Environment and Innovation

Ofgem Report 2017/18

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Executive Summary

WPD's Environment and Innovation Report aims to provide all of our stakeholders with a transparent and public account of our environmental and innovation performance over the last twelve months.

We will use this report to provide an all-inclusive overview that includes clear justification for our actions and the benefits to our customers.

Reducing our impact on the environment and embracing the increase in low carbon technologies is one of our key RIIO-ED1 outputs. To this end throughout 2017-18 we have achieved the following improvements:

Environmental highlights

- Re-certification and transition to the new ISO14001:2015 environmental management standard across the WPD network
- Roll-out of SF_6 camera detection equipment across the business
- Reduction in our Business Carbon Footprint
- Significant reduction in office energy use
- Decrease in the overall tonnage of waste we produce

Innovation transition highlights

- 1.4m miles driven as part of our Electric Nation project
- Over 120km of network assessed f or losses optimisation
- Over 1,610 users of the Carbon Tracer App and growing
- Over £3m of innovation work completed through UK SMEs
- New seasonal boundaries for OHL capacity identified

Challenges

- Maintaining and improving progress in RIIO-ED1 business environmental outputs
- Further reducing the tonnage of waste we produce and finding alternative disposal routes other than landfill
- Maintaining and developing our ISO14001:2015 certification
- Ensuring our environmental performance and compliance record is maintained
- Investment in smart enabling solutions
- Large scale adoption of low carbon technologies (LCTs) by customers
- Providing visibility of network congestion
- Forecasting future energy volumes across the network
- Driving value from the smart meter programme

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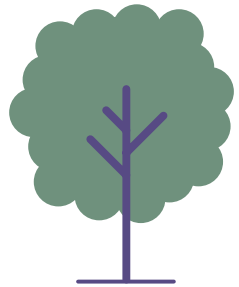


1.0 Introduction

1.1 Who we are and what we do

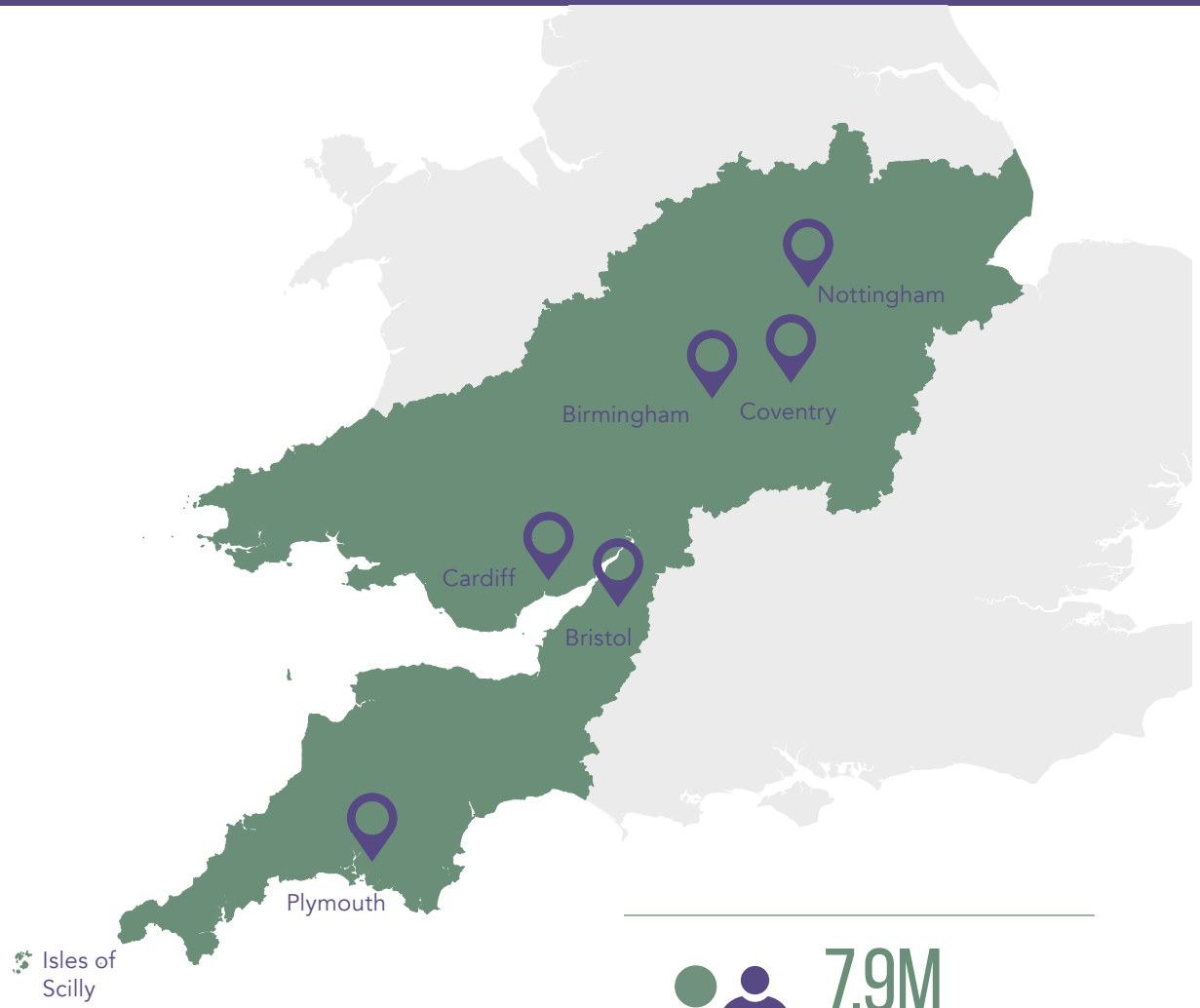
We are one of the six Distribution Network Operators (DNOs) who deliver electricity to homes and businesses across England, Wales and Scotland. Our network, which serves 7.9m customers, is the largest in the UK, operating from the Lincolnshire coast, across the Midlands, South Wales and the South West to the Isles of Scilly.

Our four key business tasks are:

1. Operating our network assets to ensure we 'keep the lights on' for all of our customers
2. Maintaining the condition and therefore reliability of our assets
3. Fixing our assets should they get damaged or if they are faulty
4. Upgrading the existing network or building new ones to provide additional electricity supply or capacity to our customers

Our role is simple

We are not a supplier. We do not buy and sell electricity, or directly bill customers. Our costs account for around 18% of an average annual domestic electricity bill which customers pay to their supplier.



7.9M

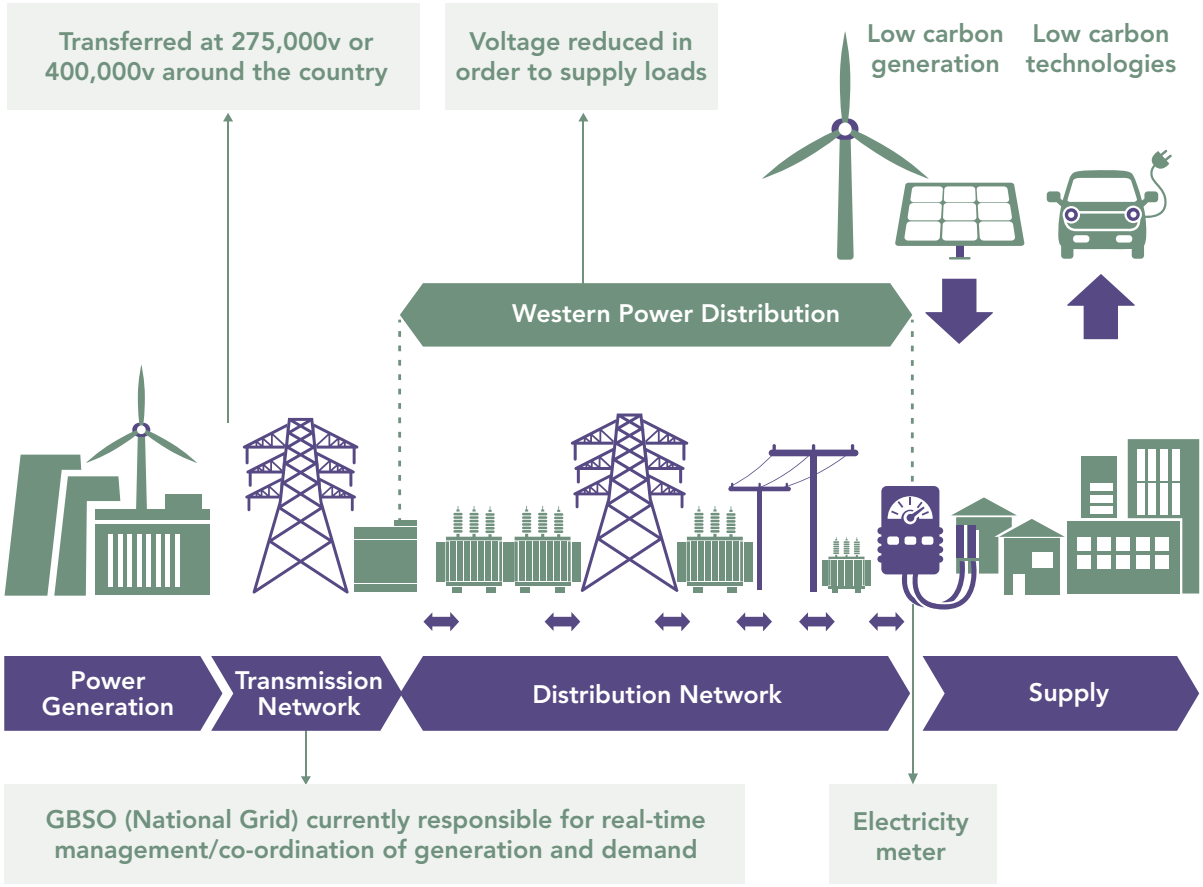
Our network, which serves 7.9m customers, by area in the UK

1.2 Our network

The electricity network we operate includes:

- Transformers that convert electricity from one voltage to another
- Underground cables and overhead lines that carry electricity across long distances
- Switches to turn the electricity on or off, or to alter its route
- Service connections to take the electricity into customers' premises
- Our network sits between the National Grid transmission network and the end customer

Asset Type	Units	WPD Total
Overhead lines	Km	90,000
Underground cable	Km	135,000
Transformers	Each	181,800
Switchgear	Each	299,000
Poles	Each	1,374,000
Towers (pylons)	Each	15,000
Customer numbers	Each	7,900,000



1.3 Improvement Opportunities

We are committed to ensuring that we meet all of our compliance obligations while minimising the overall impact that our activities have on the environment in which we work and operate.

Wherever possible we aim to adopt best practice to continually improve on our environmental performance.

As such during RIIO-ED1 we have committed to achieve the following environmental improvements (outputs) throughout our business:

A reduction in technical network losses

- Installing oversize transformers when replacing assets at highly loaded locations
- Using larger sized cables when installing new network in Low Carbon Technology (LCT) hotspots
- Undertaking innovation projects specifically related to technical losses

A reduction in our carbon footprint

- All replacement vehicles to have lower CO_2 emissions than those they are replacing
- Ensuring all new or refurbished WPD buildings achieve a minimum rating of 'Excellent' for new build and 'very good' for refurbishment under the BREEAM* rating
- Reducing the amount of waste we produce and send to landfill

Reduction in the leaks from our equipment, specifically;

- The volume of oil lost through leaks from fluid filled cable
- The volume of SF_6 gas that is lost from switchgear
- Installing effective oil containment 'bunds' around plant containing high volumes of oil

*Building Research Establishment Environmental Assessment Method

1.4 Stakeholder Engagement

Engagement with stakeholders is core to WPD's operations. We continue to identify opportunities for improvement and ensure our resulting outputs are appropriate, efficient and measurable.

Stakeholders attending our events say they engage with us because we act on their feedback. One example of this is our annual workshops, which hosted 250 stakeholders at six events in 2017/18. We were able to engage with them on the appropriateness of our current Business Plan outputs including fifteen actions under the 'environment' banner.

Stakeholders also discussed the outcomes they wanted to see achieved in RIIO-ED2 (our next price control period). Many expressed a keen interest in seeing investment in innovation, particularly storage, smart metering and a sustainable network, and a sizeable majority focused on environmental issues like the decarbonisation of energy and sustainability.

Stakeholders were asked to decide how we should address a number of key issues including changes in our flood risk planning and the use of electric vehicles.

250

Stakeholders at six events during 2017/18

Flood Risk Planning

On a scale of 1-10, stakeholders ranked the issue of changes in flood risk planning (for WPD to address) as 7/10.

Stakeholders were asked:

Should we amend our ED1 outputs to reflect any agreed changes in flood planning or do we address this within ED2?

Almost half of those stakeholders voting across the six events felt that flood risk planning should continue to sit within the current Business Plan Framework.

Electric Vehicles

On a scale of 1-10 stakeholders ranked the issue of electric vehicles (for WPD to address) as 7.9/10.

Stakeholders were asked:

Should we have a specific output related to electric vehicles, e.g. 'XX number of charging points installed'? Should we demonstrate how we have mitigated the impact of changes in demand as a result of increasing electric vehicle charge points?

69% of stakeholders voting wanted new measurable outputs for electric vehicles immediately rather than waiting for RIIO-ED2:

Stakeholders also said:

- Charging capacity in domestic properties may become redundant as the future of electric vehicles might not be in individual car ownership.
- Electric vehicle charging should be in wide bays near substations.
- WPD could consider incentivising drivers to charge their cars in such locations.

Fig. 1.4a Flood risk

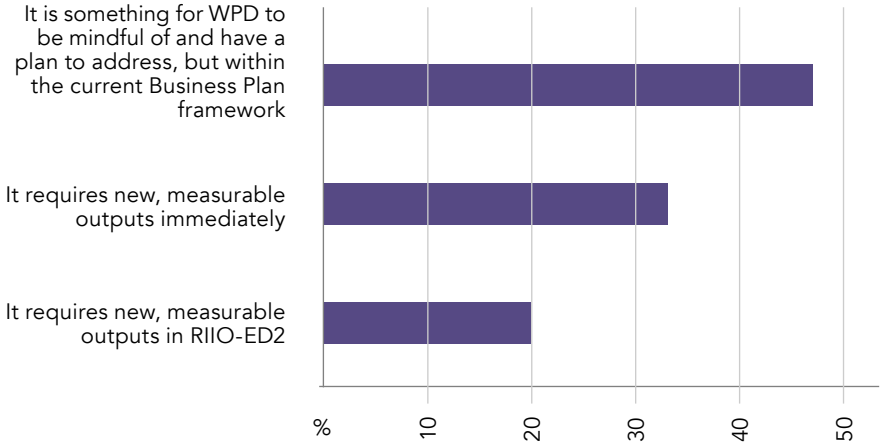
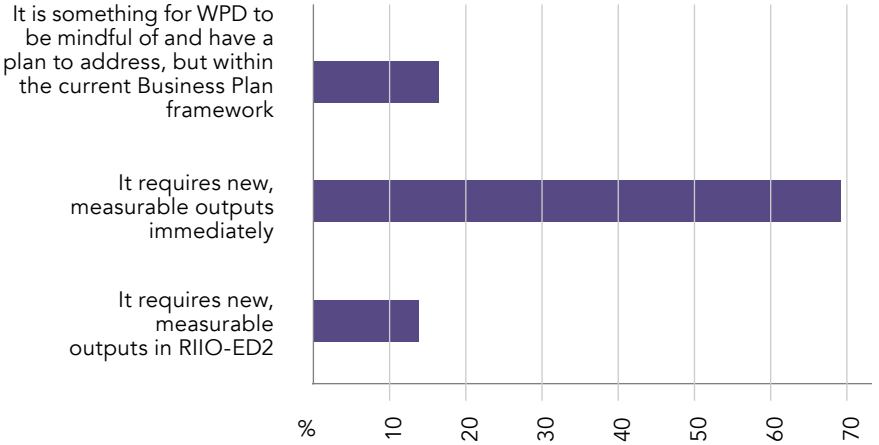


Fig. 1.4b Electric Vehicles



Losses and Innovation

Losses are a function of network usage and we expect the network to be used more in the future as a result of The Carbon Plan (e.g. due to the increased use of electric heat pumps and vehicles). We have already begun to prepare for this change by installing larger cables and transformers. In addition to making 'engineering' changes to our network a number of innovative projects will be undertaken to ensure we prepare for this change.

For example, working with Manx Utilities we are undertaking the first UK initiative to measure losses on the network. We are currently recording losses of less than 5% of total energy distributed.

Key themes and issues raised by stakeholders on losses and innovation at our annual workshops included:

- New developments should all have three-phase supply available.
- WPD should encourage competition or collaboration between DNOs to reduce losses.

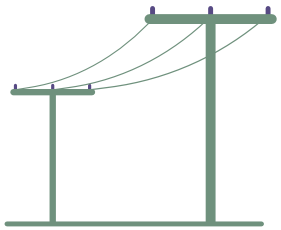
2.0 Managing our environmental impact

2.1 Introduction

All of our operational activities have the potential to impact upon the environment. As a certified ISO14001 operating organisation our robust environmental management system ensures that any risk to the environment is minimised and that as a company we continually improve how we manage all environmental aspects associated with our operational activities.

2.2 Protected Landscapes

We operate 90,000km of overhead lines predominantly in rural locations.



While overhead lines are widely accepted as being part of the countryside, there are a number of protected landscapes, including National Parks and Areas of Natural Beauty ("AONB") across our geographical footprint where removing our overhead lines and replacing them with underground cables would visually improve matters. We coordinate the undergrounding of overhead lines with established steering groups consisting of representatives from AONBs and National Parks who help us identify and prioritise where work will take place. We provide information and appropriate assistance to stakeholders to help them in scheme selection including budget costing and feasibility assessments. The years in which funds are spent are dependent on the views of the steering group, and the timescales needed to develop and implement the schemes.

As part of the Ofgem-approved voluntary initiative, following stakeholder engagement and feedback, our approved business plan for the regulatory period 2015-2023 includes a total sum of £7.6m for undergrounding of overhead lines in National Parks and AONBs.

The £7.6m is the total for our four licence areas for eight years and is split according to Ofgem's allowance caps for each electricity network licence area across England and Wales as follows:

- West Midlands: £2.3m
- South West: £3.0m
- East Midlands: £0.9m
- South Wales: £1.4m

The work carried out by licence area is as follows:

Table 2.2 – Undergrounding in National Parks and AONB's (km)

	Target for RIIO-ED1	Completed (to date)
West Midlands	14	7.9
East Midlands	10	5.3
South Wales	10	1.3
South West	21	2.2
WPD Total	55	16.7

2.0 Managing our environmental impact

2.2.1 Scheme selection and engagement/ consultation

- We believes that projects should be selected by stakeholders/interest groups. We implement these projects within the regulatory rules and take into account any technical or planning constraints (such as consents or environmental/ planning restrictions).

- The principal groups concerned with project promotion, selection and also stakeholder engagement are the National Parks and AONBs in our area, along with affiliated organisations (for example 'friends of' groups) and other stakeholders/interest groups such as environmental organisations (CPRE, Natural England, Natural Resources Wales).

- Our principal stakeholders select projects and put them forward for consideration.

- We rely on principal stakeholders/interest groups to carry out their own engagement and consultation on projects before putting these forward. The degree and type of engagement varies and it is up to these organisations to determine what is appropriate and proportionate.

- Our stakeholders consider the best use of the funds available when selecting projects. Usually, but not always, this means focusing on 'iconic' sites.

- Steering Groups are encouraged to ensure that National Parks or AONBs which have previously had little or no investment are encouraged or assisted to bring schemes forward. The Steering Groups may need to decide the level of funds to be allocated to these areas, using a fair and pragmatic approach.

- Depending on the location and terrain, the time to implement a project can vary greatly. For example, village projects with low voltage lines or sites with many habitats or archaeological constraints normally take longer.

- We assist stakeholders as much as possible with information needed to select suitable candidate projects. We work with them to establish the technical viability of proposed projects and we provide high-level cost estimates to assist in high-level decision-making about which projects may be suitable for consideration.

- The selection criteria for projects in each WPD region is discussed and agreed by the Steering Groups for those areas.

- The Steering Group discusses and agrees which projects are to be put forward for implementation with reference to a Visual Amenity Impact Assessment Form. our employees do not participate in any voting.

- Stakeholder feedback, like comments from parish councils for example, is encouraged and collated. It is one of the criteria the Steering Groups consider when selecting schemes and allocating funds.

Across all four of our licence areas, with our steering groups we are currently assessing a number of projects for completion in this eight year regulatory period. These pipeline projects are in various stages of development but those that have been approved and are ready for construction equates to potential 21km of overhead lines to be undergrounded. Further projects will also be added to the list at our steering groups' instigation.

2.3 Oil Leakage

In order to improve insulation properties and enhance cooling some older styles of electricity cable contain oil. Leaks from these cables can occur from time to time when equipment is damaged or seals deteriorate so we must take steps to reduce the number of leaks and to minimise the environmental impact of them when they occur.

The risks associated with operating fluid filled cable (FFC) and related assets can be reputational, regulatory and financial. The primary risk is associated with the leakage of insulation oil into the environment causing pollution, loss of fluid and ultimately cable pressure. Leaks typically occur as the cable sheath deteriorates with age, at joint failures or as a result of third-party damage.

> “ DURING RIIO-ED1 WE HAVE COMMITTED TO APPLYING PFT TO ALL CABLES WITH A HISTORY OF LEAKAGE.

To minimise environmental damage we aim to ensure that:

- Fluid levels in all our cables are monitored remotely, the loss of pressure triggering an alarm in our Control Centres. This enables us to react quickly to any leak event.
- Leaks are located quickly preferably using perfluorocarbon tracer (PFT) and repaired.
- Cables with a history of high leak rates are selected for replacement.

Additional mitigation may range from visual inspection or PFT tracing, to spot repair, sectional drain and seal or the full extraction of the cable.

Older types of higher voltage cables (33kV and above) also contain oil-based fluids to assist in the insulation and cooling of the cable. Again these cables sometimes leak due to third-party damage or age-related deterioration. New higher voltage cable designs do not use oil-based fluids and therefore any risks associated with these cables will reduce over time.

All leak rates are recorded and a database of leak and cable information held centrally. Monthly reports of fluid filled cable leaks are submitted to both the Environment Agency and Natural Resources Wales.

2.3.1 Improving leak location

We have introduced a tagging system using a small amount of perfluorocarbon tracer (PFT) that can be readily detected above ground when a cable leak occurs. This helps to quickly pinpoint the leak location and speeds up the repair process. The use of PFT reduces the environmental impact of the leak by quicker detection, lowers associated costs, avoids inconvenience to customers and minimises the amount of excavation required to locate a leak.

2.3.2 WPD Fluid Filled Cable Reported Information

Since 2012/13 we have achieved the following across our business:

16%
Total length of FFC in service has reduced by 140km or 16%

31%
Total volume of oil in service (FFC) has reduced by 738,427 litres or 31%

46%
Volume of oil used to top up cables has reduced by 19,765 litres or 46%

Table 2.3.2 WPD FFC Reported Information

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
FFC in service (km)	871	700	785	755	739	731
Volume of oil in service (litres)	2,325,794	2,167,663	2,106,920	2,024,588	2,097,250	1,587,367
Volume of oil used to top up cables (litres	43,123	22,216	30,950	17,291	17,251	23,358

2017/18 witnessed an increase in the reported volume of FFC leaks; this was due to a number of reasons;

- Improved reporting of FFC across our business
- Better detection of FFC leaks
- Maturing assets
- Severe winter weather conditions experienced in the latter half of 2017/18

FFC oil leakage - All WPD

2.3.3 Oil mitigation schemes

In 2017/18 a total of 23 oil mitigation schemes associated with fluid filled cables have been completed across the business. A number of schemes have involved the application of PFT to detect leaks quicker and with minimal disruption to the network.

2.4 Carbon Impact and Climate Change

2.4.1 Business Carbon Footprint

Our Business Carbon Footprint (BCF) details the impact that our operational activities have on the environment in terms of associated carbon dioxide (CO_2) emissions. We measure and report our BCF using equivalent tonnes of carbon dioxide (tCO_{2e}). The data compiled and the figures which we report follow a recognised methodology as described within international business carbon footprint standards, the Greenhouse Gas (GHG) reporting protocol and ISO14064-1.

All of our published BCF data has been verified and data assured for accuracy and compliance with the standards detailed above.

Our BCF takes account of our energy usage from offices, transport emissions (operational and business), fuel combustion and the release of greenhouse gases (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 under the Ofgem reporting requirements.

Table 2.4.1a Annual BCF Reporting

WPD Carbon Footprint Report (tCO_{2e})								
Aspect		**Scope**	**2012/13 Total tCO_{2e}**	**2013/14 Total tCO_{2e}**	**2014/15 Total tCO_{2e}**	**2015/16 Total tCO_{2e}**	**2016/17 Total tCO_{2e}**	**2017/18 Total tCO_{2e}**
Buildings energy usage	Buildings – electricity	2	12,098.2	9,979.9	12,454.4	10,997.7	10,622.2	7,633.5
	Buildings – Other fuels	1	191.6	260.1	207.6	193.1	192.5	220.2
	Substation electricity	2	28,836.7	24,856.9	27,578.7	25,813.8	22,981.6	19,618.6
Operational transport*	Road	1	33,335.9	35,400.6	40,018.8	37,804.8	34,902.6	33,329.5
	Rail	1	0.0	0.0	0.0	0.0	0.0	0.0
	Sea	1	0.1	0.1	2.4	2.4	0.24	0.24
	Air	1	1,253.0	1,624.4	1,428.1	1,831.0	2,163.5	2,113.6
Business transport	Road	3	3,903.7	3,792.9	3,304.0	5,116.2	3,196.5	3,395.3
	Rail	3	10.8	20.8	21.6	20.6	21.97	21.8
	Sea	3	0.1	0.1	0.0	0.3	0.97	0.1
	Air	3	30.1	53.9	106.4	41.5	92.37	124.1
Fugitive emissions	SF_6	1	6,063.4	7,384.9	8,282.1	14,307.5	9545.7	10,689.5
Fuel Combustion*	Diesel / Gas oil	1	3,653.2	11,836.7	8,574.1	7,100.9	7,041.6	6,382.3
Total Carbon (tCO_{2e})			89,376.7	95,211.1	101,978.1	103,229.8	90,761.7	83,528.7
Network Losses		1	2,384,281.5	1,896,261.7	1,906,640.7	1,687,342.2	1,530,164.6	1,377,491.8
Total carbon (tCO_{2e}) including losses			2,473,658.2	1,991,472.8	2,008,618.8	1,790,572.0	1,620,926.3	1,461,020.5

Scope relates to definitions in DEFRA guidance and is detailed in the commentary at Appendix B. *Includes contractor emissions

Our annual performance in almost all of the elements that make up our BCF has been positive, resulting in an annual reduction in company BCF (excluding losses) of 8%. Specifically companywide this includes;

18%
Reduction in annual building energy use – 2017/18

7%
Increase in annual business transport – rail journeys

However the total BCF (excluding losses) has been affected by the significant increase in the leakage and scrappage of SF_6 from switchgear and an increase in the carbon equivalent associated with our company business transport.

13%
Increase in total SF_6 emissions since 2012/13

Progress to achieve our target by the end of 2022/23 will continue to be challenging.

Fig.2.4.1a Annual BCF (tCO_{2e}) excluding network losses

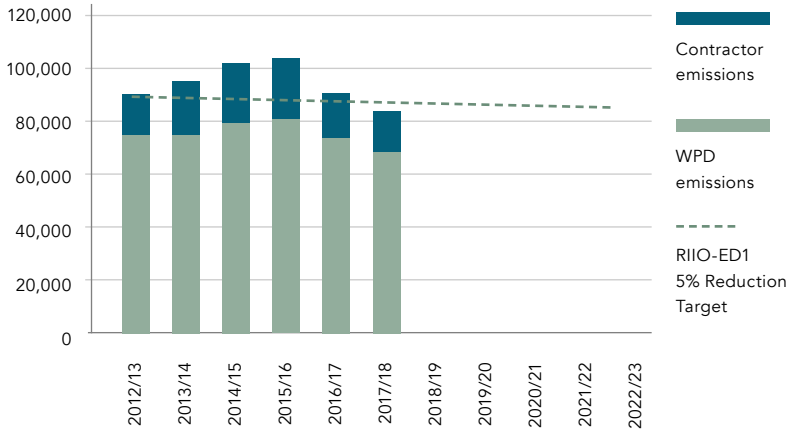
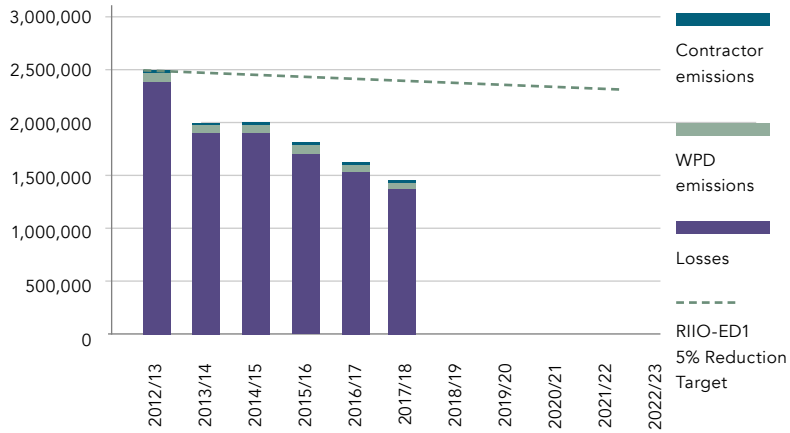
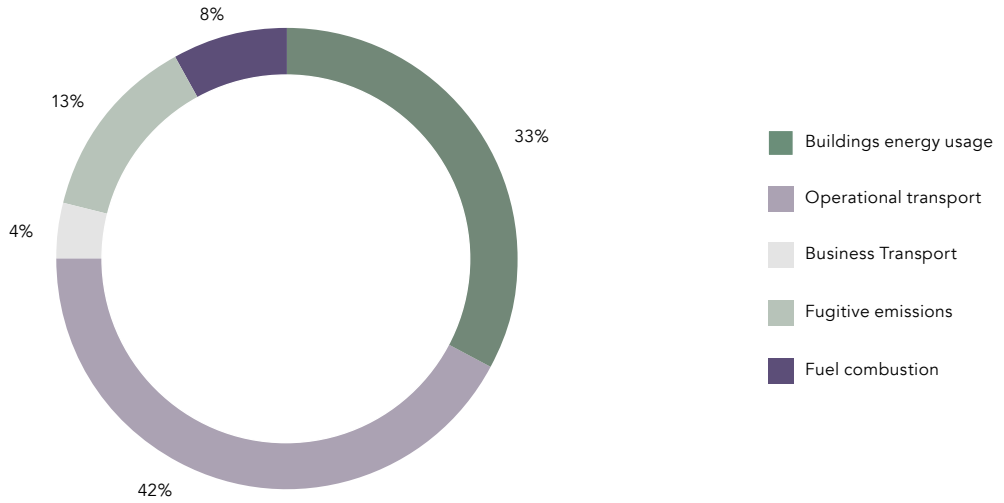


Fig.2.4.1b Annual BCF (tCO_{2e}) including network losses



As shown opposite, the main contributors to our Business Carbon Footprint (BCF) excluding losses are buildings energy usage, operational transport and fugitive emissions. During 2017/18 we enhanced the methodology and the data we collect for SF_6 by also including the volume of gas 'missing' from scrapped equipment. We have been able to obtain data for the ED1 period and this has led to an increase in SF_6 leakage being reported. This data was not included in the original data used to set targets so we have provided additional comparisons that show performance on a like-for-like basis.
(see section 2.4.2)

Fig.2.4.1c Business Carbon Footprint - WPD



We have the following initiatives in place to try to improve overall BCF performance:

- Fugitive emissions (consisting mainly of SF_6 gas leakage) make up 13% of the total BCF. We continue to investigate alternatives to SF_6 via an ongoing innovation project (NIA funded project SF_6 Alternatives) and we have invested in four infrared SF_6 detection cameras which enable us to quickly pinpoint the source of leaks. We replace any 11kV distribution assets that leak, if a repair is not possible, and we replace EHV assets if they have leaked three times.
- Building energy use (operational and non-operational) accounts for 33% of BCF. We have been installing low energy lighting and undertaken an energy efficiency review at non-operational sites which has led to a reduction in electricity usage in offices and depots.
- We are also focused on reducing emissions from operational transport (making up 42% of BCF) through the ongoing replacement of older vehicles with more fuel efficient alternatives.

Reducing Emissions from Vehicles

Our network is spread over an area of 55,500km^2 so we need to operate a significant fleet of vehicles to serve this territory effectively. Emissions are reported as part of our Business Carbon Footprint and are calculated based on fuel usage data, in line with the published 2017 DEFRA conversion factors. Procurement processes are used to ensure that when our vehicles reach the end of their useful lives, they are replaced with more efficient options. An example of replacements for some of our most commonly used operational vehicles shows this process in practice (data comes from the vehicle registration certificate).

In 2017/18 228 operational vehicles were replaced with emission alternatives as per the Table 2.4.1b.

Table 2.4.1b Emissions variations for operational vehicle replacements

Emissions – operational vehicle replacements			
Previous Vehicle	**CO_2e emissions (grams per km)**	**Current vehicle**	**CO_2e emissions (grams per km)**
Fiat Doblo SWB	137	Transit Connect SWB	115
Fiat Doblo LWB Euro5	137	Transit Connect LWB	115
Landrover 110	295	Isuzu D Max	183
Landrover 110 MEWP	295	Isuzu D Max MEWP	183
Transit 350 LWB RWD	234	Transit MWB FWD 130psi	176
Transit 350 2.2 E5	228	Transit Custom 310	157
Ford Fiesta Van 1.5	98	Vauxhall Corsa	94

Fig. 2.4.1d WPD vehicle fuel use (litres) per year (2012-2018)

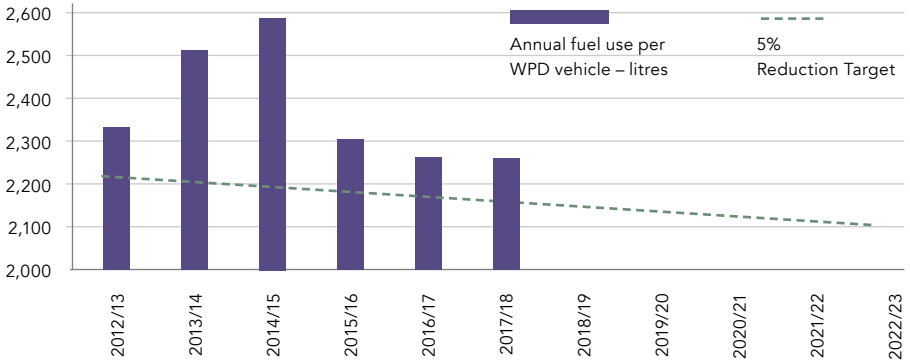
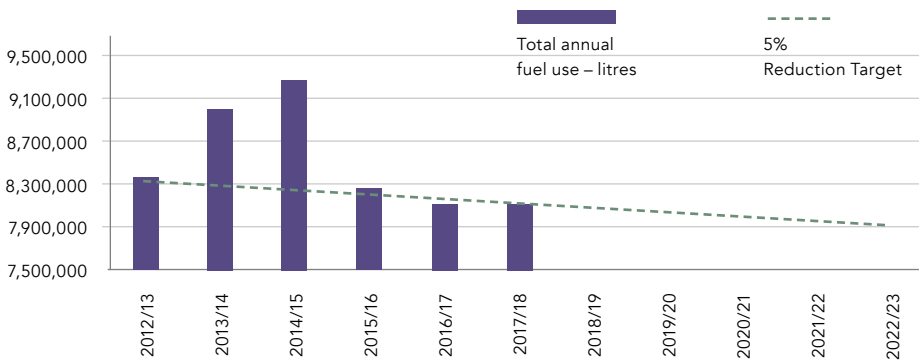


Fig. 2.4.1e Total WPD fuel use (litres) per year (2012-2018)



We measure the contribution of vehicle emissions to our overall BCF performance in terms of fuel usage converted to equivalent tonnes of carbon dioxide (tCO_{2e}). Performance during 2017/18 provided a small reduction in terms of litres of fuel used per WPD vehicle in addition to a slight reduction in terms of total fuel use. Accordingly we are still making good progress towards meeting our RIIO-ED1 5% reduction target for annual fuel use.

We also continue to trial vehicles that use alternative fuels. Currently we have three electric operational vehicles in use; these vehicles continue to be assessed.

Elements such as range between charging, payload (the weight capacity of the vehicle) and usage will be reviewed in order to identify how appropriate these vehicles are for future use. At this stage in the project, we have identified some reliability issues with charging, cell failure and limits to range and payload in comparison with diesel equivalents which we are continuing to address.

In 2014 we began an initiative to trial commercial vans which have been converted to dual fuel – specifically hydrogen. We purchased and converted two vehicles and they became fully operational in April 2018

Analysis of the project is being undertaken in conjunction with the University of South Wales; and the vehicles are likely to remain operational for around six years depending on performance.

Building Energy Use

We operate from 59 offices that vary in age and construction. We know that when refurbishment of these buildings takes place, there are opportunities to improve their energy efficiency.

In West and East Midlands, many offices were new or refurbished to the BREEAM standard of 'excellent' or 'very good' when facilities were being developed for our local team based operational structure, and all new builds achieved the 'excellent' rating.

In the South West and South Wales our properties are older, with more scope to implement energy savings measures. Whenever refurbishment work is planned we ensure, where appropriate, that it is carried out to the "very good" standard under BREEAM to reduce energy consumption. The "very good" standard is the highest which can be achieved for a refurbished building.

During 2017/18, we successfully completed the following BREEAM refurbishments/new builds:

Table 2.4.1c Non-operational Depot Site BREEAM Rating.

Non-operational Depot Site	BREEAM Rating
Leicester	Excellent
Birmingham	Very good

Local improvements include:

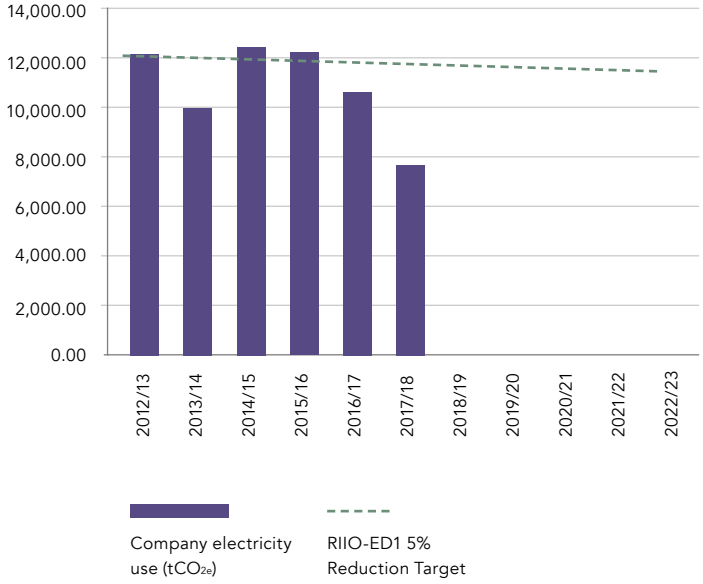
- Installation of motion sensors
- Improvements to air conditioning units
- Low energy lighting

The property redevelopments, improved employee awareness and energy efficiency improvements, are leading to energy savings.

This is evident in the electricity usage we recorded in our overall BCF reporting. We propose to save around 5% of electricity used in offices and depots over the RIIO-ED1 period. As demonstrated we are more than meeting this target with a reduction 36.9% since 2012/13.

Current Performance

Fig. 2.4.1f Company building electricity use (tCO_{2e}) – taken from depot SMART meter.

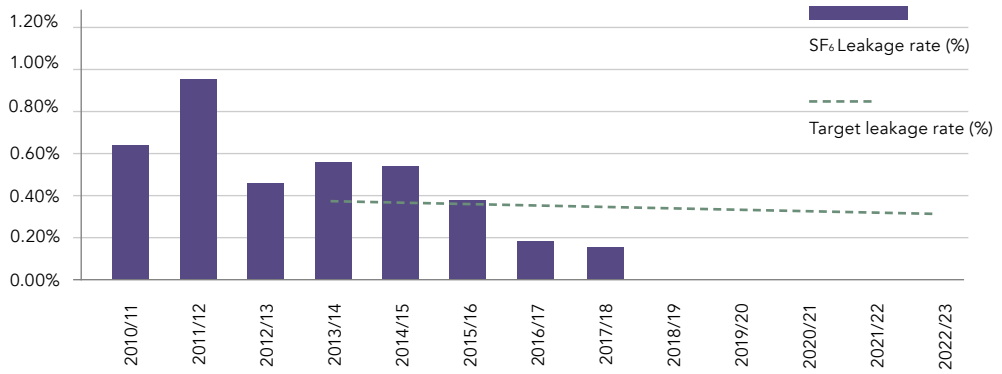


2.4.2 Sulphur Hexafluoride (SF_6)

SF_6 gas is used throughout our industry as an insulating medium in switchgear. Although it provides many benefits, it is a potent greenhouse gas (1kg SF_6 is equivalent to 22 800kg CO_2e). There are currently no viable alternatives to SF_6 and so it is replaced when necessary on a like for like basis. We will continue to replace older oil filled switchgear with SF_6 insulated switchgear and we predict that our total SF_6 bank will be approximately 23,000 kg by 2023 – an increase of 10,000kg on our baseline year.

The graph on the right shows that the volume of SF_6 leaked annually is very small at less than 0.2%.

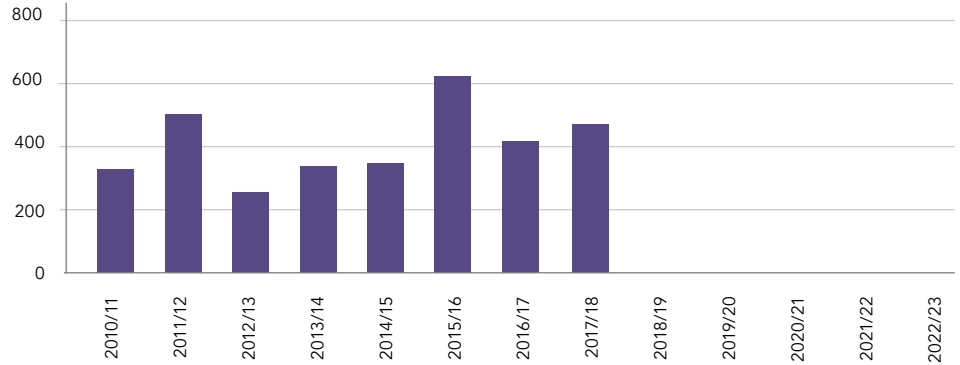
Fig. 2.4.2a Actual percentage loss of SF_6 to Total bank



As detailed right the data for SF_6 emitted in 2015/16 and 2016/17 has been restated and added to the current RRP E2 and E3 tables for each of our licence areas. The data has been restated based on an enhanced methodology used to calculate the 2017/18 SF_6 emissions using the following data sources;

- SF_6 top-up figures as reported on our company asset database
- Scrapped units returned empty to our company plant centres
- Units returned empty to manufacturers
- Hawker Siddeley GVR return programme

Fig. 2.4.2b Annual SF_6 emissions (kg)



*Includes all top-ups, units returned to manufacturers' and scrapped units

The methodology measures the amount of SF_6 emitted during installation, service and decommissioning. The new methodology now includes the amount of SF_6 from scrapped units returned to plant centres, manufacturers and the GVR return programme. The SF_6 may have been emitted over the life of the unit, rather than being attributable to a particular year. The enhanced SF_6 emission data now included in the RRP Tables is set out below and tCO_{2e} calculated accordingly within the tables;

Table 2.4.2a

	WPD SF_6 emissions (kg)			
	Reported 15/16	**Revised 15/16**	Reported 16/17	**Revised 16/17**
East Midlands	45.17	**75.61**	35.47	**53.8**
West Midlands	163.58	**352.64**	51.97	**207.9**
South Wales	88.35	**93.9**	77.7	**88.3**
South West	99.65	**105.3**	63.4	**74.0**

Table 2.4.2b

Measure	DNO	Target	Actual*	RAG	Comments
SF_6 emissions (emissions as a percentage of SF_6 bank).	West Midlands	0.36%	0.06%		Like for like comparison against target set ahead of enhancements to data collection.
	East Midlands	0.29%	0.10%		
	South Wales	0.38%	0.44%		
	South West	0.38%	0.64%		

*Actual values excludes contribution from 'missing' SF_6 derived from scrapped equipment.

Overall the level of leakage is reducing over time as older units are replaced with new units which also contain lower levels of SF_6.

When replacing switchgear, we give priority to the switchgear with the highest leak rates. Within RIIO-ED1, we have committed to replacing any 11kV distribution assets that show signs of leakage and any higher voltage assets that have leaked three times. SF_6 leaks are monitored and logged within our asset database – the volume of leaks is determined by the volume of gas required to top-up the asset or the amount taken out of the unit if it is to be replaced. Leaks are identified by either a low gas alarm being triggered via control systems or from a low gas reading on a gauge identified during a switching operation or a routine substation inspection.

When a leak becomes apparent, we locate its source so that a strategy can be developed to manage the situation, taking into account the potential for repairs and the lead times for replacement switchgear to assist in the identification of leaks we have purchased four SF_6 cameras and trained staff in their use.

The amount of SF_6 lost is expressed as a percentage of the overall 'bank' of switchgear containing SF_6 as this will vary over the period of RIIO-ED1. The target is based on a four-year average of emissions between 2009/10 and 2010/11.

> DURING RIIO-ED1, WE HAVE COMMITTED TO REDUCING THE VOLUME OF SF_6 LOST BY 17%.

2.4.3 Distribution Losses

Introduction to Losses

The importance of reducing electrical losses all on distribution networks is growing as a result of the increase in intermittent distributed generation and higher production costs.
The energy lost in distribution creates a financial cost which is paid for by the customer. DNOs are obliged, as part of their licence, to reduce loses on their networks as far as reasonably practicable. The energy lost which includes theft, accounts for unnecessary carbon emissions, which impacts climate change.
Reducing losses effectively can also increase the network capacity. This is crucial with energy consumption likely to increase sharply over the next 15 years, as a result of The Carbon Plan and the uptake of new technologies like electric vehicles and heat pumps become more common. This means network loading will increase, which will increase losses, as explained in the variable losses section. Losses may increase further due to the increase in distributed generation.
By reducing losses wherever possible, it could reduce the need for costly network reinforcement projects. In addition to the environmental effect, the financial cost of losses contributes to customer bills. Any financial savings that loss reduction produces should ultimately be passed on to consumers directly.

Reducing losses can also effectively increase the capacity of our network, as less power needs to be delivered to produce the same output.

The electricity network was designed for large centralised generators to supply power to the high voltage network and then this would flow through the low voltage network to customers.

However, new renewable energy sources tend to be smaller and well spread out; so they are often connected to the low voltage network and the power may then have to flow back to the high voltage network to reach its customers. Previous networks were not designed for distributed generation, so it may not be the most efficient. Our network is already changing to incorporate distributed generation and losses are a priority consideration when making these changes.

Causes of Losses

Distribution network losses can be broadly defined as the difference between the electrical energy entering the distribution network, and the electrical energy exiting the distribution network.

Distribution network losses are conventionally broken down into two categories:

- Technical losses
- Non-technical losses

Electrical losses are very difficult to measure accurately. As the meter-data from customers cannot currently be recorded accurately or frequently therefore non-technical losses are difficult to account for.

Technical Losses

The total amount of technical loss is made up of a fixed component (a function of the network itself, independent of the load on the network) and a variable component which is dependent on the level of load on the network. Variable losses may also be impacted by the power factor, network imbalance and the effects of harmonics.

Fixed Losses

Some electrical energy is dissipated by network components and equipment such as transformers or conductors as a result of being connected to the network and being energised. Even if no power is delivered to customers, the system has losses just because it is electrically energised. These losses take the form of heat and noise and are called 'fixed losses' or 'no-load losses', because they are independent of how much electrical energy the network delivers. Transformers' energisation is responsible for the majority of the fixed losses (although this equipment also gives rise to variable losses).

Phase Imbalance

A network which does not have its load evenly distributed across all three phases will have higher currents in at least one phase meaning it is not optimised for losses. There will also be currents flowing in the neutral conductors if they are present. Due to the quadratic dependence of losses on current discussed above, this load imbalance across the three phases will increase losses.

Imbalance is found on all parts of the low-voltage (LV) network due to customers who use one or two phases having different load consumptions. On the high-voltage (HV) network, imbalance is due to the uneven distribution of single-phase transformers or two wire spurs and different loads on each phase for three-phase customers. The most obvious way to reduce phase imbalance is to carefully balance the aggregated load on each phase, but as customer consumption is not always predictable and varies at different times of day, this can be difficult.

Power Factor

There are two ways to define the power in a system. The real power is the capacity of the system to do work. The reactive power is the product of the voltage and the current flowing. The power factor is the ratio of the real power to the reactive power. Where the power factor is less than unity the current has to increase to deliver the required amount of real power, which results in a loss. This has historically been an issue for installations used by industrial and commercial customers, where most motor loads or power electronic loads were seen. Developments in domestic power electronics and heat pumps mean we will start to see this issue occurring more on domestic networks.

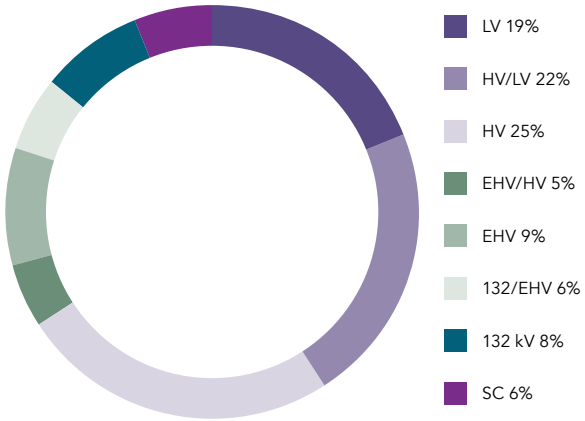
Since 2010 we have included an excessive reactive power charge for HV and LV half hourly metered, via the Use of System Charge, have a power factor of 0.95 lagging. This is to ensure that the reactive power is kept to the minimum as with any load the WPD has to cater for the reactive power for the sizing of the circuit even though that reactive power is not being used effectively.

Non-technical Losses

Non-technical losses are caused by actions that are external to the power system. They refer to lost energy that is not directly related to the transportation of electricity and occur independently of the physical, technical characteristics of the network (technical losses). Cases of non-technical loss cannot be fixed by upgrading equipment or altering network design. Instead investigations, audits and collaborations with other bodies are required. This kind of loss involves the abstraction of electricity with a loss of revenue to both the network operator and the supplier.

Non-technical losses fall into two main categories: Theft in Conveyance and Unmetered Supplies. Theft in Conveyance is where an illegal connection to the network is made, or where properties do not have a registered supplier. Unmetered supply occurs on equipment such as street lamps and traffic lights, which are impractical to meter, due to the number of units. Instead, their consumption is estimated based on standard power usage figures and the number of units. These estimations can be inaccurate and result in energy not being correctly billed. The extent of unmetered supply losses is relatively small but not insignificant, but theft in conveyance costs us 2.8GWh of energy a year.

Fig. 2.4.3a Breakdown of distribution losses



Both of these types of losses can only be reduced by investigations, audits, enforcement and correction

Where Do Most Losses Occur?

Network modelling work described in the SOHN losses report [1] predicted that the distribution of electricity at LV produces the most losses on our network. The service cable and LV cables supplying electricity to properties account for 25% of the total losses. The distribution transformers add another 22% with the 11kV network accounting for another 25%. The higher voltages (33kV and 132kV) make up the remaining 28%. These percentages vary between urban and rural networks.

2.0 Managing our environmental impact

Losses Strategy

Our Losses Strategy is updated annually and details the approach to losses and all of the interventions that have been planned. This includes both programmes of asset replacement that we are undertaking and innovation projects that aim to provide new solutions for loss reduction in the future.

This year sees a change in the focus of the strategy. With the replacement of pre 1958 transformers, the tapering of circuits and use of 95mm² Al LV and 11kV cables no longer permitted, we are looking at new and innovative areas to reduce losses. For instance, we are taking a lead from the motor industry and government announcements to restrict the sales of petrol and diesel cars by targeting the effect electric vehicle charging will have on the LV network.

Vehicle charging is likely to be the first major low carbon technology demand to be seen on the low voltage network, which has to be accommodated as a result of the Government's introduction of The Carbon Plan – 2050. With this in mind and the work carried out for ENA Technical Losses Working Group and research completed by the Engineering Consultants WSP, we will be carrying out a project on new network design and retro-fitting of networks to take into account electric vehicles, photo voltaic (solar), energy storage (battery) and heat pumps as part of the Losses Discretionary Reward application in 2018, Our losses strategy plans will be completed alongside the normal business as usual. The strategy provides an introduction to the theory behind losses and the main ways that they can be produced with descriptions of our approach to loss reduction through asset replacement, improved understanding, stakeholder engagement and revenue protection.

Activities Undertaken in the Regulatory Year

This section contains all the various areas that we are currently focusing on with a view to reducing losses going forward. These actions will enable us to reorganise the network to make it run more efficiently with the revenue protection, identifying actions that can be taken to prevent or reduce energy loss to theft or unmetered supplies. However, there are also some discussions, particularly in the network design section of policies which we will be able to implement following innovation projects which WPD has undertaken to better understand losses. Where appropriate, we have referenced the SOHN recommendations to which the actions correspond.

- We have established a specific losses engineer within the Policy Section to take into account the losses policies developed within the Network Strategy and Innovation Team;
- The continued pro-active replacement of 1,996 distribution transformers;
- The design intervention for losses on new installation of 8,184 distribution transformers and 11,880 kilometres of underground cables;
- A review of our policies to ensure losses are a priority consideration for all of our investment decisions;
- The upgrading of the existing modelling tool for LV mains of our network, to output direct losses data and be compatible with smart-meter data;
- A comprehensive programme of stakeholder engagement including biennial stakeholder consultation events;
- The development of a new losses page on our website;
- The ability to now identify units lost to supplier side abstraction, unmetered supplies and theft in conveyance throughout the period.

The Losses Investment Profile over the RIIO-ED1 Price Control Period

Under our current business plan, we have not allocated any funds specifically for the reduction of electrical losses. Instead, investments into asset replacement are taken from the network reinforcement budget when it is seen to be economically viable to do so, under the Cost Benefit Analysis (CBA) scheme described in section 2.4.3.5.

We also have a number of innovation projects which aim to help reduce losses. These projects are funded by the Network Innovation Allowance (NIA). Projects such as the Losses Investigation, which has set up a fully monitored LV network on the Isle of Man, are aimed solely at improving the understanding of losses. While projects such as FALCON, which was aimed at smart-grid related techniques, have other primary aims, their outputs benefit losses as well. NIA funding is provided by Ofgem to all Distribution Network Operators (DNOs) to run technical or innovation projects directly related to their network, which have the potential to deliver financial benefits to customers.

Cost Benefit Analysis, Tools and Methodologies

We will only undertake loss reduction activities when a CBA has found them to be economically beneficial. We use the standard Ofgem CBA spreadsheet and financially value losses using the Ofgem agreed figure of £48.42 per MWh. This figure is the average wholesale cost of energy in 2011/12, expressed in 2012/13 prices. It is intended to represent the societal cost of losses.

For some analysis, the Ofgem CBA spreadsheet is not sufficient and a bespoke model is constructed. When this is the case, we produce a simplified version in the Ofgem format and publish the bespoke CBA to explain the full methodology.

The environmental benefits can be calculated using the agreed equivalent carbon emissions conversion factor of 0.41205 kg CO_2e per KWh.

Table 2.4.3a Current Assessment of Distribution Losses

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Total annual losses (GWh)	5,158	4,103	4,125	3,651	3,713	3,918
Carbon equivalent (tCO_2e)	2,384,281	1,896,261	1,906,640	1,687,342	1,530,164	1,377,491.8

Fig. 2.4.3b Total Annual Losses (GWh)

Fig. 2.4.3c Carbon Equivalent (tCO_2e)

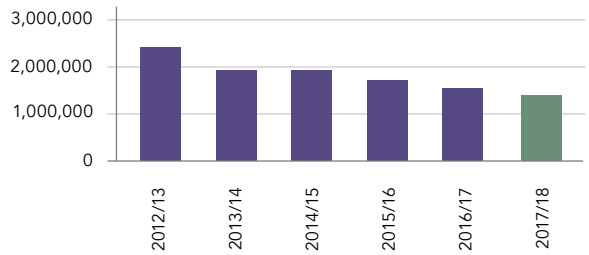


Table 2.4.3b Summary of losses and benefits from activities in RIIO-ED1.

Proposal	Interventions per Annum	Savings per Annum (kWh)	Interventions through RIIO-ED1	Savings through RIIO-ED1 (MWh)
Transformers				
Replace pre-1958 transformers	250	2,694,543	1,996	21,556
Install a minimum size of pole-mounted transformer	575	68,072	4,600	545
Discontinue 315kVA ground-mounted transformers	448	1,140	3,584	9
Cables				
Discontinue small size service cables	343 km	412,629	2,744	3,301
Upsizing LV cables	694 km	3,049,799	5,552	24,398
Discontinue small size 11kV cables	448 km	951,421	3,584	7,611
Imbalance				
Correct Imbalance at LV substations	Per substation	1,014	Per substation	tbc

2.5 Other environment related activities

2.5.1 Certification and transition to ISO14001:2015

Since 2011 we have been certified to ISO14001:2004 Environmental Management Systems however the standard has recently undergone a major revision to ISO14001:2015. We successfully transitioned and gained certification to the new standard in May 2017. In order to achieve certification to the 2015 standard we had to take into account a number of specific changes to the structure, content and focus of the revised standard.

During the transition and certification process no major non-conformances were raised and by the end of the 10-day audit just six minor non-conformances were outstanding. Throughout the course of 2017/18 those minor findings have been addressed and successfully closed out.

Six monthly surveillance audits continue to be undertaken by our auditors throughout the three year certification period and we continue to demonstrate effective and responsible environmental management via the company ISO14001:2015 certificate.

Full certification across all four licence areas since 2015;

Benefits of ISO14001:2015:

- Validates our environmental management system (EMS)
- Provides confidence to interested parties and regulators
- Provides a consistent environmental management approach across WPD
- Helps to ensure legal compliance
- Demonstrate our value of good environmental stewardship

We transitioned to the new ISO14001:2015 standard in May 2017.

Five key approaches on the new ISO 14001:2015

1 **Emphasis on leadership**

Greater commitment from the top management

2 **Focus on strategic fit & risk management**

An increased alignment with unique context, strategic direction and risk orientation

3 **Effective communication & awareness**

Driven through a communication strategy and its effectiveness

4 **Greater protection for environment**

Proactive initiatives, objective measurements & improving environmental performances

5 **Life cycle perspective**

Each stage of a product or service; from development to end-of-life is on focus

2.5.2 Waste Management

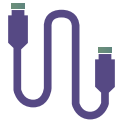
We work closely with all of our waste contractors ensuring that where possible waste streams are diverted from landfill and that we always apply the principle of the waste hierarchy.

Redundant cabling and metal work is segregated at our depots and collected by one of two dedicated contractors who we have worked with for many years. We receive monthly revenue for the collected metal/cable and this waste is, in turn, processed and eventually returned to the marketplace for re-use.

Wooden poles from our networks are collected from many of our non-operational depots. Previously the poles, which are classed as a hazardous waste, would have been disposed of via landfill, but we now dispose of them at a waste to energy plant in the north of England, avoiding expensive landfill costs and complying with the waste hierarchy. During 2018/19 we hope to be proceeding with a small scale creosote removal trial in South Wales which would, if successful potentially remove the creosote from wood poles and therefore re-classify the waste as non-hazardous and therefore reusable. We have been in discussion with Natural Resources Wales, who are supportive of the project and we look to commence the trial in late 2018/19.

We continue to segregate our waste at all of our depot locations and transport units into the following waste streams:

METAL



CABLE

DRY MIXED RECYCLABLES

(Cardboard/paper/plastics)

GENERAL WASTE

WOOD

ORGANICS

REDUNDANT WOOD POLES

HAZARDOUS WASTE

(Batteries/contaminated rags/ used electrical insulating oil/ aerosols/fluorescent tubes)

Fig. 2.5.2a Percentage breakdown of WPD Waste 17/18 (not including metal and cable)

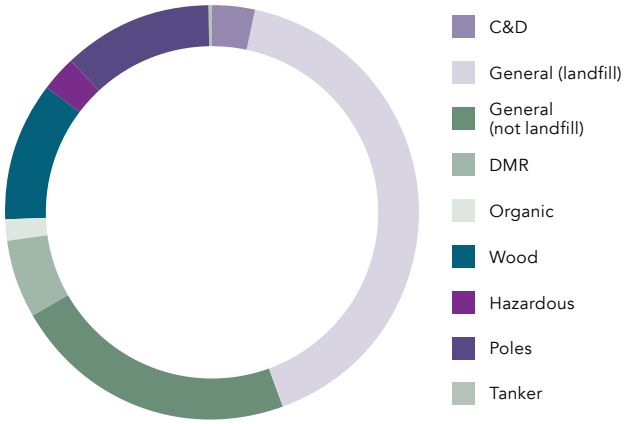
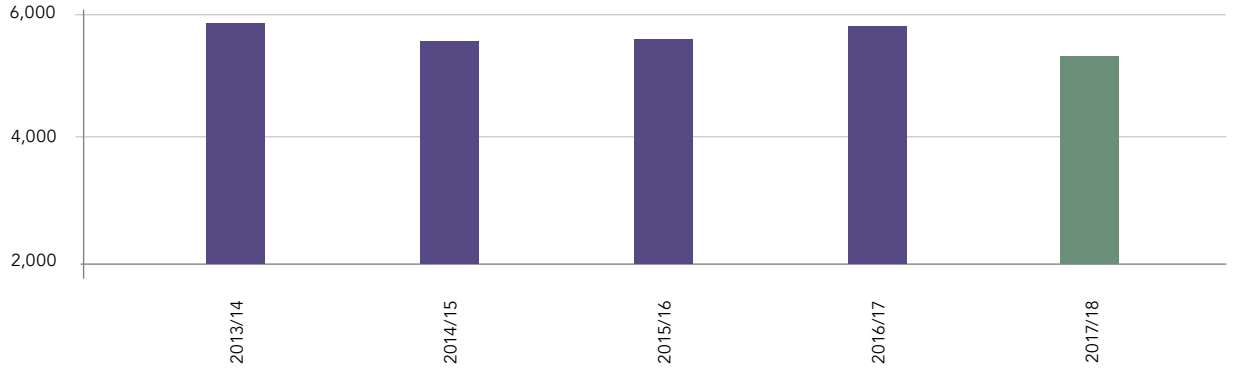


Fig. 2.5.2b Tonnage of total waste



In 2018/19 we will be awarding new waste management contracts across the business. One of the key performance requirements of the new contracts will be to reduce the overall tonnage of waste we produce and maximising the amount of waste sent for non-landfill disposal. A challenge moving forward will be to improve on the amount of dry mixed recycling we send for recycling / recovery. The last 12 months has seen a significant shift in the viability of the plastics recycling market. Waste contractors are requiring higher and cleaner grades of plastic to make recycling viable. Lower grades, for example plastic cups, are no longer considered to be suitable for general recycling.

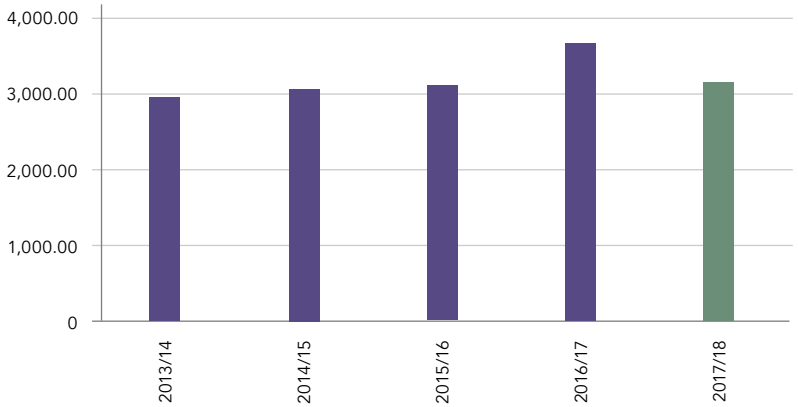
RIIO-ED1 Target – Waste

Our RIIO-ED1 Business Plan states that we will reduce the amount of waste sent to landfill by 20% over the first two years of RIIO-ED1 and 5% per annum thereafter. This target does not include the recycling of our scrap metal and cable.

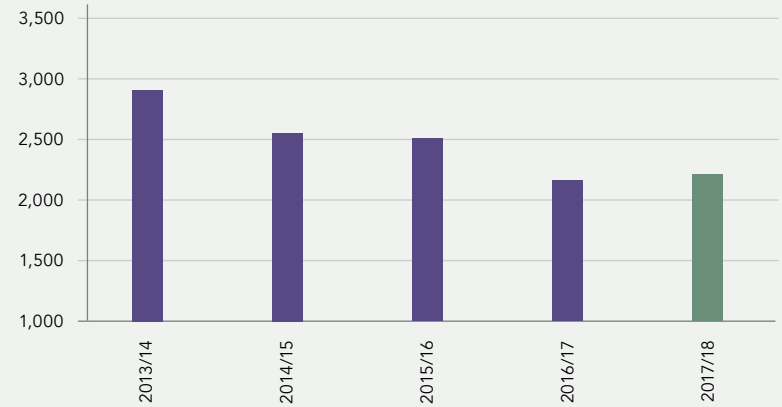
The overall tonnage of waste produced by us has reduced to 5,344 tonnes from 5,839 tonnes in 2016/17 a reduction of 8.4%. However the percentage of this total tonnage which has been disposed of to landfill increased slightly in 2017/18 to 2,189 tonnes from 2,162 tonnes in 2016/17 an increase of 1.2%. We have looked at the reasons for this in order to continue to achieve reductions

The percentage of our waste disposed of to landfill has decreased by approximately 11% since our baseline year (2012/13 - 52%, 2017/18 - 41%). Much of this reduction can be attributed to the avoidance of treated wood poles being diverted from landfill, improvements in office recycling and greater employee and contractor waste management awareness.

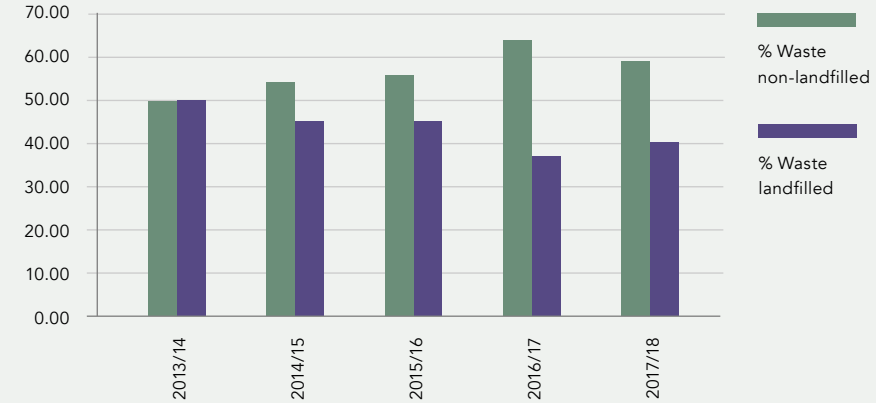
2.5.2.c Tonnage of waste to non-landfill



2.5.2.d Tonnage of waste to landfill



2.5.2.e Annual percentage waste to landfill vs. non-landfill



2.5.2.f Percentage of waste to landfill

Although the % age of our waste sent to landfill has increased this year, we are still on target to achieve our RIIO-ED1 target by 2022-23. What is encouraging is that the actual tonnage of waste we produce has reduced for the first time since we started reporting on RIIO-ED1 performance.

Although the percentage of our waste sent to landfill marginally increased this year, we are still on target to achieve our RIIO-ED1 target by 2022-23. What is encouraging is that the actual tonnage of waste we produce has reduced for the first time since we started reporting on RIIO-ED1 performance.

Waste initiatives

During 2018/19 we will continue to target the tonnage of waste we produce across our business – employing the principles of the waste hierarchy wherever possible as well continuing to focus on the amount of waste being reused and recycled. We will specifically:

- Work closely with our new waste contractors to identify innovative ways to reduce waste and to segregate waste at source.
- Aim to further decrease the actual tonnage of waste that we produce as a business and further investigate innovative ways, alongside suppliers and manufacturers, to reduce the amount of packaging waste and improve the reuse/ recyclability of items we purchase.
- Investigate with manufacturers the opportunities to reduce the amount of embedded waste, via improved design and life cycle analysis of the products that we routinely purchase like electrical equipment, operational vehicles and information technology equipment.

2.5.3 WPD Depot Environmental Permits

Under the European Waste Directive, the UK Environmental Regulators have declared that all used electrical insulating oil drained from operational plant or used plant containing oil which is to be removed from site be classed as a hazardous waste. This means that our depots in England that store in excess of 3,000 litres of used oil (1,000 litres for depots in Wales), in drums or within redundant plant, now require an environmental permit to store the used transformer oil prior to final disposal by a third party contractor or via one of our Plant Centre.

Since 2014 we have successfully applied for 29 environmental permits with the Environment Agency / Natural Resources Wales. As part of the application process, our permitted sites must be able to demonstrate to the Environmental Regulator that all pollution prevention measures are robust, fit for purpose and legally compliant. We have also demonstrated a thorough approach in terms of oil storage, risk minimisation and the management of the environmental permits.

Throughout 2017/18 we have had a number of planned and unplanned visits by the Environment Agency / Natural Resources Wales at our permitted sites, to date we have had no major non conformances issued at any of the sites visited and any minor non-conformances identified have been addressed promptly and closed by the Regulator.

During 2017/18 we will continue to manage our permitted sites in line with Environment Agency / Natural Resources Wales guidance and environmental legislation.

WAMITAB Competency Assessment

In order for us to maintain and comply with our depot environmental permits for the storage of used electrical insulating oil, the Environmental Regulator needs assurance that our employees are competent and responsible for the safe and secure management of the site.

One way to demonstrate competency in terms of waste management is to complete the Waste Management Industry Training and Advisory Board (WAMITAB) competency assessment. The process assesses an individual's competency in terms of environmental compliance, pollution prevention and risk minimisation, as well as health and safety. Staff should also operate in line with all company policy.

To date, 38 selected employees based at our sites have successfully completed the assessment and have been issued with their WAMITAB certification. Additional employees are now in the process of completing the competency assessment and will be certified during 2018/19.

2.5.4 Environmental Employee Awareness

Environmental awareness / training sessions are undertaken across our business and at various levels. In 2017/18 we delivered environmental awareness training to approximately 640 employees across the business.

Apprentice Inductions

All of our apprentices attend a mandatory dedicated environmental awareness session which specifically considers the following environmental aspects;

- Environmental sustainability
- Carbon Awareness
- ISO14001
- WPD Environmental Aspects
- Pollution Prevention
- Ecology
- Waste Management
- Employee Responsibility

General Environmental Awareness

As an ISO14001 certified organisation we ensure that all of our employees maintain a good general awareness of any environmental issues concerning the business. We do this by running environmental awareness sessions throughout the organisation.

We have continued to improve environmental awareness amongst employees using various poster campaigns, environmental bulletins, leaflets, briefing sessions and awareness training videos.

Environmental Key Performance Indicators

Following the publication of the RIIO-ED1 WPD Business Plan and in line with our commitment to achieving our environmental outputs during the ED1 period, throughout 2017/18 we have continued to produce quarterly environmental key performance indicators (KPIs).

The KPIs are published across the business and report on our performance at a company, licence area and local level. Specifically the KPIs monitor the following environmental outputs:

- Waste management (total tonnage, percentage waste to landfill vs. non-landfill)
- Building energy use (kWh)
- Operational vehicle fuel use (litres)
- Fluid filled cable losses
- Reportable environmental incidents
- SF_6 emissions and bank

These KPIs make managers and site owners aware of their comparable performance and help drive the correct action as we reduce the environmental impact.

640

We delivered environmental awareness training to around. 640 employees in 2017/18

2.5.5 Community Awareness

Environment forms part of our wider community support strategy and continues to develop to reflect the changes within the industry, as well as the needs of the communities we support.

Schools and volunteer-led conservation groups often have the commitment and enthusiasm to implement positive changes that will benefit the environment, but often lack the financial means to see the project through.

In the past year, we have helped a variety of these projects including volunteers representing Retire Common in Bodmin. The Common is a Site of Special Scientific Interest (SSSI) which requires timely but specialist scrub clearance. The Retire Common Association of volunteers needed to purchase some tools for the task and we gave a donation for this purpose.

Wherever possible, for all our community environmental activities, we work with established organisations to maximise the outputs for beneficiaries. We have an excellent relationship with various wildlife trusts that operate in our network areas. As well as providing hands on nature experiences for children and their families our support has enabled some of the projects managed by the trusts to grow and develop.

For example, Avon Wildlife Trust wanted to purchase some digital microscopes to expand the learning for hundreds of people who come into contact with their various programmes. The donation from us enabled them to purchase the microscopes which will improve the learning experiences for keen naturalists of all ages and promote positive environmental awareness.

In recent years, the native tree planting scheme we provide for community groups, not-for-profit organisations and schools has changed the way it operates so that we can maintain the level of planting while ensuring we keep people engaged in the wider benefits trees provide to the local landscape and wider environment. We've seen an increase in requests for fruit trees to help schools create an orchard as well as hedgerow planting schemes to improve wildlife corridors for bees.

In most areas, we work with regional conservation groups who manage the tree scheme on our behalf, purchasing the native trees and helping with the planting schemes so that the beneficiaries know how to look after them not only until established, but well into the future. In addition, due to lack of finances within the public sector, there has been an increase in requests from parish, district and county councils to help with public planting schemes.

2.5.6 Ecology

Awareness of protected species legislation is improving across our business with Planners, Wayleaves Officers, Surveyors, Team Managers, Technicians and Project Engineers all calling on the services of our experienced ecologists, Green Ecology. During 2017/18 advice and assistance has been widely sort in how to follow best practise and relevant legislation to ensure operations proceed without delay while remaining fully legally compliant.

Requests for advice covered a wide range of topics from bats, otters, reptiles, nesting birds and great crested newts to habitat surveys ahead of new installations, activities on sensitive designated sites and complex licensing requirements. One very common enquiry is badgers and their desire to live as close as possible to electrical distribution network infrastructure.

Badgers

Badgers are found in an array of urban and rural habitats but they often favour places with less human activity therefore it is not surprising that they are often found in our substations. They are also attracted to the heat that underground HV cabling gives off and they cannot resist entwining their homes with our infrastructure.

Badger exclusion being undertaken at a primary substation.

Over the last year, our ecologists have helped us inspect setts, close setts, dig them out under licence and badger proof cable runs and substations (including several primary substations). We have also seen the introduction of the Class Badger licence (CL35) by Natural England which gives a handful of experts the power to take on licensing activities without the need to obtain a licence from Natural England. This new process allows setts to be dug into or closed with much less delay or cost and our ecologists are already employing this innovative approach with us in Staffordshire.

2.5.7 Adaptation/Flood Preparedness

In May 2015 we produced a second Climate Change Adaptation Plan.

There has been no change to the fundamentals of climate change risk since our first report. The UK Climate Predictions (UKCP09) published under the Climate Impacts Programme remain in place as the base dataset for climate change in the UK.

Throughout 2017/18 we have continued to work with the University of Newcastle to complete more research on the effects of climate change. We have provided the University with locational data and other weather related impact data for our network. They have simulated the effects of climate change on the whole range of environmental impacts that may affect our business. The main risks that impact our network remain unchanged; they include extreme weather events, flooding and significant temperature changes.

Understanding uncertainties

Using the impact of UKCP09 climate predictions, we have plans in place to mitigate climate change on our network. New research has highlighted the increased risk of interdependencies, such as the effect of high winds after periods of prolonged rainfall which can increase the chance of trees being uprooted and affecting our overhead lines.

Details of actions

We continue to work through our programme of substation flood prevention work.

We have further developed our capability to respond to flood events using portable equipment and mobile pumps. We have also altered our specification for pole-mounted transformers to improve their resilience to lightning. Our amended overhead line design standards which take into account a potential rise in temperature are now in place.

Addressing barriers and interdependencies

We do not see any barriers to our adaptation to climate change. Instead we remain focused on addressing the interdependencies, including the impact of transportation issues when flood water could hamper our access to our substation sites.

Monitoring and evaluation

The recent report from the Adaptation Sub Committee highlighted the work carried out within the electricity industry. We report on our actions to our regulator, Ofgem, and our response to recent winter storms demonstrates that we are well prepared for the impact of any climatic changes.

3.0 Smart grids, innovation and our role in the low carbon transition

3.1 Introduction

Innovation is at the core of our business strategy. Improving the services we deliver to customers and driving the network to be more efficient through better ways of working has always been fundamental.

We have facilitated the transition to a de-centralised energy system by re-engineering our networks, which were designed for 14GW of demand, to enable them to accommodate 20GW of generation. Accommodating the increased intermittency, variability and volatility of the energy flowing around our assets has only been achieved through innovation of our design and construction methods. We have adopted new technology to make our networks more sophisticated and responsive, forged new relationships with customers and developed our operational practices.

Making our networks smarter, integrating outputs from innovation projects as they develop and enhancing our existing datasets with information from smart meter datastreams will enable us to increase capacity and security at a lower cost.

By carrying out a wide portfolio of innovative projects which build upon what we have already learnt and incorporating successful developments from other DNOs, we can ensure the network will meet all future needs and we will maintain our position as the leading performer in network availability and customer service.

We look for innovative developments across five broad areas;

- Network performance and efficiency – searching out better processes, equipment and technology that ensure we continue to be efficient
- Low carbon networks – supporting future electricity demand and generation requirements
- Smart grids and meters – developing new techniques and utilising enhanced data to help develop more dynamic network control
- Environment – reducing our business impact on the environment
- Customer service – developing smarter ways of delivering better customer service

Key Challenges

The energy system is changing and distribution network operators will continue to have a greater need to actively manage energy flows on a real time basis in order to develop an efficient, co-ordinated and economic network that accommodates emerging system needs and delivers benefits and savings for customers. The way electricity is generated and the ways in which electricity is consumed are changing at an unprecedented rate and further integration of low carbon technologies and the electrification of transport and heat will continue this trend into the future. Greater flexibility of the networks will be required to manage the impacts of the varying patterns and levels of loads locally and nationally.

Smart energy technology and processes have the potential to deliver lower bills and allow customers to connect low carbon technologies quicker, cheaper and more efficiently. By prioritising these principles for implementation, we aim to deliver benefits for our customers sooner.

3.0 Smart grids, innovation and our role in the low carbon transition

Our five key areas for prioritisation are:

1
Understand historic and real time energy flows

2
Forecast future energy volumes and flows across the network

3
Actively reconfiguring the system dependent on need

4
Undertaking commercial arrangements to contract services eg. DG, active demand, storage

5
Co-ordinate DSO operations with National Grid (SO) and look to provide services

3.2 Progress of the Innovation Strategy

Our Innovation strategy has been reviewed annually since its submission as part of our RIIO-ED1 Business Plan. We have completed a number of projects since the submission (SoLa Bristol, FALCON, Low Carbon Hub and FlexDGrid at Tier 2) and have added additional projects. We remain on target with all of our projects.

In 2016 we were awarded funding for our first Network Innovation Competition (NIC) project, OpenLV. The project develops a distribution substation operating system and software to allow third party "Apps" which can analyse network conditions and make available information in a variety of formats. In 2017 we were awarded funding for a second NIC project, EFFS (Electricity Flexibility and Forecasting System). The project explores forecasting arrangements required to build a DSO system capability. It will determine system requirements incorporating common standards and will collaborate with other DSO readiness projects, enabling enhancements to be made to an existing system to deliver and prove DSO system capability.

The intention of the new projects is to better integrate additional distributed generation and Low Carbon Technologies within the network.

In addition, we have started to progress a number of the smaller initiatives that formed the basis of the business plan. For example, Project FREEDOM is looking at how the natural gas grid could be used in unison with electricity to heat customer homes with minimum disruption while reducing carbon emissions. Several of our domestic demand side response projects have demonstrated the relative difficulty in achieving a suitable reduction in energy usage at peak times in demand. The projects concluded that home automation is key and that future low carbon technologies like electric vehicles may be more suited than today's appliances.

Our Innovation Strategy is underpinned by the three themes of Assets, Operations and Customers and is focused on trialling and testing innovative ways of making the job that we do both better and more cost effective while remaining focused on the environmental impact. Our Innovation Strategy is updated annually.

3.2.1 Key Themes of the Trials

As well as the Innovation Strategy, we publish an annual NIA innovation progress report.

	Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
Solar Storage		✓		✓	✓
LV Plus	✓	✓	✓		
Industrial & Commercial Storage		✓	✓	✓	✓
Time Series data tools		✓		✓	
Superconducting cables	✓	✓		✓	✓
Common Information Model		✓	✓		
NEXUS – Global Analysis of Telecoms		✓	✓	✓	
EV emissions testing	✓		✓		✓
Time series data analysis	✓	✓		✓	
Project SYNC		✓	✓		✓
Losses Investigations		✓			✓
Airborne Inspections		✓		✓	
CarConnect (Electric Nation)		✓	✓		✓
ENTIRE		✓	✓		✓
FREEDOM		✓	✓		✓
LV Connect and Manage	✓	✓	✓	✓	
Carbon Tracing			✓		✓

3.0 Smart grids, innovation and our role in the low carbon transition

Major Low Carbon and Smart Grid Projects

We have been successful in receiving funding for eight projects through the Ofgem network innovation competitions, three of which are yet to conclude. We are also project partners in two major innovation projects funded through national and EU innovation mechanisms. The projects investigate a range of network issues from 132kV active network management to rewiring of customer homes with DC systems.

Network Equilibrium

The focus of Network Equilibrium is to balance voltages and power flows across the distribution system to better configure the network. This project will help to integrate additional distributed generation within electricity networks more efficiently and deliver major benefits to distribution customers. It is developing solutions that will be initially demonstrated across Somerset and Devon.

The project uses three methods:

Enhanced Voltage Assessment (EVA)
This develops a new network modelling tool for 33kV and 11kV networks. It will allow better visibility of time series power flows and voltage profiles at 33kV and 11kV, not just the extreme scenarios.
It will improve contingency planning, modelling, and forecasting of both demand / generation profiles.

System Voltage Optimisation (SVO)
SVO will dynamically adjust 33kV and 11kV voltage profiles across eight Bulk Supply Points and eight primary substations within the trial area. It will aim to overcome the issue of fixed voltage points at key substations by using telecommunications and centralised network management software.

Flexible Power Links (FPL)
The project will trial the use of novel power electronics to optimise the power flows between two different 33kV networks. Flexible Power Links will be used for the first time by a British distribution network operator and will transfer both real and reactive power flows, on a dynamic basis, between previously unconnected networks.

3.0 Smart grids, innovation and our role in the low carbon transition

We expect to unlock an additional 344MW of generation capacity across the trial area. The EVA work is complete and is being used to assess the capabilities of the project area and our wider network. The SVO development work is in progress with installation work at 16 sites and the centralised optimisation system is currently being built and tested by Siemens. The FPL contract has been awarded to ABB and this is currently being built.

Open LV

OpenLV will create a software platform which enables enhanced real time assessment and visibility of low voltage network capacity. This improved visibility will allow the distribution network companies to more actively manage this level of the network, which is necessary as more generation and demand is connected locally. Such an approach would ensure the available capacity is used more effectively, minimising the costs of reinforcement.

The decarbonisation of heat and transport through the wide scale customer adoption of heat pumps and electric vehicles will increase demand on LV networks. Under current business practice this would result in a large amount of conventional LV reinforcement, at significant cost and disruption to customers, to accommodate this increase in demand. New solutions are becoming available, but each delivered on separate, proprietary platforms.
The functionality delivered by the OpenLV Solution will be proven via three complementary Methods :

- Method 1: LV Network Capacity Uplift;
- Method 2: Community Engagement; and
- Method 3: OpenLV Extensibility to 3rd parties.

The OpenLV Solution includes the following key components:

- Intelligent substation devices that can support software applications or 'Apps' from multiple vendors on a single device. Providing a low cost hub that, once deployed, can act as a hub for many more functions
- A secure platform that enables the intelligent substation devices to be remotely managed
- A secure platform that provides LV network data to community groups and third party organisations

This will facilitate non-traditional business models by opening up network data to third parties to understand the network and deploy solutions. The roll out of the overall solution proposed across Britain will support the Low Carbon Plan and uptake scenarios presented in the UK Government's Fifth Carbon Budget by minimising the impacts of low carbon heating and transport on the LV network, therefore removing this as a barrier to customer adoption where it is applied. This has significant potential to deliver environmental benefits and cost savings to future and existing customers by negating and/or deferring the need to reinforce the LV network.

3.0 Smart grids, innovation and our role in the low carbon transition

EFFS (Electricity Flexibility and Forecasting System)

This project will explore in detail the additional functionality required as a DSO, to evaluate the potential options and implement systems that provide that new functionality.

This will include:

- Creating weather adjusted forecasts for load and generation at different time-frames and adjusting these for planned flexibility service despatch in order to determine the nature, duration and frequency of expected constraints
- Determining the optimum set of actions to manage potential constraints including evaluating the suitability of flexibility services
- Communicating flexibility services requirements to the market and creating commercial agreements for those services
- Executing flexibility services including arming, execution and validation of delivery and payment
- Sharing information with interested parties to avoid conflicts in flexibility service use

The project will consider the optimum degree of integration with existing systems and whether simplified alternatives to full optimised power flow analysis can provide sufficiently reliable information.

EFFS will work closely with the ENA Open Networks project which is specifying the functional requirements for DSO operation and the likely data exchanges. EFFS is also working together with Fusion and Transition, NIC projects by Scottish Power and Scottish and Southern Energy Power Distribution respectively that are also supporting DSO transition.

Local Energy Market

A key conclusion of the Smart Grid Forum Workstream 6 was for market participants and network operators to have visibility of each other's proposed DSR actions and requirements. Our NIA project, Visibility Plug and Sockets, will support a much larger EU funded initiative led by Centrica in Cornwall to create a local energy market.
The project will develop a platform to enable suppliers, aggregators and communities to inform the network operator of planned changes to assumed electricity profiles (either DG or demand). It will allow the network operator to post information about potential congestion, enabling a market solution to them.
Any requirements for residual balancing and direct DSO schemes would thus be minimised.

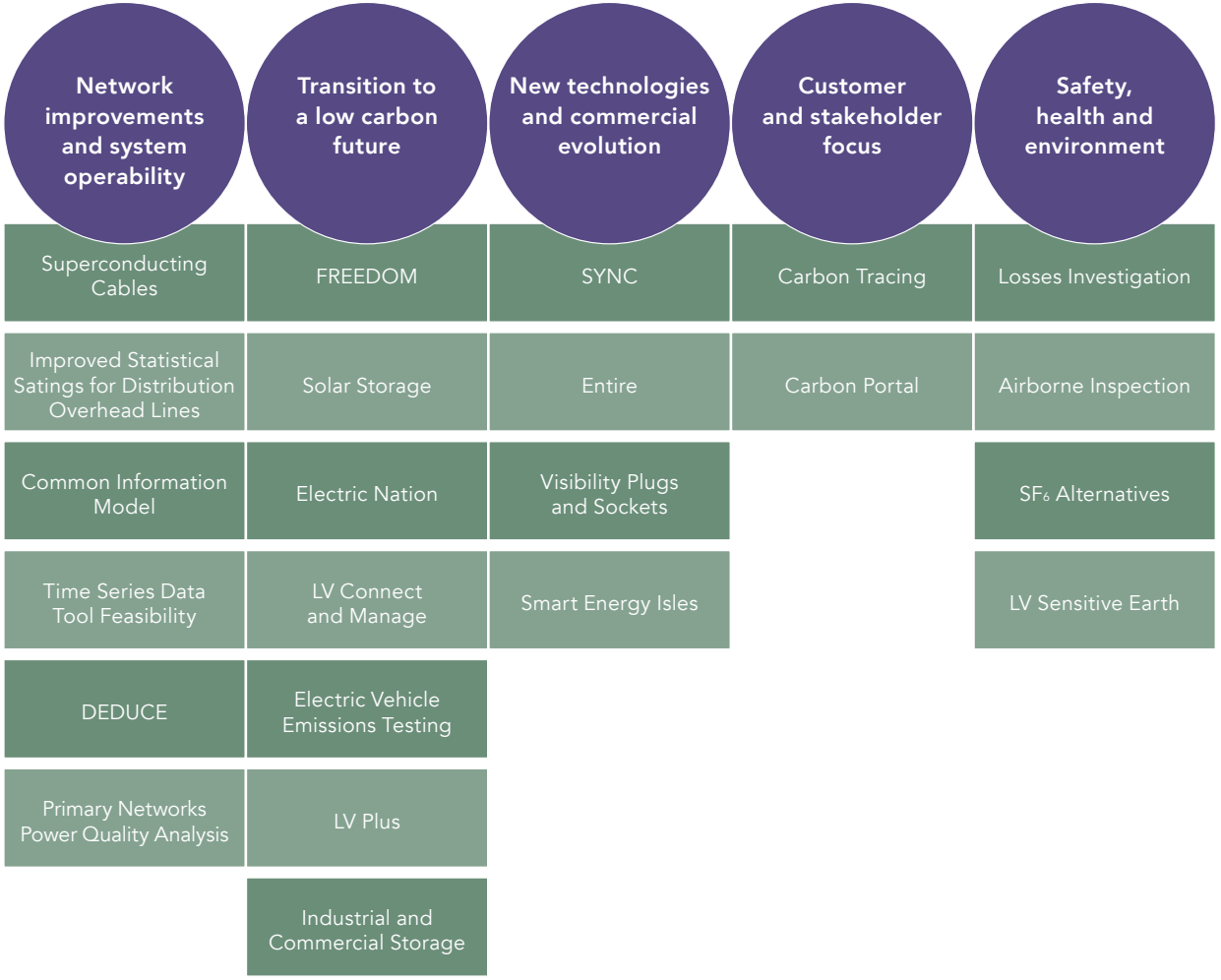
Smart Energy Isles

We are is part of a Hitachi led consortium awarded EU funding to build and operate a renewable energy microgrid on the Isles of Scilly. In addition to the integration of renewable generation the project will install energy efficiency measures and control system in homes and businesses.

3.0 Smart grids, innovation and our role in the low carbon transition

Low carbon and smart grid smaller project portfolio

In addition to the large projects, we are continuing to deliver a portfolio of smaller low carbon projects listed here;



3.3 Roll-out of Smart Grids and Innovation into Business as Usual

We deliver innovation through an in-sourced model with a small team of specialists using the resources of our operational teams to deliver tools or products onto the network. The Innovation Team works alongside the company's Policy department, interacting with equipment specifiers and technical experts of the wider business. Once trials are successfully completed, the outputs are taken forward and replicated across our network.

As outputs are delivered, they are developed into new learning that can be taken forward and developed as business as usual. Outputs obtained from other DNO projects are fed into this process to ensure that we gain maximum benefit from innovation projects.

All solutions rolled out from innovation follow the same route as our other policies and techniques introduced into the company. Policies are reviewed by the senior network managers before they are introduced. The rollout process includes implementation plans and, where appropriate, training and dissemination sessions. We monitor all the projects as they develop and make use of learning and outcomes as they are reported.

Our RPZ1 project developed a practical application for Dynamic Line Ratings (DLR) on our 132kV overhead lines. The project results have been embedded into business as usual and are documented in a dynamic line rating policy.

Our Lincolnshire Low Carbon Hub project developed a practical application of Active Network Management which is part of our Alternative Connections policy suite. Alternative Connections are available to all generation customers seeking a connection where significant reinforcement is required.

Export limitation devices have been developed by manufacturers to locally balance generation and demand, however due to the lack of an industry standard, the variance in the quality and method of operation of these devices is wide. We developed a policy for acceptance of these schemes which outlines the minimum requirements to achieve compliance with a new WPD policy. This policy was circulated to the other DNOs and following further refinement was developed in conjunction with manufacturers to form a new UK standard, ENA Engineering Recommendation G100.

All projects produce new or revised WPD policies for use during the project lifetime. These policies are always written in such a way that they can be extended to apply beyond the project and, in a larger geographic area if the solutions trialled turn out to be successful.

3.0 Smart grids, innovation and our role in the low carbon transition

3.3.1 Roll-out Strategy

Stages of Innovation

Projects will continue to deliver additional knowledge across all output areas. The project portfolio will remain balanced across multiple areas:

- Working at various stages of development spanning higher Technology Readiness Levels (TRL) 3 to 8
- Exploring both technology and commercial solutions
- Covering the whole range of asset types and network voltages
- Assessing risk, with no projects carrying unnecessary risk
- Utilising a variety of external funding mechanisms to supplement our own R&D budget

> “ INNOVATIVE SOLUTIONS WILL BE IMPLEMENTED ACROSS THE NETWORK USING ‘BUSINESS AS USUAL’ TEAMS.

Lower TRL projects will generally be carried out by external research partners under the supervision of our engineers. Higher TRL projects which, in the shorter term, are more likely to produce a solution for our network or processes will mostly be delivered in-house using business as usual teams.

3.3.2 Innovation Process

Innovation is core to our business strategy. We have a dedicated innovative team exploring innovative ideas including the delivery of smart grid projects. Our projects are predominantly generated from ideas from staff and stakeholders. When they involve the installation of equipment on our network or require a change to business processes we do this in the same way as our standard engineering activities using the skills and efficiencies of our engineering teams. We also draw on the expertise of our suppliers and help them develop solutions, and we work with a range of research establishments using their specialist skills.

Approach to innovation

The way we approach innovation is fundamental to delivering against our objectives effectively and efficiently. Our approach is to:

- Actively involve staff from across the business in the generation of ideas, development of solutions and implementation of projects
- Work with a wide range of stakeholders to understand their needs
- Make use of a wide range of innovation incentives and funding provided by the government, regulator and other funding mechanisms
- Define clear objectives for each project so that delivery can be focussed and progress can be accurately tracked
- Use a small core delivery team to co-ordinate innovation projects
- Avoid theoretical research or innovation that doesn’t have clear objectives and benefits
- Incorporate innovative solutions into existing equipment and processes
- Share what we’re learning with other organisations and learning from others

3.3.3 Benefit and Impacts of roll-out

The innovation solutions we have rolled out have provided a series of benefits both to our customers and to our business. The details of those benefits can be found further within this document in section 3.3.10.

3.3.4 Innovation Roll-Out Mechanism

The Innovation Roll-Out Mechanism is provided to promote the adoption of innovative solutions that do not provide an immediate benefit. All of our solutions provide immediate benefits, so we have not used the mechanism.

3.3.5 Maximising the Benefits of Smart Meter Roll-out

Smart Meters have the potential to provide data to enhance our existing core business activities such as fault management, network planning and asset management. There are also potential benefits which could lead to future applications that would help the deployment of low carbon technologies and the move to actively managed networks. With many of these applications the benefits increase as the density of smart meters on the system increases.

Fault management

Smart metering will provide a number of functions to support fault restoration and reporting activities. For example when there is a power cut, 'last gasp' functionality will trigger a message to notify a loss of supply. This will provide a level of visibility down to the individual premises that has not been available before. Additional functionality will allow the 'energisation status' of meters to be checked remotely, giving us a clearer understanding of which customers are off supply, enabling us to determine what kind of fault has occurred (blown fuse, open circuit fault, single premises). This will help ensure that we respond in the right way first time and improve our restoration times. In the case of a call regarding a 'single premises', it will also help to remotely identify if the issue is on the network or on the customer's own equipment.

On completion of any restoration work, it will be possible to check that all supplies have been restored. This is particularly useful in storm scenarios where faults at High Voltage (HV) can mask additional issues at Low Voltage (LV).

The ability to check will reduce the possibility of teams leaving the area whilst customers may still be off supply. As smart meters record interruption and restoration times, fault management applications will become more effective over time as the density of installed smart meters increases and more information becomes available to provide comprehensive view of the network.

> "SMART METERS HAVE THE POTENTIAL TO PROVIDE VALUABLE DATA WHICH COULD ENHANCE OUR CORE BUSINESS'

Network planning

Existing network planning assumptions are already being challenged due to the volume and type of distributed generation on the LV network. At present, the majority of load data is derived from measurements at source 11kV circuit breakers at primary substations. At LV, maximum demand indicators provide us with a limited view of load at distribution substations but no load duration is collected. Smart meter data can provide increased visibility on the aspects of network activity that can subsequently inform load-related investment decisions. Data on half-hourly power flows (real, reactive, import, export) and maximum demand (both for individual meters and aggregated for network sections) allow us to determine load profiles, which can be used to:

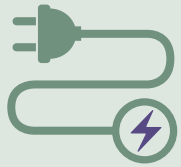
- Check that loading is within operational and thermal capacities of network components
- Determine thermal capacity headroom to gauge the scope for accommodating additional (LCT) loads
- Inform the prioritisation of load-related network investments
- Avoid unnecessary reinforcements or network issues from demand over or underestimation
- Identify reverse power flows, which might require us to take measures
- Identify where power factor correction is necessary or can act as an alternative to network reinforcement
- Identify areas where network losses are highest

The data collected will provide us with a more comprehensive understanding of where there are issues on the network and where there is adequate capacity to accommodate additional connections or more LCTs without the need for network reinforcement.

Aggregated load data will create a more detailed profile of the loads experienced at points on the network. This can support the identification of overloaded sections of network and aid in the prioritisation of network reinforcement where load issues have been identified.

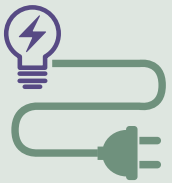
Aggregated load data can also ensure that network reinforcement is avoided where it is not necessary. For example, maximum demand indicators may suggest that a substation is overloaded based on a momentary high load, whereas aggregated metering data may demonstrate that this was of very short duration and in line with design parameters requiring no intervention.

Connections



As with load-related network investment, increased visibility of voltage levels and power flows can help us reduce the time to connect new loads and generation. It can also provide benefits to new connectees via lower connection charges and the ability to assess options for the use of smart solutions to reduce or avoid upstream reinforcement.

Asset management



A wide range of data will be available from smart meters to support asset management activity. Each meter will be able to act as a voltage monitoring point and be capable of issuing alarms relating to voltage anomalies (under voltage, over voltage).

3.3.6 Smart Meter Penetration

The percentage penetration of Smart Meters in each of the DNO's Distribution Services Area at the end of 2017/18 period is provided in table 3.3.6.

The Smart Meter Rollout is being managed by Electricity Suppliers in the UK and is due to be completed by 2020.

3.3.7 Status of IT and Communications Investments (DS)

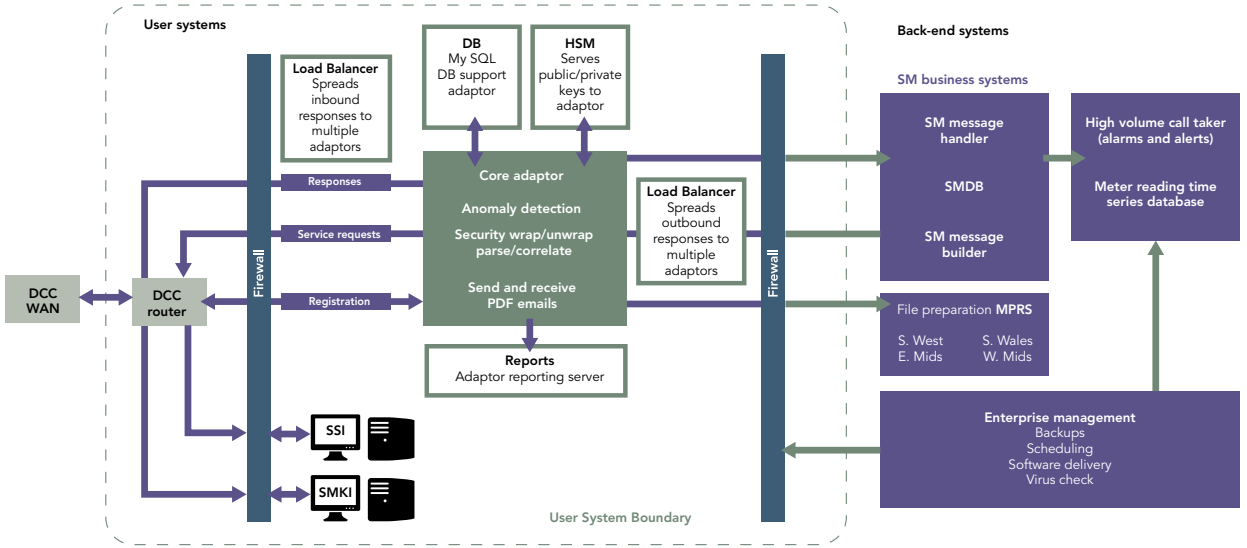
The current status of IT and communications investments which are required to maximise the benefits of smart metering data – are detailed in Worksheet E5 – Smart Metering (published as an appendix to the Report) and the accompanying commentary report.

We have been connected to the DCC release 1.3 since December 2017. In addition to proving system functionality we have successfully passed an independent audit to ensure our security architecture and environment meets the security requirements of the overall National programme.

Table 3.3.6 Smart Meter Penetration by WPD Licence Area.

Licence Area	East Midlands	West Midlands	South Wales	South West	Total
No. MPANs	2,699,963	2,537,996	1,160,469	1,669,900	8,068,328
No. Smart Meters Installed to date	566,321	542,419	235,450	316,058	1,660,248
Total Penetration	20.97%	21.37%	20.28%	18.93%	20.57%

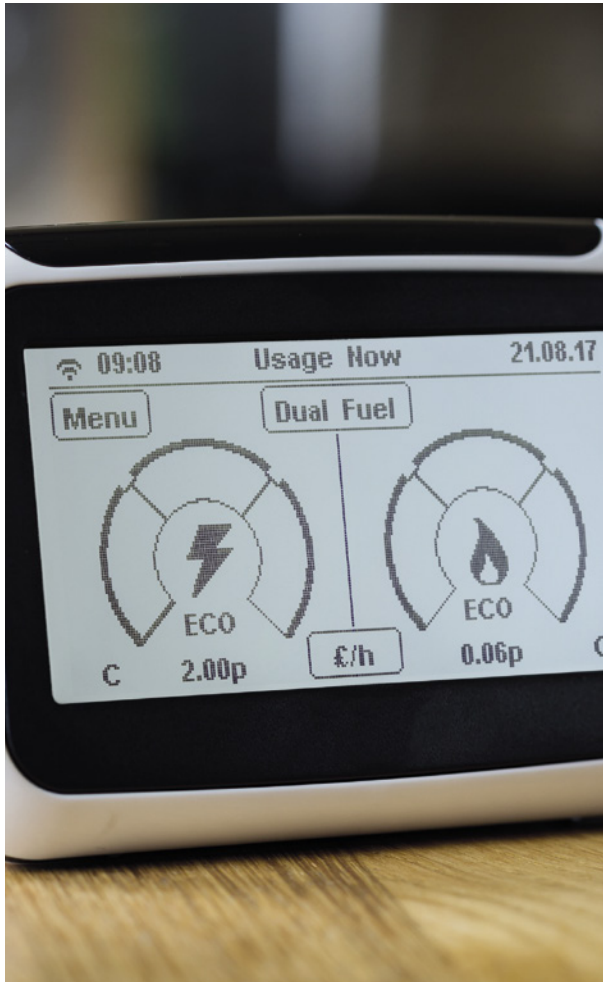
Fig. 3.3.7 Smart Metering – User System Environment.



3.3.8 Maximising the Value of Smart Meter Data

While suppliers have been installing smart meters in our distribution area these are not compatible with the national infrastructure. As such no smart metering data has been received and consequently no benefit has been realised as yet.

This will continue to be the case until large volumes of SMETS2 smart meters start to be installed. There has seen a steady increase of SMETS2 meters being installed and we now lead the way with in excess of 250 units installed within our licence areas. The numbers will increase during 2018/19 as all suppliers will
be installing SMETS2 meters by 2019.



A typical visual display unit a customer would have in the home connected to a smart meter.

3.3.9 Smart Meter Data

At present our innovative connections solutions are targeted at large scale customers. Soft Intertrip and Active Network Management (ANM) require real-time links so do not use smart meter data. We can use smart meter data to complete retrospective checks on Timed Connections. As our innovation continues and smaller customers are focused for solutions, smart meter data will become a key dataset for us.

> EXISTING INSTALLED SMETS1 METERS ARE PLANNED TO BE ENROLLED IN TO THE DCC THROUGHOUT 2018/19.

3.3.10 Estimated Actual Benefits

The estimated actual benefit of using smart metering data during the current price control period was included in our RIIO-ED1 Business Plan and was as follows;

Table 3.3.10a

	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Efficiency saving on load-related reinforcement	0.00	0.00	0.00	0.00	0.43	0.70	0.85
Efficiency saving on connections-related reinforcement	0.00	0.00	0.00	0.00	0.50	0.80	0.98
Savings from last gap functionality	0.00	0.08	0.23	0.38	0.60	0.75	0.75
Savings from restoration confirmation	0.00	0.01	0.04	0.06	0.09	0.11	0.11
Total per annum	**0.00**	**0.09**	**0.26**	**0.43**	**1.62**	**2.36**	**2.69**

Table 3.3.10b

Smart metering benefits for demand side response and active network management (£m)								
	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Total per annum	0.00	0.00	0.00	0.00	0.00	0.5-1.5	0.5-1.5	0.5-1.5

The level of estimated actual benefit declared in the WPD Business Plan was based on a number of assumptions which are either no longer valid or have the potential to be no longer valid, for example:

- Commencement of mass rollout of smart meters was not delayed
- Penetration of SMETS1 meters was very low
- Customers numbers with no Smart Meter WAN coverage was very low
- Consumption data was able to be used in disaggregated form
- Power outage/restoration alerts are received in a timely manner
- Smart Meter voltage measurement has a high and known accuracy

Consequently the level of estimated actual benefit will need to be reviewed once the outcome of the aforementioned becomes clearer.

3.3.11 Forecast Actions

The start of an increased number of SMETS2 meters since the beginning of 2018, and supplier trials within the licence areas has led to increasing numbers of SMETS2 meters throughout 2018.

During the early part of mass roll-out, including the 2017/18 regulatory year, we will be in 'evaluation mode' whereby the smart metering data we receive will be assessed, but our existing business processes and systems will largely continue as before.

The actions we intend to take are as follows:

Avoided losses to network operators

This benefit depends on:

- A high penetration of smart meters
- The availability of Supplier Time of Use (TOU) tariffs
- Significant numbers of customers taking up these tariffs
- The TOU tariffs incentivising a customer response which reduces the maximum demand
- The In Home Display driving changes in customers' consumption behaviour

We intend to monitor developments in this area as smart meter roll out continues.

Reduction in Customer Minutes Lost (CML)

This benefit depends on sufficient penetration of smart meters to allow for rapid identification of fault type/position and thus quicker responses and repairs. These were not realised during the 2017/18 regulatory year.We intend to evaluate the outage and restoration alerts that we receive during this period.

Reduction in operational costs to fix faults

While there is the potential for us to benefit from avoiding unnecessary site visits for single outage calls as soon as the very first meter is enrolled into the DCC, in practice this depends on:

- SMETS2 meters being installed
- The meter being connected at a premise where a single outage call occurs

The integrated system is already in place and has correctly identified network faults with the currently installed SMETS2 meters. Savings for other faults requires sufficient SMETS2 meters on faulted circuits to allow rapid identification of fault type/position and thus quicker response and repair.

We intend to evaluate the outage and restoration alerts that we receive during this period.

Reduction in calls to faults and emergency lines

This benefit depends on:

- A high penetration of SMETS2 smart meters
- Supply outage and restoration alerts being received in a prompt manner from the CSP systems
- Customers being familiar with smart meter capabilities and having sufficient trust to rely on the meter to notify us about power loss.

Better informed investment decisions for electricity network enforcement

This benefit depends on:

- Data privacy plans being approved
- A high penetration of SMETS2 smart meters
- Sufficiently detailed customer connectivity models
- Access to sufficiently granular consumption information

This was not be realised during the 2017/18 regulatory year. We intend to complete and seek approval of our Data Privacy Plan and Privacy Impact Assessment during the year.

Avoided cost of investigation of customer complaints about voltage quality of supply

Any voltage quality of supply benefit is limited by undefined accuracy of meter voltage measuring elements.

While there is the potential for this benefit to start being realised from the very first meter enrolled into the DCC, in practice it depends on:

- SMETS2 meters being installed
- The meter being connected on sub-optimally performing parts of the distribution network.

> “ ALTERNATIVE CONNECTIONS OFFER CUSTOMERS QUICKER CONNECTIONS AND REDUCED COSTS

Network capacity investment savings from electricity demand shift

This benefit depends on:

- A high penetration of smart meters
- The availability of Supplier TOU tariffs
- Significant numbers of customers taking up these tariffs
- The TOU tariffs incentivising a customer response which reduces the maximum demand.

These were not realised during the 2017/18 regulatory year. We intend to monitor developments in this area as smart meter roll out continues.

3.3.12 Innovative Solutions to new connections

The drive to connect DER remains at the forefront of our activity and with it the impact on the distribution system meaning scarcity of readily available capacity. While we are still encountering an appetite to connect traditional forms of generation many developers are turning to energy storage as a means of providing flexible services to the market. With its requirement for an equivalent demand capability, energy storage brings its own challenges to design and operation of the distribution system. To realise the customer’s capacity requirements we often need to undertake conventional reinforcement but that can take time and sometimes can be prohibitively expensive. There is also an increased risk of stranded assets or reinforcement lagging development as the growth rate of DER and LCT demand increases.

To avoid the need for network reinforcement and thus reduce connection timescales and costs we have developed a suite of Alternative Connections (see 3.3.14) that offer a number of options for those customers who are open to the possibility of being flexible and are prepared to accept a level of curtailment. These options are particularly useful where an existing distribution asset is only compromised for a single system condition and curtailment levels mean the scheme is still viable.

We have been implementing these Alternative Connections across our region and they now have a proven track record. They allow us to drive system efficiencies by utilising assets more resourcefully and mitigating the need for reinforcement and its associated environmental impact. We will continue to develop and refine the use of flexibility as part of our innovation strategy and commitment to move from DNO to DSO. As we improve network visibility and monitor real time energy flows we can deliver a distribution system that makes optimal use of capacity.

You can find out more about our use of Innovative Solutions by visiting our 'Alternative Connections' page on our website.

3.3.13 Benefits for Using Innovative Solutions for Connections

Below, we have summarised the benefits that innovative solutions have delivered for new connections.

This shows that significant capacity has been released across the our service territory. Roll-out of these techniques across the whole network continues and we anticipate gaining further benefits as we adopt additional techniques.

Table 3.3.13

MVA Released		Avoided Costs (£m)	
		Customers	WPD
Active Network Management	89.6	5.20	0.24
Soft Intertrip	52.0	3.05	0.34
Timed Connection	22.7	1.38	0.15
Totals	164.3	9.63	0.73

3.3.14 Alternative Connections Descriptions

Our innovative solutions allow customers to connect their distributed generation at reduced cost, with quicker timescales but will contain some form of curtailment to avoid expensive reinforcement costs.

Soft Intertrip

Some networks are constrained due to a single upstream asset requiring reinforcement, or a single limit being infringed under certain conditions. This solution has an on-site soft-intertrip Remote Terminal Unit which provides two normally open contacts for the customer's control system to monitor; Stage 1 and Stage 2.

When both sets are open, the connection will be free of constraints. The levels of curtailment corresponding to the operation of the Stage 1 and Stage 2 contacts will be defined at the planning stage.

Active Network Management (ANM)

This solution is the most complex and used mainly with larger new connections and primarily generation. Customer control equipment is installed into a WPD control solution which allows for full dynamic control of the network, generation and demand.

Timed Connection

This solution is a simple timer-based device that monitors the connection agreement with the customer, which will include some form of curtailment based on times of day.

The customer's connection agreement will include an operating schedule which will define the times and levels of capacity available to them. The solution is supplied by the customers equipment and does not require any additional investment from us to implement.

Export Limiting

This solution measures the apparent power at the customer's exit point and uses that information to restrict generator output when the customer's agreed export capacity is about to be exceeded. This solution is suitable for all capacities and voltage levels but fault level assessment still needs to be completed.

3.3.15 RIIO Outputs that Alternative Connections Facilitate

Our innovative solutions cover a number of our RIIO outputs. The outputs of each project are detailed in our Innovation Strategy. At a high level these solutions cover:

1. Connections and customer satisfaction: Providing a faster service and engagement with major connections customers
2. Reliability and safety: Enhancing network resilience and doing so in a safe manner
3. Environment: Increasing the uptake of LCTs

By allowing more DG customers and other major customers to connect to the network in a way that is more cost-effective and does not impact on other users, we are changing the way the business operates (with new policies and procedures) and facilitating the connection of new customers with LCTs. The rapid adoption of these solutions show how successful these changes have been.

3.3.16 Benefits and Impacts

Our Alternative Connections give a number of clear benefits and impacts:

- They allow the connections to the network that in the past would have required significant reinforcement
- They enable connections to be made more quickly
- They do this at reduced cost currently (£5.13m reduction to customers connection costs)
- They do not require significant change to our business and so are able to be rolled out in a structured way
- They release significant capacity (83.2MW 2017/18)

3.3.17 Forecast for roll-out of Active Network Management (ANM)

We are releasing new ANM zones every six month. The full roll-out table is below.

Table 3.3.17

GSP Group	Active BSP Group	Quoting from	Building during
Bicker Fen	Skegness	Active	Active
Grendon	Corby Northampton	Active	Active
Bridgwater	All	Active	Active
West Burton	Horncastle	Active	Active
Indian Queens	Truro	Active	Active
Swansea North	Swansea	Active	Active
Pembroke	Pembroke	Active	Active
Cellarhead	Meaford	Active	November 2018
Rassau	Abergavenny	Active	November 2018
South Devon	Landulph – Abham – Exeter GSPs	Active	January 2020
Feckenham	Feckenham	November 2018	April 2019
Aberthaw	All	Active	April 2019
Staythorpe	All	November 2018	November 2019
Berkswell	Warwick	April 2019	April 2020
Axminster	All	April 2019	April 2020
Shrewsbury	All	April 2019	April 2020
Bishops Wood	Hereford	November 2019	November 2020
Rugeley	All	November 2019	November 2020
East Claydon	All	November 2019	November 2020
West Burton	All	November 2019	November 2020
Pyle	Pyle	April 2020	April 2021
Remaining GSPs requiring ANM.	Actual GSP will be dependent on applications and any resultant constraint.	January 2021	November 2021

Timed Connections do not require any actions on our part and are therefore available to customers as needed. Soft Intertrip and Export Limiting is available in a discrete set of circumstances so is available to all relevant customers.

The number of deployments and related capacity released through the roll out of all our innovative solutions will of course be dictated by customer demand. However, we expect to see similar or slightly increased deployments to those in recent years.

3.3.18 Trials Deriving Solutions

The most successful innovative solution to come through specific trials was ANM. We trialled our ANM solution on the Tier 2 Low Carbon Hub project.

The solution was further developed on equipment specification using shared best practice (with other DNOs in particular).

We now have ANM contracts to multiple vendors. By using multiple vendors we keep competition active in this particular market, thereby keeping costs to customers and our business at their most competitive.

In addition to other innovation project successes we also derive innovative solutions through business as usual development.

Appendix

Appendix A

East Midlands RRP Environmental Innovation 2017/18
South Wales RRP Environmental Innovation 2017/18
South West RRP Environmental Innovation 2017/18
West Midlands RRP Environmental Innovation 2017/18

Appendix B

RRP Environmental Innovation Commentary 2017/18

Western Power Distribution (East Midlands) plc, No2366923
Western Power Distribution (West Midlands) plc, No3600574
Western Power Distribution (South West) plc, No2366894
Western Power Distribution (South Wales) plc No2366985

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