensuring that the design of our systems and infrastructure remains compliant with the Smart Energy Code (SEC) which is a mandated requirement for all parties who interface with the DCC.

Our expenditure associated with the development of our IT and communications systems and payments made to the DCC during 2016/2017 are detailed in worksheet E5, they are also summarised in Table 3.3e

Table 3.3e – IT expenditure for Smart Meters during 2016/ 2017

Licence Area	SM IT Costs (£k)	SM Communication Licence (DCC) Costs (£k)	Elective Communication (DCC) Costs (£k)
SHEPD	1,070	483	0
SEPD	4,281	1,744	0

Delivering Value from Smart Metering Data

In our business plan we explained how having access to data from smart meters will provide opportunities for us to deliver benefits to our customers. We split the benefits into a number of categories and provided an estimate of the potential benefit that could be delivered for both the RIIO-ED1 and ED2 periods.

The benefits that are delivered by us having access to data from smart metering can be split into the following categories:

1. Avoided losses to network operators
2. Reduction in CML
3. Reduction in operational costs to fix faults
4. Reduction in calls to faults and emergencies lines
5. Better informed investment decisions for electricity network enforcement
6. Avoided cost of investigation of customer complaints about voltage quality of supply
7. Network capacity investment savings from electricity demand shift

In the design of our systems we considered the need to have access to data that will enable us to use the information to provide benefit to both customers and the wider Scottish and Southern Electricity Networks business. In the development of our smart metering business processes and systems consideration has been made to ensure that maximum benefit can be delivered from how we use data from smart meters. Our efforts throughout 2016/2017 are detailed in Table 3.3f.

Table 3.3d – Volume of smart meters installed during 2016/17

Licence Area	SMETS1			SMETS2		
	Installed in 2016/17	Total Installed	% Penetration (year end)	Installed in 2016/17	Total Installed	% Penetration (year end)
SHEPD	29,090	51,890	7.06%	0	0	0
SEPD	156,509	287,709	9.75%	0	0	0

Table 3.3f – Progress on delivery of benefits from Smart Metering throughout 2016/2017

Category of Benefit	Work Undertaken
Avoided losses to network operators	• Detailed design and development of our Networks DCC Access Gateway (NDAG) to enable access to relevant functionality in smart meters including meter configuration and access to appropriate data. • Work on being able to access consumption data, see note 1 below.
Reduction in CML	• Detailed design and development of our NDAG to ensure that power outage and power restore alerts are available for use in appropriate areas of the business. • Detailed design and development of our outage management system (SIMS) to receive power outage and power restore alerts from smart meters. • Engagement with the DCC regarding the future operation of power outage and power restore alerts, see note 2 below.
Reduction in operational costs to fix faults	• Detailed design and development of our NDAG to ensure that: o We are able to check the energisation status of individual customers via their smart meter. o Power outage and power restore alerts are available for use in appropriate areas of the business. • Detailed design and development of our outage management system (SIMS) to: o Enable the initiation of supply energisation status checks from relevant locations. o Receive power outage and power restore alerts from smart meters. • Engagement with the DCC regarding the future operation of power outage and power restore alerts.
Category of Benefit	**Work Undertaken**
Reduction in calls to faults and emergencies lines	• Detailed design and development of our NDAG to ensure that power outage and power restore alerts are available for use in appropriate areas of the business. • Detailed design and development of our outage management system (SIMS) to receive power outage and power restore alerts from smart meters. • Engagement with the DCC regarding the future operation of power outage and power restore alerts.
Better informed investment decisions for electricity network enforcement	• Detailed design and development of our NDAG to enable access to relevant functionality in smart meters including meter configuration and access to appropriate data. • Work on being able to access consumption data.
Avoided cost of investigation of customer complaints about voltage quality of supply	• Detailed design and development of our NDAG to ensure that voltage related alerts are available for use in appropriate areas of the business. • Detailed design and development of our outage management system (SIMS) to: o Receive voltage related alerts from smart meters. o Enable users to request further information from smart meters regarding recorded voltage measurements.
Network capacity investment savings from electricity demand shift	• Developing a means to influence suppliers regarding how customer load is controlled.

Looking Forward to 2017/2018

Details of the actions we propose to take during 2017/2018 in relation to each of the benefit categories identified are detailed in Table 3.3g.

Table 3.3g– Smart meter actions proposed for 2017/18

Category of Benefit	Work to be Undertaken during 2017/ 2018
Avoided losses to network operators	• Build, test and commission the NDAG to enable access to relevant functionality in smart meters including meter configuration and access to appropriate data. • Development of our smart meter data privacy framework • Detailed design and development of a new data repository which is required to manage and store consumption data from smart meters.

Category of Benefit	Work to be Undertaken during 2017/ 2018
Reduction in CML	• Build, test and commission the NDAG to enable access to relevant functionality in smart meters including meter configuration and access to appropriate data. • Build, test and commission changes to our outage management system (SIMS) to receive power outage and power restore alerts from smart meters. • Business engagement, communication and training for identified user groups. • Continued engagement with the DCC regarding the future operation of power outage and power restore alerts through the early life study.
Reduction in operational costs to fix faults	• Build, test and commission the NDAG to ensure that: o We are able to check the energisation status of individual customers via their smart meter. o Power outage and power restore alerts are available for use in appropriate areas of the business. • Build, test and commission changes to our outage management system (SIMS) to: o Enable the initiation of supply energisation status checks from relevant locations. o Receive power outage and power restore alerts from smart meters. • Business engagement, communication and training for identified user groups. • Continued engagement with the DCC regarding the future operation of power outage and power restore alerts through the early life study.
Reduction in calls to faults and emergencies lines	• Build, test and commission the NDAG to ensure that power outage and power restore alerts are available for use in appropriate areas of the business. • Build, test and commission changes to our outage management system (SIMS) to receive power outage and power restore alerts from smart meters. • Business engagement, communication and training for identified user groups. • Continued engagement with the DCC regarding the future operation of power outage and power restore alerts through the early life study.
Better informed investment decisions for electricity network enforcement	• Build, test and commission the NDAG to enable access to relevant functionality in smart meters including meter configuration and access to appropriate data. • Development of our smart meter data privacy framework. • Detailed design and development of a new data repository which is required to manage and store consumption data from smart meters.
Avoided cost of investigation of customer complaints about voltage quality of supply	• Build, test and commission the NDAG to ensure that voltage related alerts are available for use in appropriate areas of the business. • Build, test and commission changes to our outage management system (SIMS) to: o Receive voltage related alerts from smart meters. o Enable users to request further information from smart meters regarding recorded voltage measurements.
Network capacity investment savings from electricity demand shift	• Continue to work with suppliers in order to better understand how recent DCUSA changes can be implemented in order to manage network loading minimise future network investment.

In order to enable delivery of the smart meter related benefits we have identified we will continue to:

- Develop our smart meter data privacy framework
- Collaborate with the DCC in commencing the power outage/restore early life study (if DCC systems go live in this period)
- Continue to support the ongoing DCUSA work associated with the management of RTS meters and SMETS2

4. Conclusion

SSEN continuously review our environmental commitments and look for opportunities to reduce our impact on the environment and deliver the environmental expectations of our stakeholders efficiently.

The progress reported for the second year of RIIO-ED1 provides a clear message to our stakeholders that we are committed to deliver the benefits set out in our business plan. We have made further progress in the last year and will continue to look to the future and pursue not only those solutions that provide a short term return but those which will deliver enduring benefits.

5. Contact us

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6. Appendix

Additional Data	Location
Environment Report 2017 Environmental Report 2017 E1-E8 Tables Environment Report 2017 E4-E6 CBAs Environment Report 2017 E1-E8 Commentary	www.ssen.co.uk/DistributionPriceControlReview

7. Glossary

Business Carbon Footprint (BCF)
A measure of the total Greenhouse Gas Emissions (in tonnes of CO_2 equivalent) resulting from operations on which the DNO has full authority to introduce and implement its operating policy and contractors emissions.

Common Distribution Charging Methodology
Used to calculate charges to users who are connected to the LV and HV levels of the network. More details can be located here: **www.eonenergy.com/for-your-business/large-energy-users/understand-energy/understanding-distribution-charges**

Demand Side Response
Demand side response is a scheme where customers are incentivised financially to lower or shift their electricity use at peak times. This helps manage load and voltage profiles on the electricity network.

Designated Area
Areas in which Visual Amenity Projects may be undertaken, according to the relevant definitions in CRC 3J (Allowed expenditure on Visual Amenity Projects).

Distributed Generation (DG)
Plant or equipment for the production of electricity that is directly connected to the Distribution Network

Distribution Losses
Units lost while being transported through the licensee's Distribution System, either as electricity turns to heat as it is transported through the network or non-technical losses, such as theft or measurement errors.

Distribution Losses Strategy
Has the meaning given in Standard Condition 49 (Electricity Distribution Losses Management Obligation and Distribution Losses Strategy) of the electricity distribution licence.

Environment Report
Standard Condition 47 sets out requirements for the licensee to publish an annual Environment Report about activities that it has undertaken in relation to environmental matters.

Fluid Filled Cables
Pressurised fluid-filled underground cables, high voltage cables in which the insulting medium is liquid oil as opposed to a solid insulator such as oil impregnated paper or PVC.

Fluid Recovered
Fluid associated with pressurised fluid-filled underground cables that has leaked from a cable and is subsequently recovered and includes:

- Fluid captured in a container whilst jointing works are being undertaken
- Spoil removed from site because it has become saturated with fluid during a cable leak

In order to avoid double counting, the volume of fluid used to top up a cable in order to prevent pressure reaching the Pressure emergency (PE) level prior to jointing or repair should be excluded.

Fluid Used to Top Up Cables
Fluid pumped into pressurised fluid-filled underground cables and includes fluid used to:

- Bring a circuit back up to pressure from a lower pressure level
- Sustain a circuit fluid pressure from reaching Pressure emergency level prior to jointing or repair of a leak

Greenhouse Gas Emission
The release of greenhouse gases into the atmosphere, including carbon emissions. Within the BCF, greenhouse gas emissions, e.g. SF_6, are calculated as equivalent carbon dioxide emissions.

Innovative Solution
A Working Group will determine the definitions of Innovative Solutions. Until such time as the Working Group can provide definitions, only solutions that meet one of the following criteria can be defined as Innovative Solutions:

- Has been trialled by any DNO as part of an LCNF, NIC, NIA, or IFI innovation project during DPCR5 or RIIO-ED1
- Was considered a smart solution as part of the RIIO-ED1 smart solutions assessment
- Involves the application of technology, systems or processes not in widespread use at the beginning of RIIO-ED1 to provide long term direct benefits to distribution network customers through:

- Improving the utilisation or provision of network capacity for demand or generation (including demand side solutions),
- Improving the management of asset condition to reduce lifetime costs,
- Increasing the DNO's ability to manage network performance, safety or security, or
- Improving the level of service provided to network customers.

Direct benefits can include improvements in economic performance, environmental benefits, safety, quality of service, reliability, and/or resilience.

IFI
This acronym stands for Innovation Funding Incentive. This was the funding mechanism that existed for small scale innovation projects pre RIIO-ED1. It has now been replaced with the Network Innovation Allowance (NIA).

Innovation Strategy
Has the meaning given in SLC 48 (The Innovation Strategy) of the electricity distribution licence. This condition requires the licensee to have in place and maintain an Innovation Strategy for the purpose of demonstrating the role of innovation within the Electricity Distribution Group of which it is a part.

LiDAR
This is an acronym for Light Detecting Aerial Radar. This technology maps network assets and clearance distances to a high level of accuracy.

Low Carbon Technologies (LCTs)
LCTs is the collective term for technologies that are being introduced to the market with the aim of reducing carbon emissions through the more efficient use of energy, the storage of energy in a flexible way or a move from another energy vector such as oil to electricity. Examples include:

- Heat Pumps
- Electric vehicles
- Domestic Batteries
- Demand Side Response

Noise Pollution
The activity of investigating reports of noise pollution, and consequential remedial works (if necessary). In this context, noise pollution is defined as levels of noise associated with the normal operational characteristics of electrical distribution assets that may be deemed to be a nuisance and subject to Part III of the Environmental Protection Act 1990 (EPA).

Non-Technical Losses
Electricity units lost for non-physical reasons, including theft and measurement inaccuracy.

Oil Leakage
The discharging of insulating oil into the environment as a result of DNO's equipment and activities.

Network Innovation Allowance (NIA)
A set allowance per network licensee

- To fund smaller technical, commercial, or operational projects directly related to the licensees network that have the potential to deliver financial benefits, and/or
- To fund the preparation of submissions to the Network Innovation Competition (NIC)

Regulatory Instructions and Guidance (RIGs)
The term RIGs refers to a collection of documents issued by Ofgem to the DNOs to enable them to complete the reporting requirements associated with the RIIO-ED1 price control arrangements. It includes excel reporting packs, instructions and guidance, commentaries and the glossary.

RIIO-ED1 Business Plan
For SHEPD and SEPD, the document submitted to the Authority and published by the licensee in March 2014 in response to the document entitled "Assessment of RIIO-ED1 business plans and fast-tracking" published on 22 November 2013. This business plan covered the period 1st April 2015 to 31st March 2023.

RIIO-ED1 CBA Tool
The CBA tool DNOs used when completing their RIIO-ED1 Business Plans.

SSEH
This stands for Scottish & Southern Energy Hydro. It is the acronym provided to our Scottish network.

SSES
This stands for Scottish & Southern Energy South. It is the acronym provided to our Southern network.

SF_6
The chemical symbol for Sulphur hexafluoride, a gas that is used as both an insulating and arc extinction medium in electrical plant. The reporting requirement is in respect of fugitive BCF emissions attributed to SF_6 lost from electrical plant.

SF_6 Bank
The total mass (in kg) of sulphur hexafluoride held by the DNO for both assets installed on the network and those held in inventory. Each DNO's SF_6 bank should be calculated according to the methods set out in ENA Engineering Recommendation S38.

SF_6 Emitted
The total mass (in kg) of sulphur hexafluoride emitted during asset installation (only if gassed by the DNO), service life and decommissioning. Service life emissions include those due to leakage (measured through top-ups); those measured during service activity requiring gassing and degassing; and those due to equipment failure resulting in the loss of all gas contained by the asset. The SF_6 emitted value should account for gas recovered.

Each DNO's SF_6 emitted should be calculated according to the methods set out in ENA Engineering Recommendation S38. DNOs should not assume a percentage leakage rate to determine any element of SF_6 emitted and if a DNO does not have measured records of SF_6 emitted, this should be highlighted in the accompanying commentary.

Smart Meter
An Energy Meter that can both send and receive information using an External Electronic Communications Network.

Tagging
Tagging is the process where the worst performing cables are targeted and injected with radioactive isotopes, which helps to identify leaks, monitor the cables and track their performance over time.

tCO_2e
Carbon dioxide (CO_2) equivalent, measured in tonnes. This is a measure for describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of carbon dioxide (CO_2) as the reference.

Technical Losses
Electricity units lost owing to the physical properties of the network. This also includes the way the network is configured and operated.

Visual Amenity Inside Designated Areas
Activity undertaken as part of a Visual Amenity Project funded under the Visual Amenity Allowance funding mechanism described in CRC 3J (Allowed expenditure on Visual Amenity Projects) of the electricity distribution licence which relates to overhead distribution assets located within a Designated Area.

Visual Amenity Outside Designated Areas
Activity undertaken as part of a Visual Amenity Project funded under the Visual Amenity Allowance funding mechanism described in CRC 3J (Allowed expenditure on Visual Amenity Projects) of the electricity distribution licence which relates to overhead distribution assets which form part of an overhead line which spans the boundary of a Designated Area and is located outside the boundaries of the DNO's Designated Area, for which up to 10% of the Visual Amenity Allowance funding mechanism described in CRC 3J (Allowed expenditure on Visual Amenity Projects) of the electricity distribution licence may be used.

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