nationalgrid

Environment and Innovation report

2022/23

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Executive summary

National Grid Electricity Distribution's (NGED'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 2022/23 we have achieved the following improvements:

Environmental highlights

- Achieving RIIO-ED1 targets for our Business Carbon Footprint, SF_6 and waste management.
- Business wide implementation and external certification of our Competence Management System (CMS).
- Routinely achieving zero waste to landfill in NGED licence areas.
- Successfully maintaining certification of our ISO14001 environmental management system.
- Increased the percentage of electric vehicles in our commercial fleet and Lease Plan vehicles.
- Implementation of our six year collaboration agreement with The Heart of England Forest.

Innovation highlights

- £4.8m invested in National Innovation Allowance projects across our focus areas; Decarbonisation and net zero, Heat and Transport, Data, Communities and Consumer Vulnerability and registered nine new NIA projects.
- First ever call for idea's for the Strategic Innovation Fund and received 42 proposals.
- Submitted five projects to the Strategic Innovation fund and had all five accepted.
- Won two industry Awards.

Challenges

- Ensure that we are prepared and positioned to successfully deliver on our sustainability RIIO-ED2 core commitments.
- Preparation for the introduction of biodiversity net gain (BNG) legal obligations in relation to NGED Major Projects.
- Continue to improve and progress on reducing fluid filled cable losses and SF_6 emissions.
- Maintain and improve our environmental performance and compliance record with the environmental regulators.
- Engagement with employees, suppliers, manufacturers and contractors to reduce the amount of waste that we produce as a business.

Contents

Section 1.0

Introduction

1.1 Who we are and what we do

As part of the National Grid Group, National Grid Electricity Distribution (NGED) is now part of the largest electricity transmission and distribution business in the UK. This means that we will be able to work together to ensure everyone can have clean, affordable energy, well into the future.

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 eight million 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 five key business tasks are:

- Operating our network assets to ensure we 'keep the lights on' for all of our customers.
- Maintaining the condition and therefore reliability of our assets.
- Fixing our assets should they get damaged or if they are faulty.
- Upgrading the existing network or building new ones to provide additional electricity supply or capacity to our customers.
- Operating a smart system by managing two-way power flows and flexible services.

Eight million
Our network serves eight million customers, by area in the UK.

We are not a supplier. We do not buy and sell electricity, or directly bill customers.

In 2022/23, our costs account for around £131.49 of a domestic customer's annual electricity bill.

We deliver electricity to over eight million customers over a 55,500 square kilometre service area and we employ over 6,500 staff.

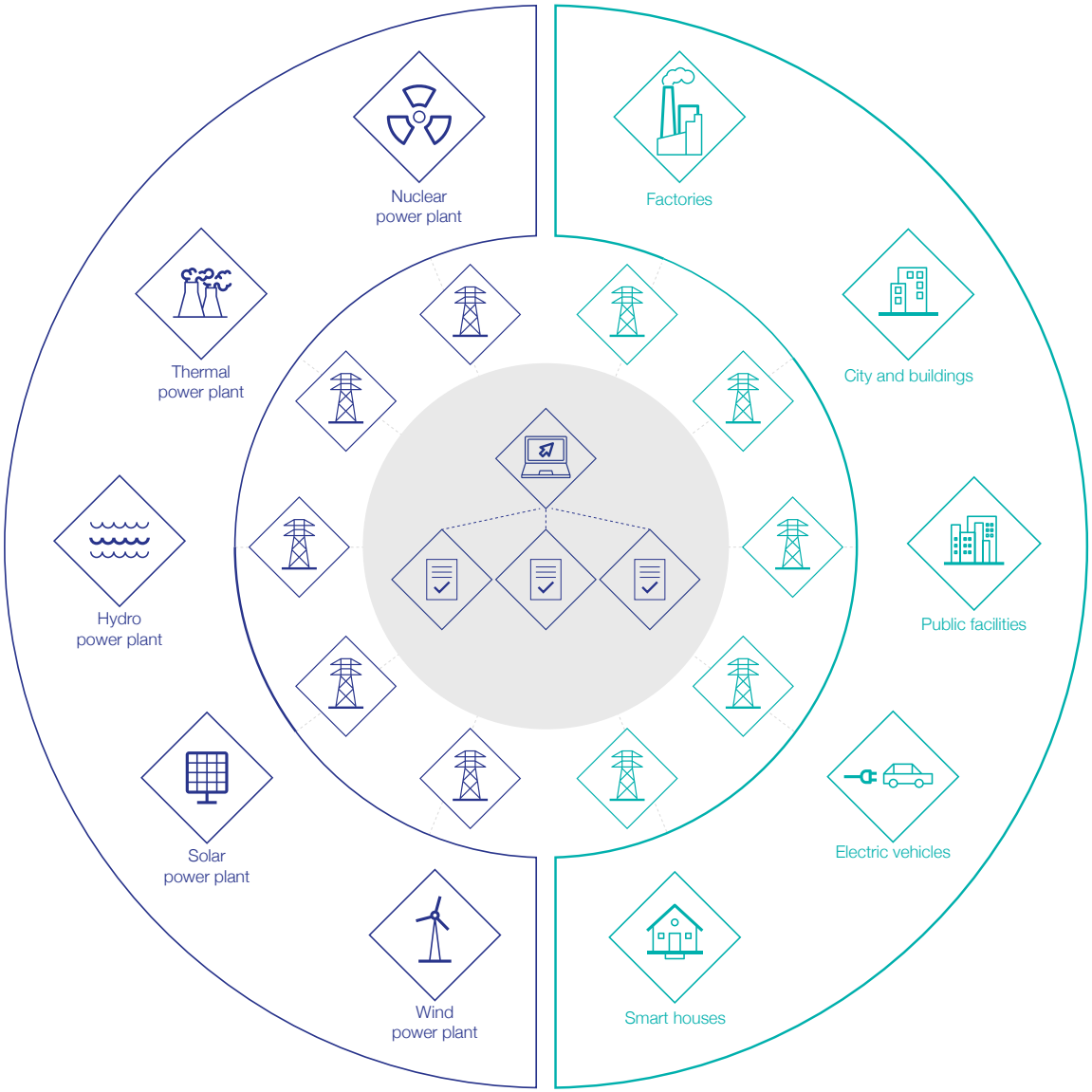
1.2 Our network

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	NGED Total
Overhead lines	km	88,835
Underground cable	km	140,315
Transformers	Each	190,899
Switchgear	Each	307,867
Poles	Each	1,359,548
Towers (pylons)	Each	14,437
Customer numbers	Each	8,028,863



1.3 Improvement opportunities

We continue to be fully 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.

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

A reduction in technical network losses

- Installation of oversized 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

- Establishing a validated 1.5ºC Science Based Target within the business, being a signatory of the UN Global Compact and adopting a number of UN Sustainable Development Goals detailed within our Environment Strategy.
- The introduction of electric vehicles (EVs) in to the NGED Operational Fleet.
- All new or refurbished WPD buildings achieving minimum rating of 'Excellent' for new build and 'very good' for refurbishment under the BREEAM* rating.

Reduction in the leaks from our equipment, specifically

- The leak rate of SF_6 gas that is released from switchgear.
- Overall, across the RIIO-ED1 period a reduction in our FFC losses.
- Installation of effective containment 'bunds' around plant containing high volumes of oil.

Reduction in landfill waste

- Working closely with our waste management contractors to ensure that we meet our RIIO-ED1 business output to reduce waste disposed of to landfill across all four of our licence areas.
- Consistently achieving zero waste to landfill throughout the business.

*Building Research Establishment Environmental Assessment Method

1.4 Stakeholder engagement

Engagement strategy

Effective engagement with stakeholders remains crucial to the success of our business. Each year we engage with an increasingly broad and inclusive range of stakeholders and their respective knowledge, interest and experience varies significantly.

The enduring nature of our engagement strategy, which has been in place since 2007, enables us to build and maintain long-term relationships with customers and stakeholders, and positions us well to identify and respond to emerging shifts in wider society and stakeholder expectations and understand how they relate to our performance and services.

Stakeholders said

"Engagement is crucial. It's the way forward. We are approaching net zero by looking at our own immediate plans and talking to those connected to our network. It's absolutely key that you continue to engage."

"I find these workshops very useful. We see good meaningful engagement at the right level now. Engagement on our Local Plan has ramped up."

Triangulating key insights and priorities across our extensive engagement programme ensured a full range of views were used to drive decision-making in 2022/23, **involving 42,000 stakeholders across more than 4,000 activities.**

Our engagement this year continues to be underpinned by five key principles:

Inclusive
We always seek to reach new, emerging and increasingly local groups. This means deliberately identifying and targeting seldom heard voices with continuous engagement to capture changing stakeholder needs.

Transparent
We ensure stakeholders have a clear line of sight when it comes to feedback and actions from our activities. We proactively share insights and learnings, making sure others can benefit.

Proactive and tailored
Early and continuous engagement, using methods that suit the needs of different audiences provides deep, actionable insights.

Purposeful and impactful
All engagement aims to learn from, improve and build plans with our stakeholders. We focus on meaningful, two-way engagement that shares decision-making power to shape our actions.

Expert-led
Engagement is strengthened by bringing together stakeholders with National Grid business leaders responsible for turning feedback into action.

42,000
stakeholder engaged at over
4,000 activities

1.4 Stakeholder engagement

An embedded culture of continuous engagement

Meaningful engagement must be an ongoing, cyclical process, so at National Grid we use a four stage process of continuous engagement to ensure we always make decisions with, not on behalf of, our stakeholders:

We engage to enable close collaboration with our customers and communities, adapting to the rapid pace of change and increasing breadth of their needs. To maximise the value of stakeholder input, we consistently broaden our range of engagement techniques and mechanisms, tailoring them to best suit the audience and utilising best practice to avoid a 'one-size-fits-all' approach.

Synthesis reports collate and summarise individual pieces of feedback in a single repository which, combined with surgeries, bilateral consultations and partnerships, enables National Grid leaders to turn engagement into action.

Key examples of outcomes driven by stakeholder insight from 2022/23 include:

We heard

"Because of budget constraints we're finding it very difficult to produce a Local Area Energy Plan (LAEP)."

and

"we're working on our LAEP, but we have a really small team. Resource is a big issue."

We did

Our Strategic Engagement Officers worked in close collaboration with LAs to develop positive feedback loops.

The resulting improvement to LA plans led to over 60 LAs having their plan classifications uplifted, allowing them to work with us to build the evidence case to drive proactive investment in our network.

We heard

"To have a real impact, you need to find out the nuts and bolts of what's happening on the ground and identify what each local region needs to live better. Then you can co-produce actions that will drive real change."

We did

We developed an innovative model for inclusive engagement, working with a hub of key local stakeholders to deliver Social Contract commitments in partnership with the community.

We heard

"The focus should be more on flexibility and community energy projects because those sorts of commitments will naturally fall into the net zero target. Flexibility means you won't have to do these big reinforcement works and it will be better for the environment. Focusing on flexibility could save a lot of building works."

We did

Embedded learning from an innovation trial to create a new flexibility offering targeting domestic participation.

In 2022/23 domestic households accounted for 20.5% of flexibility contracted, providing direct financial benefits to customers.

1.4 Stakeholder engagement

Engagement leads to action

Our ongoing engagement strategy and program ensure we allow in-depth conversations and exploration of relevant topics with those who wish to engage with us.

For example, in June 2022, a round of topic-specific workshops sought to understand how our stakeholder priorities were evolving. The workshops, led by the senior managers responsible for the topics being discussed, provided a constructive and collaborative forum allowing us to use stakeholder input to update our strategies and action plans and develop our short and long-term activities.

Stakeholder priorities were independently synthesised with feedback from our other engagement in one report allowing us to ensure engagement, and its resulting feedback, leads to measurable action.

The table opposite highlights some examples of the stakeholder drivers we heard during 2022/23 and the resulting actions and benefits for our customers and stakeholders (in three key areas relevant to this report).

In three words

In three words stakeholders were asked for the biggest challenges currently facing NGED and the wider industry, that we should be addressing for our customers.

June 2022 workshops

Stakeholders driver	Action	Benefit
Innovation		
Customers seeking to connect low carbon technologies want a digital journey option.	**Innovative online connections portal introduced** with 'budget estimate' and electric vehicle (EV) application self-serve tools.	Customers can apply for EV connections online and receive an immediate response (57% of applications are instantly approved).
Motorway services require the equivalent capacity to power 10,000 homes to meet increasing EV charging demand.	**Our brand new standardised, substation solution** provides the required capacity in one compact unit.	Quicker and easier installation of EV rapid charges is enabled at motorway service stations across the UK.
Distribution System Operator		
Demand for new flexibility products and services is ramping up.	**Online procurement portal 'Market Gateway' launched** to standardise and digitise the commercial and technical registration processes.	Our gateway is saving an estimated 1,110 hours annually for Flexible Service Providers (FSPs) in time spent registering for flexibility opportunities.
Many LAs need ongoing support to achieve their net zero goals.	We have **tailored our Embedded Capacity Register** to show LA areas and a localised view of renewable generation schemes in progress.	LAs can now create their net zero road maps efficiently with an up-to-date accurate view of renewable generation in the pipeline.
Environment and sustainability		
Stakeholders reinforced the need for us to partner with communities to realise the principles of our social contract at local level.	**Solar panels in schools pilot extended** providing a scalable solution we can roll out to other schools.	Schools benefit from reduced energy bills and a more sustainable environment.
Reducing carbon while improving biodiversity is a recurring priority for stakeholders.	Partners with the Heart of England Forest to **create areas of new native broadleaf woodland** in our region.	New native broadleaf woodland that also improves our impact across the value chain by improving procurement processes.

1.5 Our social contract

At National Grid, we are committed to doing the right thing, delivering social and environmental value for our colleagues, customers and wider society. It's enshrined in our purpose – Bring Energy to Life.

Our Social Contract, first published in 2021 and updated this year, sets out how we do business in a way that actively benefits our region and the people we serve, both now and well into the future.

Developed in partnership with stakeholders, the Social Contract's three focus areas: "Our people", "Our customers and communities" and "Our environment" each contain key actions for us to deliver wider social and environmental benefits in our communities, in order to maximise the positive impact of everything we do as a company.

Initiatives include installing solar panels on schools and community buildings, providing funding for projects related to biodiversity, low carbon and reducing climate change, company volunteering days for environmental projects, and the delivery of local outreach and education related to sustainability and the net zero transition.

To ensure these promises are meaningful and impactful, the Social Contract is a 'living document' using learning from our delivery and engagement to ensure continued improvement, with a report and action plan published annually.

Social contract strategy

Section 2.0

Managing our environmental impact

2.1 Introduction

Throughout RIIO-ED1 NGED have been and continue to be fully committed to the protection of the environment and ensuring that all of our operational activities have minimal impact upon it.

Our certified company-wide ISO14001 Environmental Management System and Competence Management System both continue to ensure that any potential risk to the environment and the communities in which we operate is minimised and that we continually manage and improve our environmental performance.

2022/23 has been another challenging year as we transition to NGED and become part of the wider National Grid Group, However, our responsibility to protect the environment has not wavered and we have continued to work and collaborate successfully with our supply chain, environment regulators, local authorities, local interest groups and other UK Distribution Network Operators (DNOs).

2.2 Protected landscapes

We operate 89,000km 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 Outstanding Natural Beauty ("AONBs") across our geographical footprint where removing our overhead lines and replacing them with underground cables would visually improve matters.

NGED 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.

Table 2.2 Undergrounding in National Parks and AONBs (km)

	Target for RIIO-ED1	Completed (to date)
West Midlands	14	14.1
East Midlands	10	10.0
South Wales	10	4.2
South West	21	11.3
NGED Total	**55**	**39.5**

Improving appearance in National Parks and Areas of Outstanding Natural Beauty (AONBs)

At the close of ED1 we have undergrounded 39.5km (72%) of the 55 km of overhead lines within National Parks and AONB we committed to underground during RIIO-ED1. We have seen progressive progress during the price control, but there have been issues that have delayed some projects.

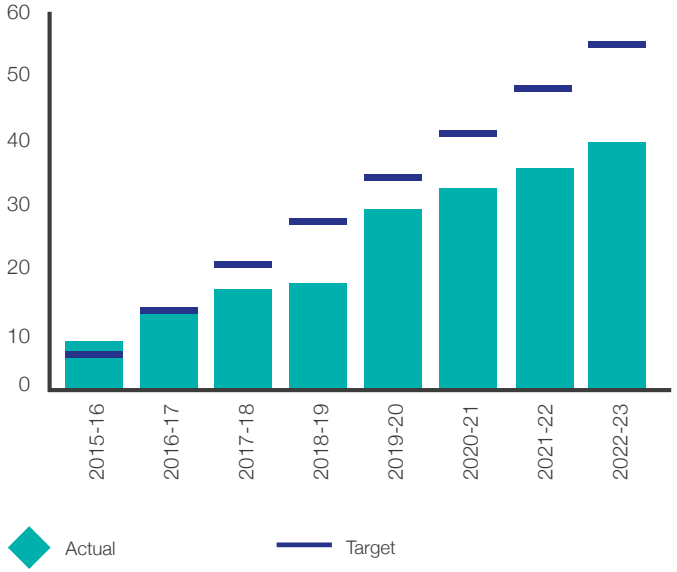
The West and East Midlands Regions achieved their overall RIIO-ED1 targets of 14 and 10 kilometres respectively, but the landscape and terrain in AONBs within the South West and South Wales regions have created additional challenges for our teams throughout ED1.

An example of a project that was subject to delays in 2022/23 was the replacement of overhead lines in the Wye Valley AONB where the scheme was within a used quarry and ran alongside the new Wye Valley Greenway Cycle Path.

Wayleave agreements were required from a landowner, who was very often outside of the UK and therefore contact was limited, prolonging the legal negotiations. This area is also a Site of Specific Scientific Interest and Special Area of Conservation. In order to protect the area, permissions are required from Natural England which require an Environmental Impact Assessment.

This assessment identified protected species in the area and subsequently placed restrictions on when the works can be completed. The job involves the removal of several poles in the quarry which are very difficult to access. Undergrounding this line requires a special diamond cut trench through the quarry and a temporary road constructed on one of the side cliffs in order to access the HV pole where the cable will terminate. All of these issues have meant that the project has been delayed, but this project does illustrate the complexities of some undergrounding projects.

Fig. 2.2 Undergrounding in National Parks and AONBs (km)



2.3 Oil leakage

Older styles of electricity cables contain oil to improve their insulation properties and to enhance cooling. Occasionally, from time to time, these older cables leak when equipment is damaged, seals deteriorate or as a result of changing ground conditions.

When this happens we take steps to ensure that any damage to the environment is minimised through the removal of contaminated ground and that the leak is fixed as quickly as possible. During RIIO-ED1 we have also put in place measures to help reduce the overall number of leaks that we have across our network.

The risks associated with operating fluid filled cables (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. Leaks typically occur as the cable sheath deteriorates with age, at joint failures or as a result of third-party damage.

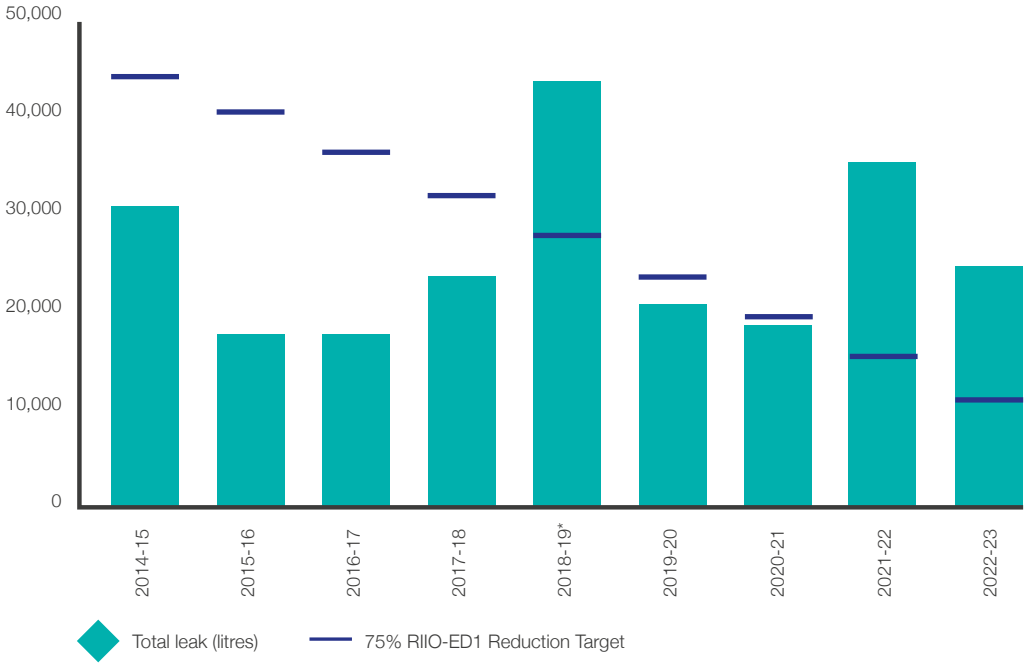
To minimise environmental damage we aim to ensure that:

- 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 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.

All leak rates are recorded and a database of leak and cable information is held centrally. Volumes of FFC losses reported within this document take into account oil subsequently recovered by our Contaminated Land specialists as part of our ongoing incident remediation activities. Monthly reports of fluid filled cable leaks are submitted to both the Environment Agency and Natural Resources Wales.

Fig 2.3 FFC losses – NGED vs ED1 reduction target



It is important to note that whilst we may not have met our RIIO-ED1 target for 2022/23 as shown in Fig.2.3 on a cumulative volume basis across the eight years of RIIO-ED1 we have achieved our RIIO-ED1 output for FFC losses.

Had we have been on target for each year of ED1 we would have lost 250,194 litres of fluid from our FFC network our actual total loss of fluid from FFC over the eight year period was however 230,357 litres. 19, 837 litres less than our stated RIIO-ED1 target.

There were 31 oil mitigation schemes covering cables, operational and non-operational activities reported for 2022/23, of which eight were in South Wales, 10 in West Midlands, eight in East Midlands and five in the South West.

2.3.1 SF_6 mitigation schemes

During RIIO-ED1 we have undertaken 14 SF_6 mitigation schemes, of these seven have been in the South West, one in South Wales, five in West Midlands and one in East Midlands.

We continue to use SF_6 detection cameras to enable us to identify the source of leaks quickly and efficiently.

We replace any 11kV distribution assets that leak. For EHV assets we are taking a more proactive approach. We replace EHV assets where repair is not possible.

Units previously repaired but which leak again are also replaced.

We take a responsible and proactive approach in monitoring our SF_6 emissions.

We report and record leaks in our business KPI information and regularly review SF_6 management performance at company board level.

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 fugitive emissions (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.

Our Business Carbon Footprint takes account of our energy usage from offices, transport emissions (operational and business), fuel combustion and the release of fugitive emissions (SF_6).

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

Table 2.4.1a Annual BCF reporting

NGED carbon footprint report (tCO_2e)

Aspect		Scope	2014/15 total tCO_2e	2015/16 total tCO_2e	2016/17 total tCO_2e	2017/18 total tCO_2e	2018/19 total tCO_2e	2019/20 total tCO_2e	2020/21 total tCO_2e	2021/22 total tCO_2e	2022/23 total tCO_2e
Buildings energy usage	Buildings – electricity	2	12,454.4	10,997.7	10,622.2	7,633.5	6,454.16	5,289.43	5,150.78	4,654.46	4,289.94
	Buildings – other fuels	1	207.6	193.1	192.5	220.2	246.48	211.46	216.45	387.51	386.80
	Substation electricity	2	27,578.7	25,813.8	22,981.6	19,618.6	17,260.18	15,585.19	14,178.38	11,558.98	10,280.28
Operational transport*	Road	1	40,018.8	37,804.8	34,902.6	33,329.5	30,569.11	36,402.08	25,437.75	25,496.63	29,550.51
	Rail	1	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00
	Sea	1	2.4	2.4	0.24	0.24	2.41	0.62	2.41	2.41	2.41
	Air	1	1,428.1	1,831.0	2,163.5	2,113.6	1,643.74	1,100.32	1,027.46	1,590.83	1,153.24
Business transport	Road	3	3,304.0	5,116.2	3,196.5	3,395.3	3,174.81	3,407.71	1,551.88	1,937.66	1,107.35
	Rail	3	21.6	20.6	21.97	21.8	20.66	18.84	0.02	13.14	13.14
	Sea	3	0.0	0.3	0.97	0.1	0.00	0.04	0.00	0.00	0.00
	Air	3	106.4	41.5	92.37	124.1	241.05	179.61	3.98	2.45	34.57
Fugitive emissions	SF_6	1	8,282.1	14,307.5	9,545.7	10,689.5	10,933.90	9,005.41	8,676.59	9208.46	9,064.23
Fuel combustion*	Diesel/Gas oil	1	8,574.1	7,100.9	7,041.6	6,382.3	9,217.60	9,337.14	8,805.23	11,121.10	7,379.66
Total carbon (tCO_2e)			101,978.1	103,229.8	90,761.7	83,528.7	79,764.10	80,537.85	65,050.93	65,973.63	63,262.14
Network losses		1	1,906,640.7	1,687,342.2	1,530,164.6	1,377,491.8	1,004,502.2	973,064.3	931,854.21	788,350.54	676,963.9
Total carbon (tCO_2e) including losses			**2,008,618.8**	**1,790,572.0**	**1,620,926.3**	**1,461,020.5**	**1,084,266.30**	**1,053,602.15**	**996,905.14**	**854,324.17**	**740,226.03**

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

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint (BCF)

During 2022/23 NGED's total BCF (excluding losses and including contractors) across all four licence areas has reduced by 2,711 tCO_2e or 4% compared to our 2021/22 BCF. Compared to 2014/15 our BCF has reduced by 38,715 tCO_2e or 38%.

Since 2014/15 our annual BCF (including losses) has reduced by 63.1% or 1,268,392 tCO_2e – the approximate equivalent carbon footprint of heating 470,002 average UK households.

Fig. 2.4.1a Annual BCF (tCO_2e) excluding network losses

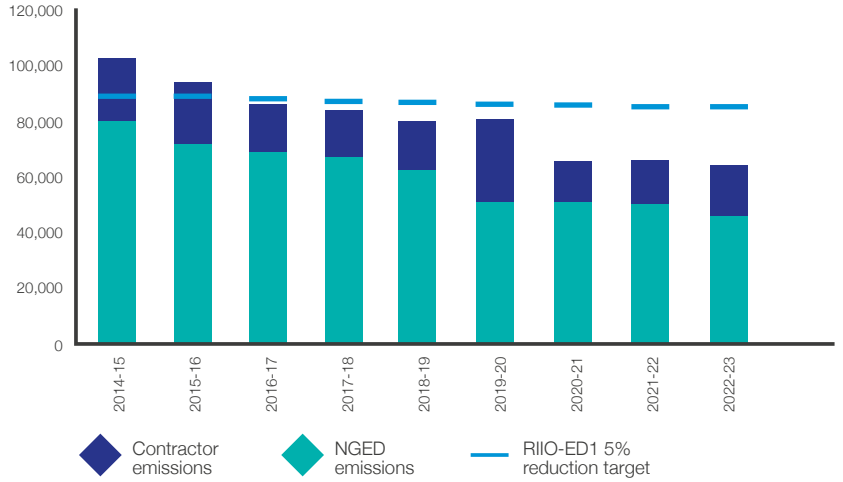
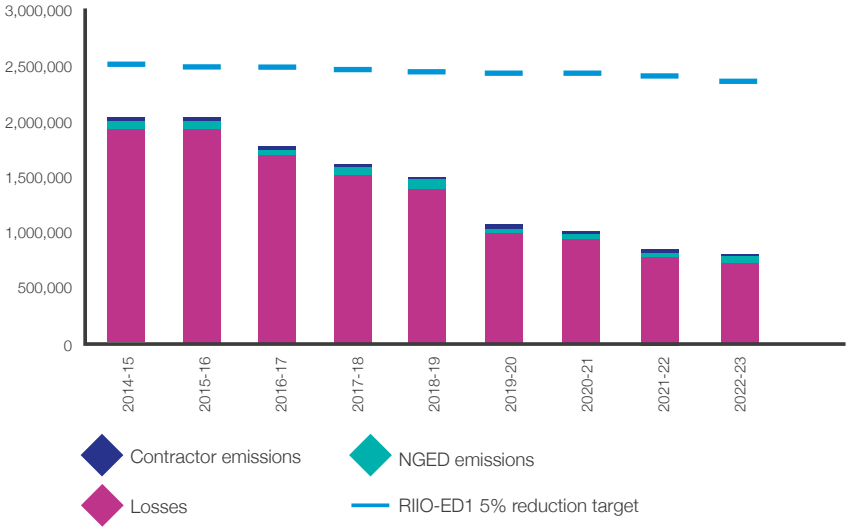


Fig.2.4.1b Annual BCF (tCO_2e) including network losses



63%

Since 2014/15 our Scope 2 carbon emissions (excluding losses) has reduced by 25,463 tCO_2e or 63%.

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

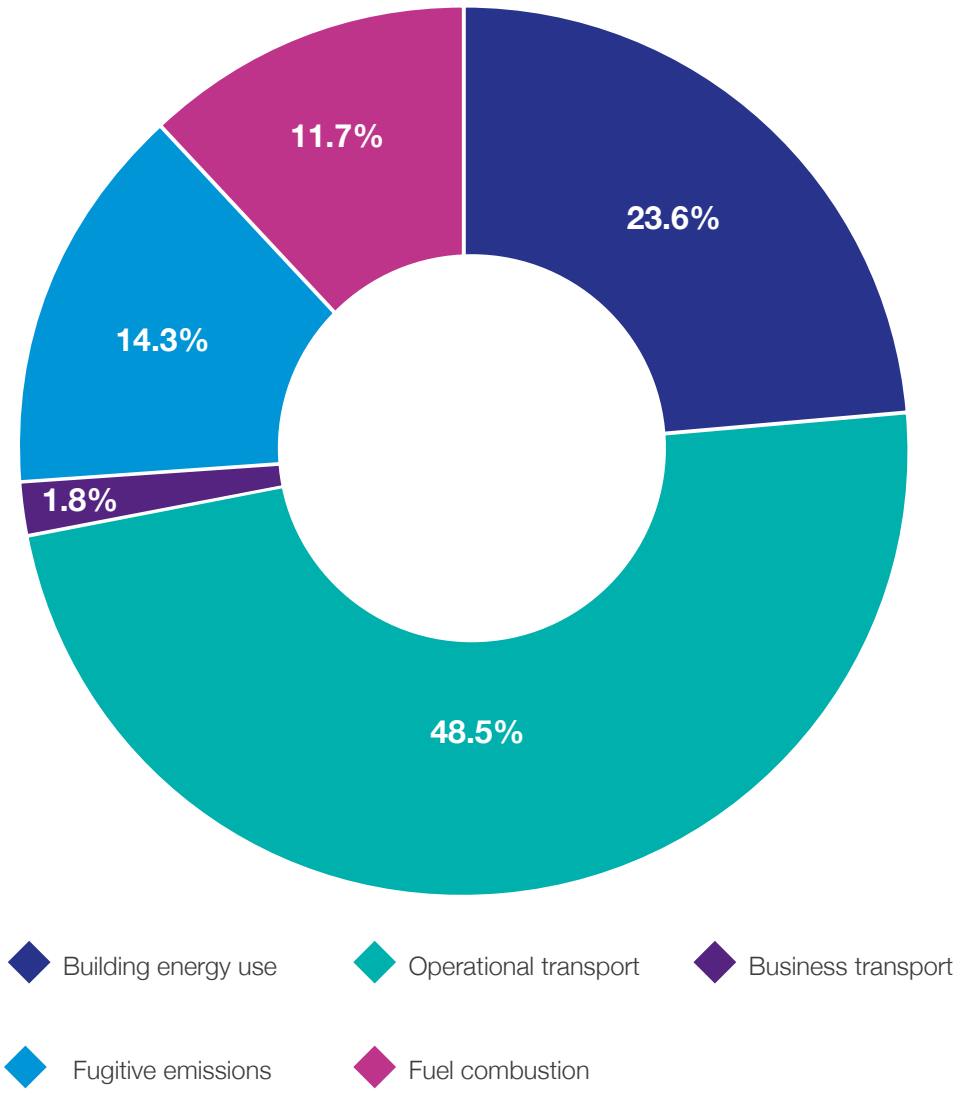
Figure 2.4.1c shows the proportion of activities that make up our BCF. The main contributors to our BCF (excluding losses but including contractor emissions) are Operational Transport (48.5%), Building Energy Use (23.6%) and Fugitive Emissions (SF_6) (14.3%).

Throughout RIIO-ED2 we will continue to focus on reducing the impact which operational transport, building energy use (including energy use at substations) and SF_6 emissions has on our overall business carbon footprint.

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

- Fugitive emissions (SF_6 gas leakage) make up 14.3% of the total BCF for 2022/23. We continue to remain totally committed to investigating and finding alternatives to SF_6 with our manufacturers. We have put to good use the 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 23.6% of 2022/23 BCF. We will continue to install low energy lighting and energy efficient heating/cooling systems throughout our property portfolio as well as undertaking energy efficiency reviews at many of our non-operational and operational sites.
- Operational transport (NGED vehicle fleet and NGED Helicopter) accounts for 48.5% of our overall 2022/23 BCF. To improve emissions associated with our operational transport activities we will continue to replace older vehicles with more fuel efficient alternatives and improve awareness of the impacts of driver style on fuel efficiency and vehicle emissions through theroll-out of our company wide Driver Behavioural System (DBS). Furthermore throughout 2022/23 we have continued to introduce electric vehicles as part of our operational road transport fleet which will have a significant impact on our business carbon footprint for years to come.

Fig. 2.4.1c - Business Carbon Footprint 2023 (excluding losses) – NGED



2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

Reducing emissions from vehicles

Our network is spread over an area of 55,500km² 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 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 line with our core commitments, the ED2 business plan stands to replace internal combustion engines (ICE) with electric vehicles (EV) where suitable alternatives exist. While the market prices for electric vehicles are currently higher than those for diesel models, there are clear environmental benefits, as well as lower fuel and maintenance costs.

To date, 166 small vans have now been replaced with the electric Nissan ENV200. At the end of FY24 C. 207 company cars and C. 256 commercial vans will be EV.

Table 2.4.1b Emissions variations for operational vehicle replacement

Previous old vehicle	CO_2 emissions (grams per km)*	Current new vehicle (2023)	New WLPT CO_2 emissions (grams per km)*
Ford Fiesta Van 1.5 Euro 6	96	Renault Zoe Van EV	0
Ford Fiesta Van 1.5 Euro 6	96	Nissan e-NV200	0
Transit Connect SWB Euro 6	135	Nissan e -NV200	0
Transit Connect LWB Euro 6	138	Nissan e-Townstar - New for April 2023	0
Transit 320 Custom Euro 6	191	Vauxhall e-Vivaro EV	0
Transit 350 MWB FWD Euro 6 CI	179	New Transit 350 MWB FWD Euro 6	234
Transit 350 MWB RWD Euro 6	196	Iveco Daily 35S14V RWD Euro 6	246
Transit 350 MWB RWD Euro 6	196	Transit 350 MWB FWD Euro 6	234
Transit 350 MWB RWD Euro 6	196	Vauxhall e-Vivaro EV	0
Transit 350 MWB AWD Euro 6 CI	226	New Transit 350 MWB AWD Euro 6	273
Isuzu DMAX Pre 21 Modul	183	Isuzu DMAX New 2021> Model Euro 6	219
LANDROVER 110 MEWP	295	Isuzu DMAX MEWP New 2021> Model Euro 6	216
Isuzu DMAX Pre 21 MEWP	183	Isuzu DMAX MEWP New 2021> Model Euro 6	216

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

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).

We have performed well during 2022/23 continued annual reductions in both the litres of fuel used per NGED vehicle and the total volume of fuel used for operational road vehicles across the business, better than our RIIO-ED1 target level.

By continuing with our vehicle replacement programme and raising awareness of the impact of driving style and the continued successful implementation of our Driver Behavioural System (DBS) we have been successful in achieving our RIIO-ED1 5% reduction target for annual fuel use whilst maintiaing a positive impact on our vehicle emissions.

The successful implementation of our Driver Behavioural System (DBS) in to our operational vehicle fleet influences individual driver style and fuel efficiency and delivers a positive impact on our vehicle emissions.

Fig. 2.4.1d Annual fuel use (litres) per vehicle

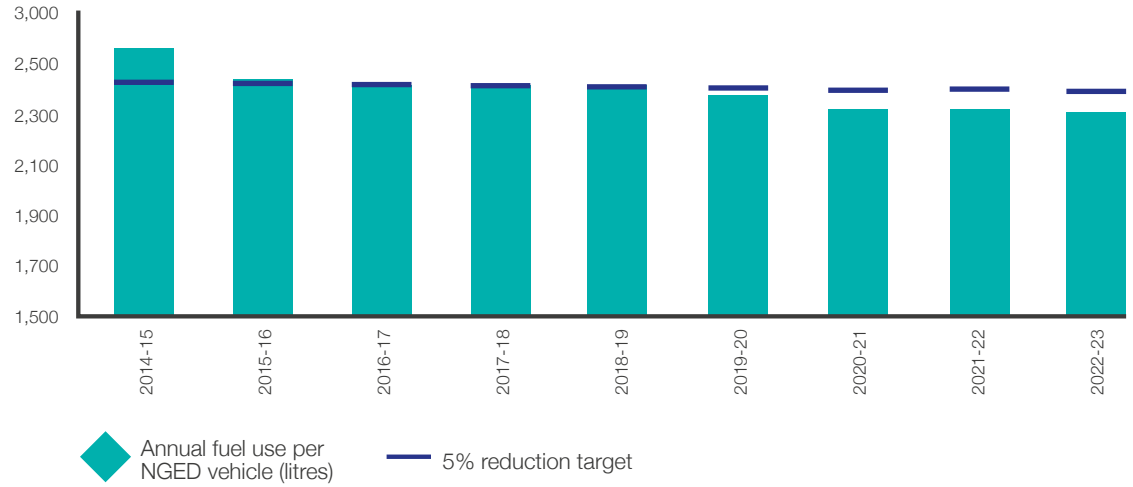


Fig. 2.4.1e Annual NGED fuel use (litres)

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

Building Energy Use

We operate from 60 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.

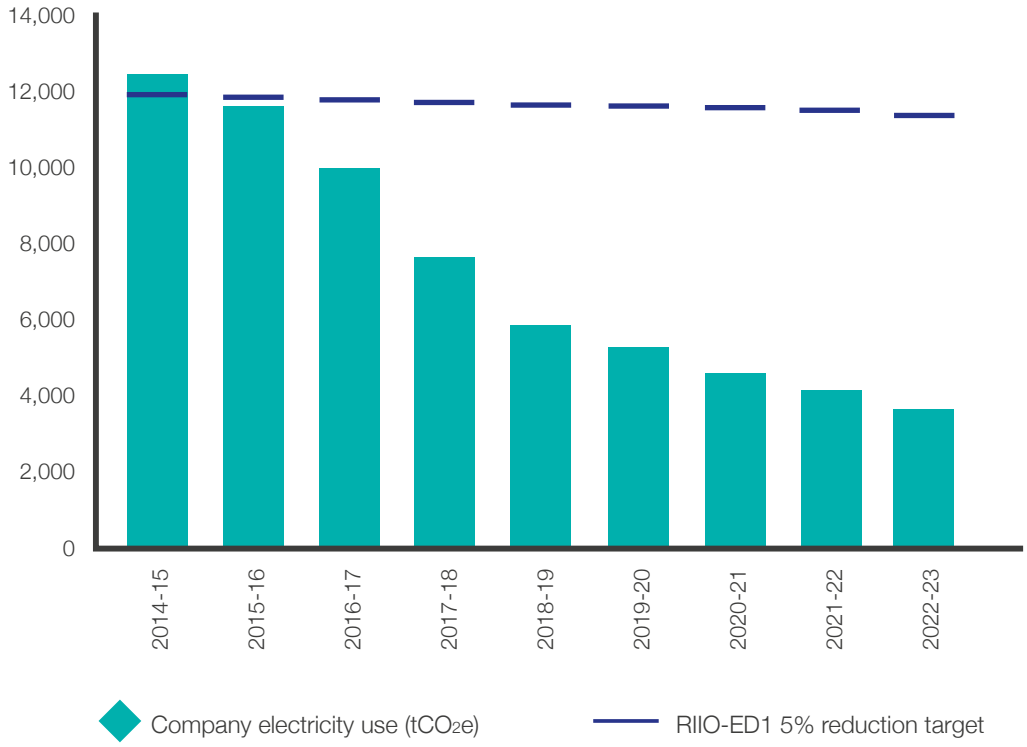
Local improvements include:

- installation of motion sensors for lighting
- improvements to air conditioning units
- low energy lighting
- installation of photovoltaic panels.

Property redevelopments improve employee awareness of energy efficiency measures and lead to energy savings. This is evident in the electricity usage we recorded in our overall BCF reporting. At the beginning of RIIO-ED1 we proposed to save 5% of carbon associated electricity used in offices and depots. As demonstrated we have more than met this target with a reduction in excess of 66% since 2014/15.

Current performance

Fig. 2.4.1f Company building electricity use (tCO_2e) taken from depot SMART meters



2.4 Carbon impact and climate change

2.4.2 Sulphur Hexafluoride (SF_6)

SF_6 is a gas which is used throughout the electricity industry as an insulating medium in switchgear. It provides many tangible benefits, however it is a potent greenhouse gas with a high global warming potential (GWP).

NGED continues to work with manufacturers in the development of SF_6 alternatives to ensure equipment meets operational safety requirements in the UK. Where an existing SF_6 asset replacement is required we replace with a lower SF_6 volume unit, lowering the overall SF_6 bank.

Over the last 12 months we have engaged with all major developers of SF_6 free apparatus (Siemens/Schneider/Hitachi/Lucy).

NGED have offered to sponsor a number of non SF_6 products through the ENA Notice of Conformity process (NoC) which aids those manufacturers selling their devices to any UK DNO and potentially others who also follow the UK ENATs and British Standard technical specifications.

We have also continued with our installation of non SF_6 145kV Live Tank Circuit Breakers and now have four active units with a fifth ready for installation at Feeder Road BSP in Bristol. We have orders either placed or planned for at least 30 units over the coming months as we move away from our internal trial to normal use.

Fig. 2.4.2a shows that our annual SF_6 leak rate (like-for-like top ups only) is still very small at 0.14% and in relation to our baseline year we have met our RIIO-ED1 ouput.

Fig. 2.4.2b details the weight (kg) of SF_6 emitted annually.

Fig 2.4.2a Annual SF_6 leakage rate (top-ups only)

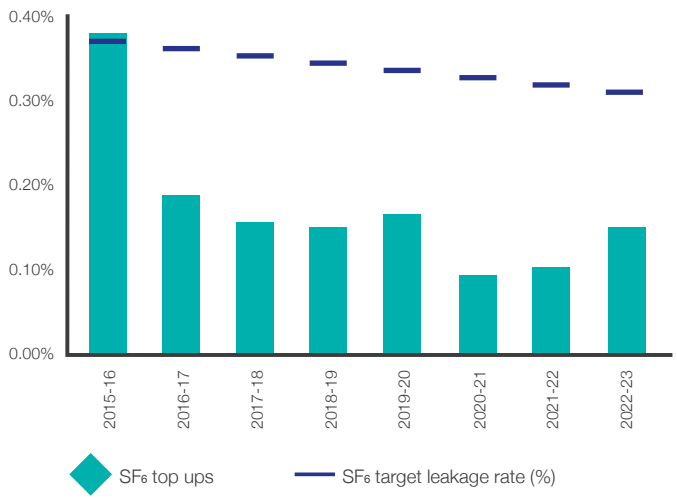
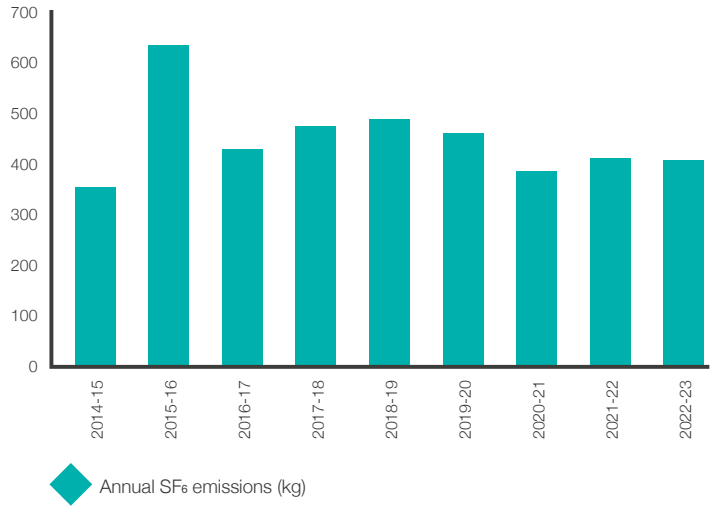


Fig. 2.4.2b Annual SF_6 losses (kg)



Our 2022/23 SF_6 leakage rates is

0.14%

we have consistently throughout RIIO-ED1 achieved our Business Plan SF_6 leak rate target.

Emission data is collated from the following data sources:

- SF_6 top-up figures as reported on our company asset database
- decommissioned units returned to our company plant centres
- units returned to manufacturers for further investigation.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

The NGED Losses Strategy is reviewed on an annual basis and stakeholder events occur on a regular basis. The Covid 19 pandemic caused some disruption to this but we will be collecting stakeholder feedback for losses in 2023, once the new ICL report has been released.

This 2023 version of the Losses Strategy provides updates on any work carried out since the last 2022 Losses Strategy document review and how NGED have progressed on each of the Sohn Associates-ICL report's recommendations.

The NGED Losses Strategy is developed within the Connection Strategy Team and is approved by the President. Each year, it is the Connections Strategy Manager who is responsible for which topics to address from the Sohn Associates-ICL Management of Electricity Distribution Network Losses report.

The chosen topics are then investigated further and addressed appropriately. As this Losses Strategy document is published on the cusp of RIIO-ED1 period finishing and RIIO ED2 starting NGED has therefore addressed each of the recommendations, Appendix 1 shows outcomes for each recommendation and a justification for the NGED assessment of each plan.

It also lays the foundations for what will be undertaken during the RIIO-ED2 period.

Objectives

NGEDs objectives regarding losses management by the end of the RIIO-ED1 period in 2023 are as follows:

- Losses across the NGED network will have been reduced to a level that is as low as economically and practically viable;
- All future investment decisions will take losses into account to ensure that the best balance is achieved between network investment costs today and energy supply costs for future customers;
- Providing the SMETS 2 smart meter data is available, NGED will have the tools and methods in place to accurately locate the points on the network with particularly high losses;
- All NGED stakeholders will be aware of the importance of losses; and
- Using the knowledge gained from innovation projects, computer modelling and investment appraisals NGED will, through business-as-usual (BAU), have produced new and effective means to reduce losses.

Outputs

During RIIO-ED1, NGED have undertaken the:

- Purchase and installation of 90 single-phase, 25kVA 11kV amorphous pole-mounted transformers (PMTs);
- Oversizing of 448 ground-mounted transformers and 575 pole-mounted transformers per annum;
- Intervention of losses design on new installations of 8,184 distribution transformers and 11,880 kilometres of underground cables;
- Discontinuation of cable tapering on all new 11kV and LV mains cable circuits;
- Standardisation of new 11kV and LV mains cables to minimum conductor sizes of 185mm^2 and 300mm^2, and LV service cables to 25mm^2 Copper (Cu) or 35mm^2 Aluminium (Al);
- Identification of units lost to supplier side abstraction, unmetered supplies and theft in conveyance;
- Commencement of a stakeholder engagement programme where losses are a designated topic;
- Review of NGED policies to ensure losses are a priority consideration for investment decisions;
- Reduction of voltages across all four license areas of NGED; and
- Introduction of three phase service cables and three phase cut-outs, where reasonably practicable, for all new builds and service alterations as BAU.

RIIO-ED2 Proposals

Under our original proposal for RIIO-ED2, NGED proposed the below items as part of our ongoing ambition to minimise losses where reasonably practicable. Although Ofgem's final determinations did not meet our funding requirements, we are still committed to managing losses as successfully as possible.

In RIIO-ED2, we will deliver further reductions by:

- Revisiting the Sohn Associates-ICL report and having Imperial review the previous cost benefit analysis with updated electricity prices and figures to ensure that the network is being optimised to its full economic potential. The report will also give new recommendations as to the actions that NGED should prioritise for RIIO-ED2.
- Continuing to invest in the most efficient and low loss transformers in line with the EU Eco Design Regulations. Losses from these are 40% lower than with traditional transformers.
- Installing cables with larger cross sectional areas (CSAs), as standard - we will use 300mm^2 low voltage cable, replacing the use of 185mm^2 (larger CSAs allow easier power flow, thereby reducing losses).
- Discontinuing the use of smaller transformer sizes on our overhead line networks and removing 25kVA single phase and 50kVA three-phase units from our traditional range. Using larger transformers results in reduced losses as a result of lower energy loss in the transformer core.
- Continuing to work in collaboration with electricity suppliers and other authorities to further reduce electricity theft and illegal abstraction.
- Replacing the 1,095 PMTs installed pre-1958 for new, 'next-size up' (e.g. 50kVA to 100kVA) transformers to increase network capacity and reduce technical losses.
- Ensuring that we consider the context of the wider energy market including changing costs of energy and the income that we receive in order to create up to date CBAs.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Asset replacement

NGED's work to update assets has continued through to the end of RIIO-ED1.

Losses pages on NGED website

NGED has developed and published a set of pages related to losses on the NGED website. They explain losses in more detail and lead into actions that are being taken to reduce losses as a result.

Revenue Protection - Unmetered Supplies

NGED has established good working relationships with unmetered customers, in particular street lighting authorities, whose unmetered connections form approximately 90% of the total unmetered load.

This involves regular group and individual meetings, which include discussions about inventory accuracy. Working closely with customers, together with the checks and balances we have in place, has provided us with a reasonable degree of confidence that unmetered system losses are minimised.

The unmetered connection agreements for larger customers, requires them to provide accurate monthly detailed inventories of all their unmetered connections. Checks are made when new inventories are loaded by NGED, to ensure there are valid reasons for records which have been removed.

NGED introduced a revised new connections process in 2016. This enables more accurate detail of the unmetered equipment to be captured, resulting in the correct calculation of annual consumptions for smaller Non Half Hourly traded MPANs.

For HH traded customer MPANs, the information enables checks to be made against the larger inventories provided.

The process also prevents connection dates being agreed without a valid UMS registered MPAN being recorded, therefore, minimising the risk of load being connected and not accounted for.

The current estimated loss from unregistered MPANs is 20,000 kWh, which is mainly made up of MPANs created prior to the revised process being implemented.

In addition, NGED will carry out physical street lighting site audits using independent contractors when our own internal inventory checks show further investigation is required. NGED has not found any such cases in recent months.

NGED Arrangements for LV street furniture connections for Electric vehicle charge points only is covered by our Standard Technique ST: SD5G clause 10, which states: The exit point demand shall be ≤ 7.36kW; and An Elexon approved active measuring device shall be used.

Distributed Generation and DSO

Traditional power stations are large and normally centralised; therefore it was justifiable to connect them directly to the National Grid transmission system.

In contrast to this, renewable energy sources and storage tend to be smaller and more distributed around the country; meaning they are usually connected to local distribution networks.

This disrupts the traditional flow of power from generators to transmission networks, to distribution networks, to the customer. If the energy from distributed generation is used locally (and within a suitably short period of time) then this reduces losses.

As NGED moves towards a DSO way of working there will be a need to manage energy flows across the network to increase utilisation and balance demand and generation. This has the potential to increase losses if power flows increase or demand and generation cannot be balanced. Alternatively it could reduce losses if the network was perfectly balanced.

This balance must be achieved against an economic and efficient measure so the cost of losses should be considered.

Work completed for the ENA Technical Losses Working Group by the Engineering Consultants WSP has shown that load could increase by as much as 40% due to the de-carbonisation of heating and transport, thus losses would increase as a result of DSO flexibility, smart solutions allow greater utilisation of network assets and losses increase as a consequence.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Revenue Protection - Theft in Conveyance

NGED retain an obligation to respond to reports from Crimestoppers whom are appointed as the Energy Theft Tip Off Service (ETTOS) and forward details of suspected theft to the appropriate Supplier or Network Operator.

NGED receive and process these notifications from ETTOS; these are referred to the Supplier to action, with a small number of cases with no registered Supplier requiring a local NGED Network Services team to investigate.

NGED Revenue Protection will be handing over 70 active investigations to Network Services.

We still have a registered scheme, under Schedule 6 of the Utilities Act 2000, which allows action to take place to recover the monetary value of units abstracted while in conveyance.

NGED publishes the unit price in the statement of charges; and in addition have taken cases to court where appropriate – although this did not happen in 2020/21.

Network Services do have processes and reporting procedures to check unregistered MPANs but the back office activity to cross-reference MPAN and UPRN data references was carried out by the RP section, but this activity is not being taken forward since the Eon did not renew the contract.

NGED's Distribution Business has a licence obligation to carry out a 'make safe' service at the request of an appropriate authority.

This obligation falls under Condition 27 of the Standard Conditions of the Electricity Distribution License (22nd April 2014) to inform the Authorised Supplier as soon as reasonably practical, when there is reason to believe that there has been either:

(a) Interference with the Metering Equipment through which such premises are supplied so as to alter its register or prevent it from duly registering the quantity of electricity supplied. Or

(b) Damage to conductors and/or any other equipment associated with the electricity service, resulting from abstraction or attempts to abstract electricity from NGED's network.

Regulation 26, Paragraph (3) of the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 states that a supply can be disconnected on the grounds of safety with immediate effect. Interference with distributer equipment or conductors by unauthorised 3rd parties can be dangerous and lead to disconnection on the grounds of safety.

There is a further obligation to report to the Relevant Owner (the occupier) if interference or damage, as described in the paragraph above, is discovered affecting privately owned equipment.

NGED must inform the Relevant Owner as soon as is reasonably practicable, except if there is reason to believe that the damage or interference was caused by the Relevant Owner. NGED is also required by the Regulator (Ofgem) to take "cost effective" actions to:

(a) Resolve cases of theft at unregistered sites.

(b) Pursue Customers for the value of units stolen where there is theft in conveyance and we have the right to pursue the Customer.

Suppliers are responsible for the investigation of theft of electricity used at customer premises.

The Suppliers discharge their responsibility either by using their direct staff or by use of an approved Revenue Protection Service provider.

Suppliers or Revenue Protection Service providers follow up on reports of meter tampering, including case investigation and the management of warrants to obtain access.

NGED are not a Revenue Protection Service provider and all service disconnections after NGED's equipment should be made by the supplier or their appointed Revenue Protection Service provider.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Industry-wide Engagement and Best Practice

National Grid

At NGED, we believe that in order to reach the shared vision of net zero, we must work collaboratively and share our work in open and transparent ways. The need for this extends across the energy sector, however, here we refer specifically to those who manage the electricity networks.

WPD had been working closely with National Grid for some time before being integrated into their business. One example was a project to adapt National Grid's standard terms and conditions to allow demand-side response (DSR) customers to operate in both the transmission and distribution flexibility markets.

This was lauded as a 'world first' Local Energy Market (LEM) with National Grid ESO and NGED able to procure flexibility through the same platform. A DSR forum was subsequently set up to discuss the platform in more detail and to widen the engagement to Ofgem and other DNOs.

Now that WPD has been incorporated into the National Grid umbrella, we expect that knowledge sharing and collaboration will continue to increase. There is the potential for this to include the sharing of international best practice as we become more connected to the American faction of the business through our parent company.

NGED has already begun to see movement amongst its staff as vacancies become internal across National Grid. This movement of people will facilitate a transferal of knowledge as well as develop a network of professional relationships across distribution and transmission.

DNOs

NGED hopes that this integration can benefit DNOs across the country as NGED has a history of working with other DNOs in joint projects and data sharing. The origins of this can be traced back to various project collaborations with UKPN as well as other DNOs supported by the Innovation Funding Incentive (IFI).

Project findings from this collaboration have been shared with many other network operators and we see that this work has helped other DNOs develop their losses strategies, as well as our own.

For example, in their strategy SSEN joined NGED in recommending the removal of pre-1960 transformers from the network and cited some of NGEDs IFI projects as the source. Equally, it is also vital that we share research which doesn't change anything or which means that the best decision is to maintain the present business as usual.

For example, NGED's research into the optimum length of LV feeders didn't produce any evidence to change existing practices and proposals. However, that is still a valuable piece of information to share.

A well rounded and successful innovation programme will have projects that don't result in change, but these innovation projects show that the industry is trying new ideas and ways of thinking.

In RIIO-ED2, we know that all DNOs will need to invest heavily in their networks to allow for greater amounts of heat pumps, electric vehicles and decentralised generation. However, Ofgem's final determinations mean that the money requested will not be granted. This means that effective compilation and sharing of data and information is more important than ever so that DNOs can maximise the resources that we have to the greater benefit.

This is beneficial to all DNOs and NGED is keen to learn from the experiences of others and utilise this information to make well-informed and strategic decisions for the future.

Previous NGED Losses Strategies have included topics highlighted in other DNO strategies; this makes sense because as DNOs we face similar issues and are moving towards a common goal. This year, NGED has noted a new type of loss, contact voltage losses, which was recognised in research by UKPN.

As we move into 2023 and RIIO-ED2, NGED is preparing to update the Sohn Associates-ICL report which has informed the Losses Strategies for the last ten years.

The original report which was completed in 2014 was presented as a paper in the Helsinki conference in June 2016 to great success. We hope that having Imperial provide an update will help inform NGED and other DNO strategies over the upcoming business period

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Plans for 2023 and beyond

Actions Proposed for RIIO-ED2 (2023-2028)

During RIIO-ED2, on the LV mains UGC network, NGED will install 300mm² Wavecon LV Mains cable using the next size up for all LV Mains cable designs in the RIIO-ED2 period.

This will cost NGED around £2.89 million per year at current costs. This means NGED will discontinue the installation of 185mm² LV mains cables except for service cables and fault repairs.

During RIIO-ED1, NGED discontinued the use of 15kVA single phase and 25kVA three phase transformers, using larger sized assets as the minimum size available. This provided both a losses and capacity benefit.

In RIIO-ED2, NGED will extend this approach and discontinue using 25kVA single phase and 50kVA three phase units. This will mean the smallest units used are 50kVA single phase and 100kVA three phase (which will be of a lower loss amorphous core design).

Taking the combined steps of uprating the minimum sizes and using amorphous cores for the smallest remaining sizes in our range will lead to around 160 units per annum being installed with a higher rating and lower losses. To improve our network visibility, we will be looking to install 15,500 monitors at the highest priority, low voltage substations.

At high voltage, NGED will ensure that it has 100% visibility of the power flows on its network at all 1,800 of its primary substations. We will also enhance and refine our network planning models through the utilisation of smart meter data. Our Distribution Network Options Assessment provides a systematic methodology to recommend a single investment option when looking at flexibility vs reinforcement.

The various options are compared using the common Evaluation Methodology, produced by the ENA, which considers multiple factors including losses. In RIIO-ED2, we will look to incorporate losses into these decisions.

The Losses Estimation Tool will also be used to estimate the additional losses due to flexibility.

We have also signed up to a Science Based Target (SBT) for our environmental actions.

Network losses must be accounted for in this, as they contribute to carbon emissions.

Therefore, any reduction in losses will support our SBT. Throughout RIIO-ED2, we will continue to work in collaboration with electricity suppliers and other authorities to further reduce electricity theft and illegal abstraction. Additionally, efficiency will remain a key consideration in our procurement activities for transformers

Current Assessment of Distribution Losses

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Total annual losses (GWh)	4,125	3,651	3,713	3,918	3,548	3,807	3,997	3,713	3,500
Carbon equivalent (tCO_2e)	1,906,640	1,687,342	1,530,164	1,377,491	1,004,502	973,064	931,854	865,615	676,963.9

2.5 Other environment related activities

2.5.1 ISO14001 Certification

Since 2011 we have been certified to ISO14001, the international standard for environmental management systems (EMS), across all four of our licence areas.

During this time we have found having the certification beneficial in a number of ways:

- validates how we manage our operational activities via our own EMS to ensure minimal impact on the environment
- provides confidence to interested parties and industry regulators
- ensures that we meet all of our compliance obligations
- provides a consistent and recognisable approach to how we manage environmental issues across our entire business
- demonstrates our value of good environmental stewardship
- encourages our business to improve our environmental performance and to look to future developments in environmental management and sustainability.

During 2022/23 we successfully maintained our business wide certification to the ISO14001 environment management system standard. Our external auditor, NQA, found no major nor minor non-conformances throughout their extensive visit.

The only findings identified were Opportunities for Improvement (OFI) which have subsequently all been assessed and acted upon if appropriate. During 2022/23 we successfully implemented a companywide Competent Management System (CMS), certified externally by NQA to the EU Skills Council standard.

The CMS is an agile and flexible system allowing competency to be demonstrated at all levels of our business on all of our permitted depot sites. The CMS replaces the WAMITAB competence qualification which in 2021 was deemed not fit for NGED business purposes.

Our new certified companywide CMS has been implemented at all NGED depot sites, ensuring competency is maintained and developed throughout the business.

Five key approaches on the new ISO14001:2015

Greater protection for environment
Proactive initiatives, objective measurements and improving environmental performances.

Effective communication and awareness
Driven through a communication strategy and its effectiveness.

Focus on strategic fit and risk management
An increased alignment with unique context, strategic direction and risk orientation.

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

Emphasis on leadership
Greater commitment from the top management.

2.5 Other environment related activities

2.5.2 Waste management

Throughout RIIO-ED1 we have worked closely with all of our waste contractors to ensure that wherever possible waste streams have been diverted from landfill, and that the principles of the waste hierarchy have been applied throughout the business.

For the second year since the end of the Covid-19 pandemic the total tonnage of waste produced by NGED has increased by 3.5% compared to the 2021/22. As shown in **Fig. 2.5.2b** for the fifth year we have outperformed our RIIO-ED1 target for the proportion of our waste being sent to landfill.

Redundant cabling and metal work, a significant waste stream within NGED, 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.

Our largest waste stream, by weight, wooden poles are replaced throughout our network and are collected from many of our non-operational depots. We continue to dispose of the poles via a waste to energy plant in the north of England, avoiding expensive and prohibitive landfill costs whilst ensuring that we comply with the waste hierarchy.

Throughout RIIO-ED2 we will continue to target zero waste to landfill across all four of our licence areas, furthermore we have a business commitment to reduce the tonnage of waste entering our business per £1M of spend. We will also aim to improve our recycling rates and reduce our reliance on recovery routes (energy from waste) for all of our waste.

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

- Dry mixed recyclables*
- General waste
- Hazardous waste**
- Redundant wood poles
- Metal
- Wood
- Cable
- Organics

*Cardboard/paper/plastics
**Batteries/contaminated rags/used electrical insulating oil/aerosols/fluorescent tubes

2.5 Other environment related activities

2.5.2 Waste management

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.

We met the initial 20% reduction target from 2015/16 to 2017/18 and we have continued to outperform the 5% reduction target year on year. In 2022/23, we disposed just 6.6% of our waste to landfill.

The overall tonnage of waste produced by NGED in 2022/23 has increased slightly by 176 tonnes tonnes from our 2021/22 total of 5,030 to 5,206 - see **Fig. 2.5.2a**. Given that as a business we are now back to operating at pre-pandemic levels it is encouraging that the increase in the tonnage of waste is so small and it has not reverted back to levels reported in 2018/19.

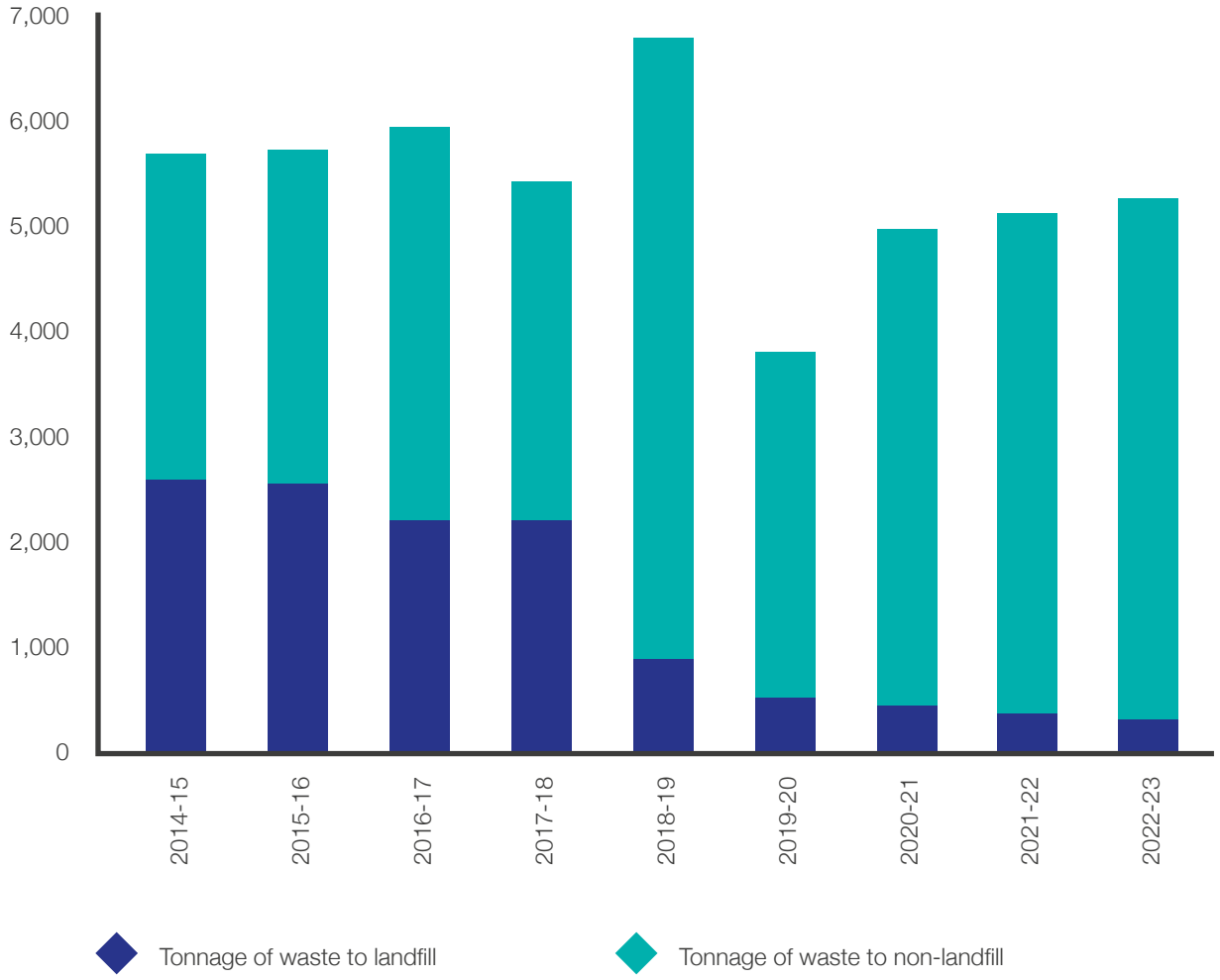
The percentage of waste sent to landfill has decreased in 2022/23 from 7.2% in 2021/22 to 6.6%. The decrease in our reliance on disposing waste to landfill is a result of working extensively with our existing waste contractors to find alternatives to landfilling waste, utilising local waste to energy plants wherever they are available and improving waste awareness at our local depots.

Throughout 2022/23, our distribution licence areas in South Wales, East Midlands and also West Midlands have routinely achieved zero waste to landfill.

Our commitment for RIIO-ED2 is firstly to reduce the amount of waste produced by our business. We will do this by working with our Procurement Team and our suppliers/manufacturers to reduce the amount of waste entering our business.

Secondly, we are committed to reducing the amount of waste we dispose to landfill in our South West distribution licence area and finally we are committed to continue to improve our recycling percentages across the entire business and to reduce our reliance on energy to waste disposal.

Fig. 2.5.2a Total tonnage of waste – non-landfill vs. landfill



2.5 Other environment related activities

2.5.2 Waste management

Fig. 2.5.2b Percentage of waste disposed to non-landfill vs. landfill against RIIO-ED1 landfill reduction target

We have outperformed our RIIO-ED1 percentage waste to landfill target for the fifth consecutive year

2.5 Other environment related activities

2.5.2 Waste management

Although the overall tonnage of waste produced has increased in 2022/23, we have made excellent progress throughout RIIO-ED1 in reducing the amount of waste we dispose of to landfill.

Waste initiatives

In order to achieve our RIIO-ED2 Core commitment on waste we must clearly target the tonnage of waste we receive and produce across our business – employing the principles of the waste hierarchy and reducing the actual tonnage of waste in the first instance before focusing on the amount of waste being reused, recycled or recovered.

We will specifically:

- liaise with our manufacturers and suppliers to identify opportunities to reduce the amount of packaging and embedded waste entering our business
- work with our Purchasing Team to ensure that waste reduction initiatives are a key requirement of future contracts where applicable
- continue to work with our waste contractors and local depots to identify alternative disposal routes for our waste, increasing the amount of waste we recycle and reducing further our reliance on both landfill and recovery disposal.

Single use plastics

We and our stakeholders are keen to reduce the amount of single use plastics entering our business.

Reducing this waste stream supports not only our commitment of reducing waste overall but also our ambition to use resources more efficiently and sustainably and offers an excellent area for collaboration with our suppliers to reduce the environmental burden.

While good progress has been made with smaller items like vending machine cups during RIIO-ED2 further evaluation of our incoming goods is expected to yield more opportunities and examples where items may be substituted.

We have begun consultation with our staff to identify where single use plastics are currently used in our depots and in products used on the network.

This is providing a platform from which we can work with our manufacturers and suppliers to obtain more goods made from recycled plastics, eliminate plastic packaging and plastics which cannot be recycled in favour of more suitable materials.

2.5 Other environment related activities

2.5.3 Polychlorinated Biphenyls (PCBs)

Polychlorinated Biphenyls (PCBs) are a family of Persistent Organic Pollutants (POPs) used from the 1920s until the 1980s in industrial and commercial applications including in electrical equipment such as capacitors and transformers.

They are chemicals of global concern due to their potential for long-range transport, persistence in the environment, ability to bio-magnify and bio-accumulate in ecosystems often ending up in our oceans. As such they have a significant and detrimental impact on aquatic life and the environment.

While PCBs were never specified for use in any of our licenced areas, their use in other electrical applications led to a very small percentage of the equipment in use on our network being unintentionally contaminated during manufacture.

As this contamination was both unintended and not requested we have very few records of the assets affected.

Before a full global ban on PCB use in new equipment was implemented in 1987 any item manufactured in a facility where PCBs were in use was at risk of contamination, so must be assumed to contain PCBs and therefore be registered with the Environment Agency and Natural Resources Wales.

In 2000, a complete ban on the use of PCBs in concentrations of 500ppm (0.05%) or above was imposed, but an exemption was made for electricity network transformers with contamination below 500ppm (0.05%) which could be left in service until the end of their useful life. This exemption ended in July 2019 when new regulations required the removal of all equipment potentially contaminated at 50ppm (0.005%) or above by 31 December 2025.

For these reasons and concerns raised by our stakeholders regarding a desire to see a reduction in leaks from our equipment we have developed strong partnerships with regulators and other network operators to create a comprehensive strategy to ensure that all PCB contaminated equipment will be removed from our network by 2025.

Our strategy for a PCB free network by 2025

Surveys of PCB contamination conducted both in our business and the wider electricity industry show that most of the contaminated oil has already been removed and disposed of by approved methods at sites authorised by the Environment Agency.

We are working in close partnership with all UK DNOs, the Environment Agency/ Natural Resources Wales and in consultation with other devolved Agencies to identify and remove remaining PCB contaminated equipment by 31 December 2025 in line with UK Regulation. This partnership is underpinned by a Regulatory Position Statement supported by both environmental regulators and DNOs.

The strategy for identification and removal includes:

- an accelerated program of testing all ground mounted equipment prior to the end of 2025
- innovation projects led by us to research and develop in situ PCB testing for energised overhead line equipment
- a UK wide program of statistical analysis pioneered by us and other UK DNOs along with the Environment Agency and Natural Resources Wales to identify, target and remove assets from the UK PCB register
- targeted replacement of assets that are both potentially PCB contaminated and also do not comply with current high efficiency standards, thereby eradicating PCB risk and reducing Network Losses.

Persistent Organic Pollutant Reporting 2022/23

562 persistent organic pollutant remedial asset changes. The wholesale replacement of assets that contain, or (where it is not possible to test) are suspected of containing, unacceptable levels of persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs).

113 persistent organic pollutant remedial oil changes. The removal of oil from assets that contain unacceptable levels of persistent organic pollutants (POPs) such PCBs.

4,987 persistent organic pollutant oil tests. The testing of oil specifically carried out to determine levels of persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs).

2.5 Other environment related activities

2.5.4 Environmental employee awareness

Ensuring and maintaining that all of our employees are aware of their environmental responsibilities and the impact that their activities could potentially have on the environment is a key requirement of our environmental management system.

Throughout RIIO-ED1 we have delivered environmental awareness training throughout the organisation, many courses tailored to specific operational needs. We have also spent more time in the business engaging directly with staff and colleagues at local offices and depots. Furthermore we have utilised other platforms to engage employees in environmental management including recording a selection of podcasts and informational videos on topics such as net zero, biodiversity and waste.

Safety, Health and Environment (SHE) Conferences
2022/23 NGED SHE Conferences have been held in person at locations across each of our four licence areas, attendance at each event being approximately 150 people.

Each Conference has been well supported by NGED senior management with both NGED employees and many of our contractors attending. Environmental sustainability is an established agenda item at every NGED SHE Conference and during 2022/23 there have been presentations delivered and roundtable discussions on a wide range of topics including:

- achieving net zero
- electric vehicles
- resource management and circular economy
- biodiversity net gain.

Employee awareness sessions

Throughout 2022/23 we have continued to deliver, both in person and virtually, environmental awareness sessions at our depots across all four NGED licence areas. While some aspects of the sessions are tailored to meet the specific needs of each depot, the following environmental issues continue to be briefed as standard:

- Environment Strategy
- RIIO-ED2 Environmental Action Plan
- ISO14001 and Competence Management System (CMS)
- Pollution prevention
- Ecology
- Waste management
- NGED environmental aspects
- Employee responsibility.

2.5 Other environment related activities

2.5.5 Community environmental support and awareness

At National Grid Electricity Distribution we take our duty to be a socially responsible business seriously by taking active steps; proactively supporting local charity and community projects that are aligned with our company objectives.

This includes a commitment to supporting the protection of our environment and wildlife, supporting the government's net zero carbon emissions aim, while also encouraging biodiversity. We seek to raise awareness of these vital activities through our internal and external communications.

As part of our ongoing commitment to the environment, we are committed to planting native trees and shrubs in our operating regions each year.

This is achieved through partnerships with The Conservation Volunteers and Groundwork Wales.

Welsh Valleys orchards

We have worked with Groundworks Wales to identify and fund the creating of new fruit orchards, starting with the planting of 60 fruit trees in the Welsh Valleys.

These orchards will contribute to long-term sustainability of food production, increasing carbon sequestration and improving local biodiversity.

Local volunteers will help maintain the orchards and organise events that will allow community members to harvest and press to make apple juice, cook dishes over campfires and share the local history of the area through the orchard.

Fruit collected will also be utilised in educational activities, like creating bird feeders. The trees will not only provide beauty to the area, they will provide a refuge for relaxation, a place for work and education and also increase air quality and provide pollinator habitats.

The orchard is located in Cefn Fforest Eco Park, which sits on the site of the Pengam Colliery, is a six-acre nature reserve near Blackwood in Caerphilly.

The Orchard was created during March 2023, with 24 mature fruit trees planted by pupils from Cefn Fforest Primary School, staff from National Grid, volunteers from the friends of group and facilitated by Groundwork Wales. A mixture of apple, pear and cherry were planted, and will hopefully bear fruit this year.

The orchard was carefully planned to allow community members easy access to the trees, for both maintenance, grass cutting and access to harvest fruit.

School Orchard Planting

In addition to the Community Orchard, four school orchards were planted around South Wales planting a further 36 Welsh heritage variety fruit trees.

The mini orchards of nine fruit trees will have a big impact visually but will also contribute to reducing food poverty, and help pollinators.

The four schools chosen are part of the Big Bocs Bwyd Scheme. The aim of the scheme is to ensure that no child is hungry and that every child is able to learn how to make good food choices that enable them to thrive.

Children and families are provided with food at 'pay as you feel' prices and supported with authentic learning experiences through growing and cooking food.

The school plan to use the fruit as snacks for the children and to sell in the Big Bocs Bwyd.

These schools will showcase the social and environmental impacts of community orchards to the public.

The Fruit trees were grown in Bangor, North Wales. These rare Welsh species have been reintroduced throughout Wales. Having been grown in the same climate means they'll thrive in Wales and be resilient to local disease.

The benefit of planting trees that are two - four years old instead of whips, means that a large proportion of the trees will be fruiting within the next two years, some this autumn. Being at this stage in development also means the trees require far less protection from grazing animals such as rabbits and sheep.

2.5 Other environment related activities

2.5.5 Community environmental support and awareness

Environmental impacts:
Throughout March nearly 1500m² of land was 'improved' by planting orchards. In addition to improving land, other environmental benefits of planting the orchards include:

- Increase in local biodiversity and air quality.
- Providing pollinator habitats.
- Once fully grown each tree can store 21kg of carbon per year. These three orchards will stop 1260kg of CO_2 from entering the atmosphere each year.
- Providing food for humans in later years of growth and food for wildlife in the early years – an apple tree can yield 320kg of apples in a year.
- Reducing surface water runoff, therefore reducing flooding.
- Increase in shade.

Social impacts:

- Strengthening of local pride and community cohesion, through ownership and interaction within the community - Orchards have played an important role in communities for many centuries, providing a focal point and gathering space for work and relaxation.
- Intergenerational planning and working takes place around orchards, reducing social isolation.
- Providing beauty to the area and attract new users to the site.
- Providing a place in which training of traditional skills can occur, such as pruning and grafting.
- Providing an area for education about the conservation of rare and endangered species of trees.
- Providing refuge for peace and tranquillity, part of wellbeing through nature goals.
- Orchards provide a place where people work together with nature to create abundant harvests.
- Social aspects of orchards include 'Apple Days' which bring communities together (usually over a weekend in harvesting season), where people bring their crops e.g. apple to be juiced, swap grafts from trees, children are involved in art competitions and apple bobbing games, apple baking competitions and recipes are shared. **Click here** for an example.
- Community orchards provide fresh fruit with zero food miles, and little or no pesticides used in the growing process compared to commercial farming. They provide a place for physical exercise and improve wellbeing. Spending time in nature (whether tending trees, harvesting or serving coffees for community volunteers) has a positive effect on physical health wellbeing and increased community cohesion and pride.
- Local businesses can connect with community orchards and their initial setup and maintenance, for example, donations of soil, manure or materials needed.
- Tree adoption and memorial schemes can be set up to increase the size of orchards.
- Schools can link activity to the National Curriculum, therefore can be used to enhance learning.

Tree planter packs

Working with The Conservation Volunteers, we designed tree planter packs suited to a range of parks and amenity spaces. Named the Parkland pack, they contained 50 trees, a mix of ten of each of the following species: Crab apple, Downy Birch, Bird Cherry, Field Maple and Aspen.

We reached out to our tree planting community across National Grid's operational region and had an incredible take-up, with all planter packs being claimed within a matter of days. This means that up to 5,000 trees have been planted through the scheme across our region.

2.5 Other environment related activities

2.5.5 Community environmental support and awareness

Promoting renewable and clean technologies

In October 2021 we began our involvement in the Greenpower Challenge, which is a project that sees teams of school children (aged 11-16) design, build and race electric kit cars with the assistance of National Grid STEM ambassadors.

The initiative focuses on renewable energy, recycled materials and a pathway into understanding the various roles available in engineering.

By ensuring that the teams have a 50/50 gender split the project offers an opportunity to encourage more females to try their hand at engineering. National Grid supplied the kit cars, the STEM ambassadors and the clothing, ensuring the project comes at no cost to the schools.

We have grown our sponsorship in 2022/23, with National Grid supporting four teams based in South Wales and the South West, who are currently working towards their race days this summer.

National Grid's first ever Greenpower Challenge team from Ivybridge Community College competed at the Greenpower International Final at Goodwood Motor Circuit, with over 100 teams from across the UK and Europe.

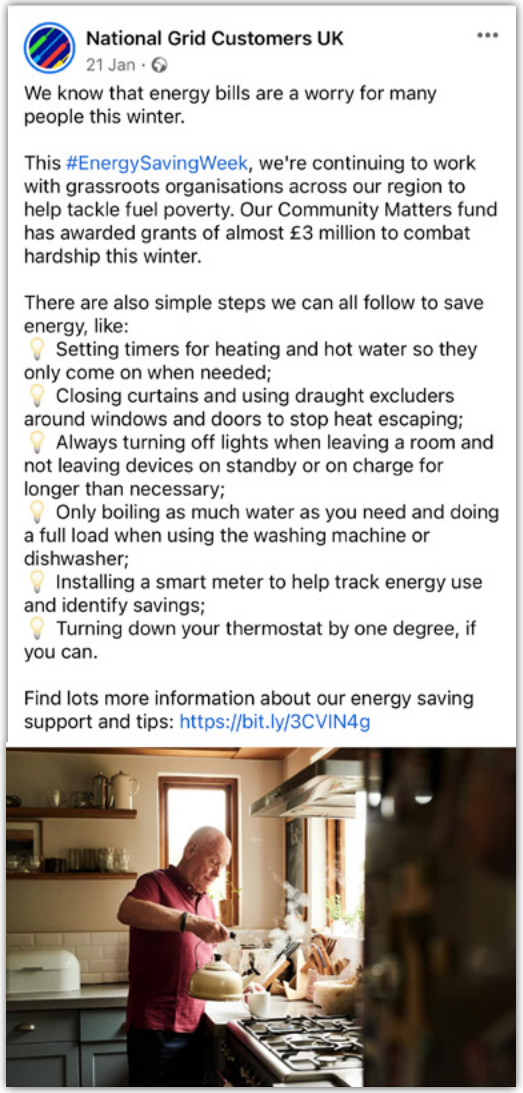
Energy savings promotion

Energy efficiency is another key contributor to preserving our environment, so we featured a campaign promoting ways that National Grid has saved energy to help inspire not only our own staff, but our customers.

We are keen supporters of Big Energy Savings Week, which we again promoted extensively on social media and online in January.

A dedicated webpage was updated to offer tips and signposting to further agencies for support.

This year we also responded to the cost of living crisis by providing more information on how to access extra support to pay for energy bills: **Click here**



2.5 Other environment related activities

2.5.6 Biodiversity

The decline of biodiversity in the UK is well documented and we are conscious that our activities can impact habitats and therefore species' ability to thrive.

In RIIO-ED2, we are committing to achieve a 10% biodiversity net gain for new major projects and for selected primary and grid substation sites.

Biodiversity net gain (BNG) is an approach to development and land management that aims to leave the natural environment in a better state than it was beforehand.

The Environment Act sets out key components of mandatory BNG and comes into place at the end of 2023:

- minimum 10% gain calculated using the Biodiversity Metric and a biodiversity gain plan
- habitat secured for at least 30 years via planning obligations or conservation covenants
- delivered on-site, off-site or via a new statutory biodiversity credits scheme
- national register for net gain delivery sites.

During 2022/23, we have been researching which BNG metrics are most suitable for NGED.

DEFRA have published the Biodiversity Metric which can be used to calculate a biodiversity baseline and to forecast biodiversity losses and gains (on-site and off-site) as a result of development or land management changes.

Also in preparation for RIIO-ED2 we are now working with external BNG consultants to identify the initial tranche of primary and grid substation sites most suited to achieve a 10% BNG across all four of our licence areas.

The baseline DEFRA metric surveys for this first tranche of sites will be undertaken during summer 2023.

Biodiversity Footprint – Risks and Opportunities Report

Working with Nature Positive NGED have produced a Biodiversity Footprint Report detailing the current and future biodiversity risks and opportunities with the potential to affect NGED throughout RIIO-ED2 and beyond.

The Report examines a number of different aspects including;

- NGEDs Value Chain - Dependancies on nature, impact on nature.
- Asset Categories and Commodity Analysis – Supply and value chain mapping, Biosphere analysis, disposal.
- Direct Operations – biodiversity risk rating of sites and operations.

The Report concluded that while NGED's direct impacts on biodiversity and the risks they present to the company are relatively well known and controlled, indirect impacts (i.e., those in the upstream and downstream value chain) are more opaque and therefore could present risk to NGED's operations.

The majority of risks to biodiversity occur during the extraction of the commodities (e.g., copper, aluminium, steel, wood, synthetic rubber and plastic etc.) that are used to produce cables and the infrastructure that is required to transmit electricity across NGED's network.

Power losses have a diffuse impact on biodiversity due to their contribution to climate change as a result of Greenhouse Gas (GHG) emissions. Climate change has been shown to have a negative impact on biodiversity due to rising global temperatures which can lead to increased drought, flooding, storm intensity, fires and by altering the suitability of ecosystems for native plants and animals.

Losses of polychlorinated biphenyls (PCBs) from transformers can have a detrimental effect on biodiversity, as can fugitive emissions of sulphur hexafluoride (SF_6) due to its impact on global warming. Escape to the environment of substances used in the production of creosote-treated wood poles, such as Volatile Organic Compounds (VOCs) and Polycyclic Aromatic Hydrocarbons (PAH), can also have negative effects on biodiversity.

Following on from the work with Nature Positive, NGED will throughout RIIO-ED2 develop an overarching biodiversity strategy which sets out the approach to managing biodiversity risks, impacts and enhancements across our land holdings, network and value chain.

The Heart of England Collaboration Agreement

In 2022 National Grid Electricity Distribution and the Heart of England Forest joined forces in a six-year collaboration agreement to facilitate the development, promotion and protection through effective cooperation and collaboration of new, recently established and mature woodland habitats within the Heart of England Forest.

Founded in 2003, the Heart of England Forest is a charity aimed at preserving and adding to a 7,000-acre forest situated across Worcestershire and Warwickshire.

The agreement between NGED and HoEF will include a range of projects, covering site access improvements for communities to large scale tree planting and habitat restoration.

Among the first projects to be completed has been to support plastic free tree planting at the Heart of England Forest's 'Spernal Hall Farm' site. NGED have helped to establish 59 acres of new native broadleaf woodlands by planting 33,250 trees at the site, all the planting undertaken has been without tree guard protection to help reduce the use of plastics in the Forest.

All the saplings at Spernal Hall Farm have been planted by volunteers. Along with the planting the project has included the funding of staff roles for three months across the planting season to lead and support the volunteers with tree planting and other woodland activities.

2.5 Other environment related activities

2.5.7 Plans for RIIO-ED2

We published our Environment Strategy and Environmental Action Plan (EAP) for RIIO-ED2 in December 2021. Our strategy embeds our core business environmental ambitions for future price control periods and our EAP presents the methodology and implementation plans to deliver our RIIO-ED2 core commitments.

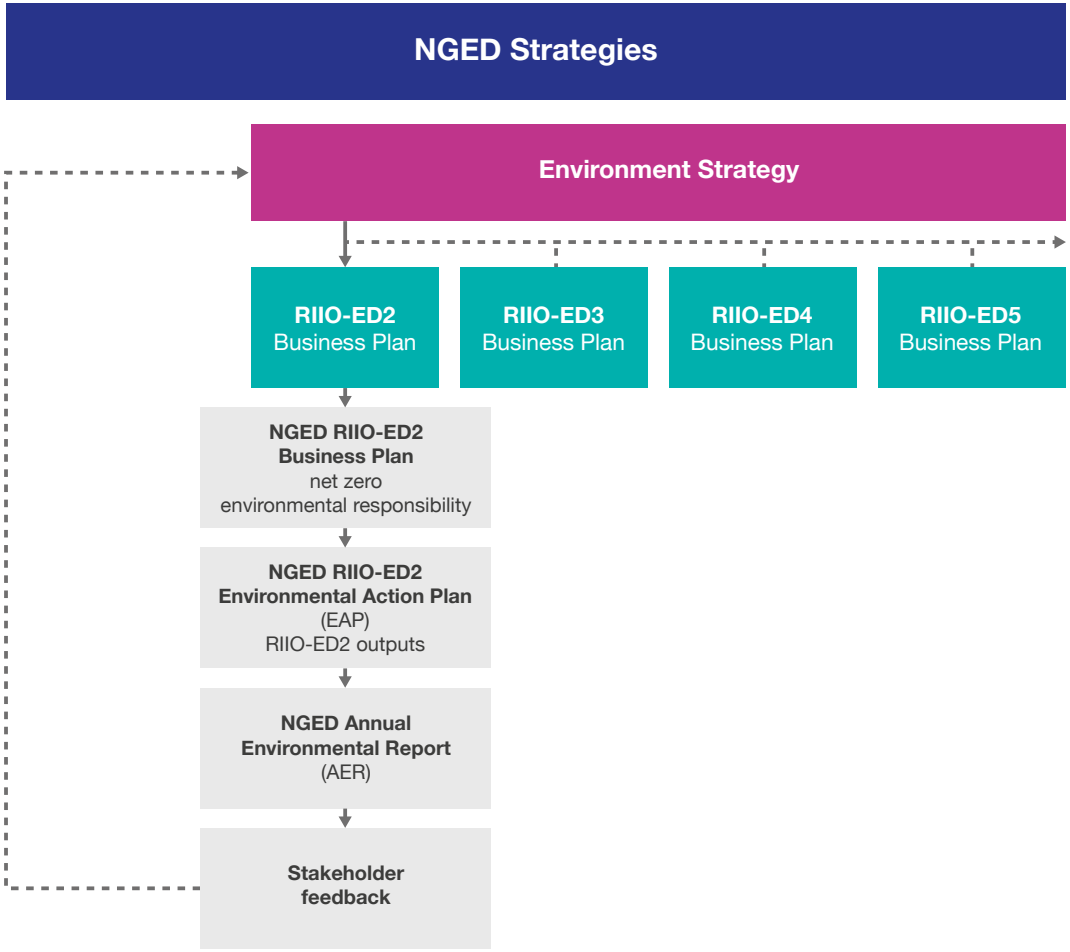
The two core strategic business areas that our strategy is based on are:

1. **Becoming a net zero carbon organisation**
   - Operation of the network.
   - Transport.
   - Heat.
   - Communities.
   - Business carbon footprint.
   - Embodied carbon.
   - Global climate change.
2. **Ensuring we are environmentally responsible**
   - Pollution prevention.
   - Biodiversity.
   - Waste and resources.
   - Supply chain.
   - Air quality.
   - Visual amenity.

Our Environment Strategy will be reviewed annually to ensure relevance to the business and our stakeholders, it will:

- ensure and enhance the protection of the environment
- provide NGED with an overarching pathway to become net zero ahead of the government target of 2050
- help us to limit NGED's impact on global climate change to 1.5°C by following a verified Science Based Target (SBT) in line with the Paris Agreement.

Figure 2.5.7a: Our Environment Strategy structure



2.5 Other environment related activities

2.5.7 Plans for RIIO-ED2

As per out Environment Strategy we are aligning our activities and focus areas to the United Nations Sustainable Development Goals (SDGs) as they provide a framework against which we can monitor, measure and explain our actions; and provide a basis to deliver positive environmental, social and economic impacts. The three SDGs our commitments are aligned with are below, but throughout RIIO-ED2 we have plans to align with more.

Achieving sustainable cities and communities

To make communities inclusive, resilient and sustainable.

Responsible consumption and production

Ensuring sustainable consumption and production patterns. The onset of the global coronavirus pandemic (Covid-19) offered an opportunity to develop recovery plans to reverse current trends and shift our consumption and production patterns to a more sustainable course. A successful shift will mean improvements in resource efficiency, and consideration of the entire lifecycle approach.

Climate action

Taking urgent action to tackle climate change and its impacts. To limit global warming to 1.5°C as called for in the Paris Agreement.

The NGED Environmental Action Plan sets out our ambitions and core commitments:

- Become a net zero organisation by 2043 in line with our validated 1.5ºC science based target (SBT).
- Avoid damage to the environment by reducing the volume of oil leaked from fluid filled cables by 50% by 2028 and replacing 90km of the worst leaking circuits with non-oil alternatives putting NGED on target to remove all oil filled cables by 2060.
- Reduce our impact on climate change by delivering a 20% reduction in SF_6 losses and drive industry partners to develop technological alternatives to reduce overall volumes of SF_6 on the system.
- Reduce the environmental impact of our operations by achieving zero waste to landfill by 2028 (excluding hazardous waste) and delivering an overall 30% reduction in tonnage waste produced.
- Improve visual amenity by removing at least 50km of overhead lines in National Parks and Areas of Outstanding Natural Beauty.
- Achieve a 10% net gain in biodiversity (in line with nationally recognised assessment tools) for new major projects and selected primary and grid substation sites.

Section 3.0

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

3.1 Introduction

Over the next 30 years, the electricity networks of the UK will need to deliver unprecedented change.

We believe that net zero can be achieved with cheaper and more resilient outcomes for customers but to achieve this we'll need to continue to challenge the status quo, innovate and find new ways of working.

Our commitments

We recognise that as a Distribution Network company we have a very important role to play in the decarbonisation of the energy system. Therefore, through our innovation work we commit to overcome the barriers to the energy transition.

We need to ensure that our electricity distribution network is able to facilitate the increasing demand from the electrification of heat and transport while at the same time allowing the connection of more low carbon generation. We will continue to innovate to find novel ways of efficiently and effectively transforming our network and the way we operate it to meet these requirements.

Our high standards of customer service, safety and reliability need to be maintained while keeping costs low for our customers. We will use innovation to achieve these aims and develop new technologies, commercial solutions and standards that will enable us to make the most out of our existing network and assets, reducing expensive interventions.

The changes that will be brought by the energy transition will create opportunities for people, making it even more important to ensure that those opportunities are accessible to everyone.

We will work with our communities to understand how best we can support our vulnerable customers and ensure that no one is disadvantaged. We aim to find the most efficient ways of addressing the technical challenges of the future electricity network, while at the same time keeping electricity affordable for everyone.

As part of this, we want to understand how we can best support our customers and our communities so that no one is left behind in the energy transition.

To achieve that, our projects are shaped around the key priority areas of decarbonisation and net zero, heat, transport, data, communities and consumer vulnerability.

3.2 Progress of the innovation strategy

For us, innovation is an embedded activity. All projects and solutions ranging from small-scale innovations through to larger scale trials need to be designed and implemented in a way that they will be suitable for 'Business as Usual' integration.

Our priority areas are:

- Decarbonisation and net zero
- Heat
- Transport
- Data
- Communities and consumer vulnerability

Our wide and varied programme of innovation has enabled us to be suitably placed to support our changing needs as a business and our customers' increasing demands and requirements.

This year has seen us deliver a portfolio of 24 active NIA projects. We have a number of projects which have produced significant learning such as Active Creosote Extraction (ACE) an environmental focused Innovation project which is trialling a new method to remove creosote from wood poles resulting in significant carbon emissions savings and taking a significant step to net zero.

Also, we have generated significant learning from Smart Meter Innovations and Test Network (SMITN) on how we can use smart meter data to help populate missing data, or find incorrect data relating to our LV network.

This includes the particular LV feeder and phase to which a customer is connected and whether photovoltaic panels are present at a property.

We remain committed to continuing and increasing our third party involvement within our innovation programme, to enable project outcomes to be taken through to business as usual quickly and effectively.

The strategy looks through to 2035, yet naturally provides more detail on the shorter term priorities, requirements and proposed initiatives.

We're now revising our innovation strategy, to make sure it's more in line with the current price control period and our organisational purposes and ambitions. We're looking to publish this later in 2023.

3.2 Progress of the innovation strategy

Our Innovation Programme

Our Innovation Programme consists of a wide range of innovation projects.

Network Innovation Allowance (NIA) Projects
Peak Heat (PEA)
System HILP Event Demand Disconnection (SHEDD)
Automatic Location of Arc-faults through Remote Monitoring (ALARM)
Overhead Line Power Pointer (OHLPP)
Electric Nation - PoweredUp (ENPU)
Arc-Aid (ARC)
Take Charge (TCH)
Energy Planning Integrated with Councils (EPIC)
Generating Additional Markets for Mature Access to Flexibility (GAMMA Flex)
Solving Intelligent LV - Evaluating Responsive Smart Management to Increase Total Headroom (SILVERSMITH)
AM - Balancing Coordination Demonstration (ABCD)
Q-Flex
Flexible Operation of Water Networks Enabling Response Services (FLOWERS)
Approach for Long-term Planning Accounting for Carbon Assessment (ALPACA)
Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution (ACCELERATED)
Demand Forecasting Encapsulating Domestic Efficiency Retrofits (DEFENDER)
Active Creosote Extraction (ACE)
Smart Meter Innovations and Test Network (SMITN)
Hydrogen Economy: Reassessing Approaches to Connecting Large Electrolyser Sites (HERACLES)
Network Event & Alarm Transparency (NEAT)
Vulnerability and Energy Networks, Identification and Consumption Evaluation (VENICE)
PreFix (PRE)
Running Cool
Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources (COMMANDER)

Strategic Innovation Fund
EV Respond
Shifting Currents
PIONEER(Proportional Investment of Networks in Energy Efficiency Retrofit)
PRIDE (Planning Regional Infrastructure in a Digital Environment)
TEED (Tyseley Environmental Enterprise District)

Network Innovation Competition
Equinox

Internally Funded - Research and Development
Research and Development of Market Structures (REDMAST)
Reliability Threat Assessment

In the period of April 2022 - March 2023 we have had 24 live NIA projects, one NIC and two Internally funded projects.

3.2 Progress of the innovation strategy

3.2.1 Key projects

Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution (ACCELERATED)

Climate change is expected to result in changes to the patterns of weather experienced around the world.

In the UK we are expecting an increase in the number and severity of storms. The higher wind speeds associated with more severe storms are more likely to cause damage to our overhead network directly and by causing greater volumes of windborne debris.

Similarly climate change is expected to result in more intense periods of rainfall which is also known to trigger faults.

The ACCELERATED project looked to understand the impact of climate change on distribution networks through analysing the historical relationships between weather variables (rainfall, wind speed etc.) and consequential faults on assets and applying modern climate science to understand how the observed trends are projected to change in medium- and long-term.

The project has also developed a methodology for integration of climate change considerations into our forecasting activities.

Lessons learned

We've learnt that wind is the main driver of the faults and the South West region is particularly vulnerable to wind-related faults.

Also, the12 Largest single events for Customer Minutes Lost (CML) occurred in the last 10 years and included five windstorms, two rain/flood events, three cold snaps, and two heat waves.

Climate change is likely to lead to an increase in the number of power outages in the NGED licence areas, particularly in the South Wales and South West.

The projections, however, differ from one licence area to the other so the caution should be applied when utilising the results of the analysis.

Customer benefits

We recognise that current and future climate change can directly affects NGED business objective of providing a safe, reliable and efficient electricity supply to our customers.

To be prepared for the projected change in chronic and acute weather conditions in short-,medium- and long-term we as a business need to be equipped with novel reliable climate change data so that our distribution networks equipped with innovative toolset for effective operation and management.

The outputs from ACCELERATED have identified at-risk hotspots so that design, reinforcement and maintenance activities are considered with climate change future proofing in mind.

Customers across all four licence areas will be ultimate beneficiaries through reduced interruption to the service and reduced maintenance/recovery cost.

Planned implementation

The climate change impact assessment procedure developed during the project established a procedure provides a guidance for adopting the climate change impact assessment as part of NGED's day-to-day activities and strategic planning.

It's primary goal is to outline a consistent and robust approach to assess and mitigate the impact of climate change. The procedure provides details of the analytical approaches developed in the project, along with applications of these for NGED.

The internal teams identified to adopt the analysis will be encouraged to review and adopt the methodology developed. In addition, the internal Policy teams will have responsibility for evaluation of the adequacy of the analysis for meeting mandatory reporting requirements in future, and coordinate identification of areas for development and potentially integration of the ACCELERATED outputs into NGED's Climate Resilience Strategy

3.2 Progress of the innovation strategy

3.2.1 Key projects

Approach for Long term Planning Accounting for Carbon Assessment (ALPACA)

ACE (Active Creosote Extraction) is an environmental based innovation project aligning with decarbonisation and net zero.

Disposal of creosote impregnated wood poles is a significant hazardous waste stream that is only going to escalate in the coming years, due to more stringent legislation likely to be put in place and the disposal method through landowners inevitably becoming unviable.

Leaving high-temperature incineration the only other current option, this method is a deterrent for DNOs needing to reduce their carbon emissions.

Lessons learned

It is estimated that 50% of a redundant wood pole can be recoverable through pre-treatment by selectively removing the outer layer for treatment. In essence, the majority of the inside of a pole is already non-hazardous.

Initial data has shown gravitational effects play a part in the distribution of creosote hotspots. Towards the bottom end of the poles, the greatest concentration of creosote is observed.

Fracturing in the wood significantly increases the creosote penetration into the wood. It has also been observed that there have been higher creosote levels deeper into the poles compared to the outside. This will be due to the inner section being 'shielded' from the environment.

Environmental Benefits

National Grid Electricity Distribution have identified the disposal of end-of-life poles as one of the biggest environmental challenges the company faces. Incinerating one tonne of wood is equivalent to the emissions produced by a Ford Transit van driving 17,500km.

Since 2017, National Grid has sent 3,311 tonnes of wood poles for incineration. That yields an equivalent emissions output of the same Ford Transit van driving 34,259,897 km. The equivalent of driving to the moon and back 44 times.

This project if successful would be able to create a new stream where these wood poles would avoid incineration and potentially be repurposed into more environmentally friendly uses.

It will also reduce the carbon emissions during the disposal process, and trial a way of recycling the carbon generated during the extraction process.

Planned implementation

This project is creating a new process for disposing wood poles which will provide us with a new stream which will greatly reduce our carbon emissions in addition to other DNO's and Utilities.

By creating a method, where creosote can be extracted from redundant wood poles to such levels they are deemed non-hazardous waste, high-temperature incineration can be avoided resulting in significant carbon emissions savings and taking a significant step to net zero.

If proven successful, the project aim to produce a proposal that can scale this up to a commercial level.

3.2 Progress of the innovation strategy

3.2.1 Key projects

Demand Forecasting Encapsulating Domestic Energy Retrofits (DEFENDER)

To avoid dependence on fossil fuels, domestic buildings must change to incorporate low carbon heating, smart tariffs, and energy efficiency measures such as insulation.

The interplay between all of these measures is not currently well understood from a forecasting perspective. We suspect that there may be opportunities to promote energy efficiency as a cheaper alternative to reinforcing the network.

Demand Forecasting Encapsulating Domestic Energy Retrofits (DEFENDER) aims to analyse the impact of insulating a home on the amount of power a heat pump needs, using actual domestic data which is used in network forecasting.

It will then look at the scale of possible benefits from promoting the uptake energy efficiency measures within the current market, with an aim to inform our strategy for the predicted widespread uptake of heat pumps.

Lessons learned

DEFENDER kicked off during March 2022 so is still in its early stages, however the early learning points that support the delivery of the project have been captured.

Investigating potential case study networks where the majority of customers are domestic profile classes found that coastal networks are the most common candidates.

However, there is a risk that weather conditions, and propensity of holiday homes, mean that these areas may not be representative. This will be considered when setting out the criteria for case studies for the project.

International comparisons for the interplay of energy efficiency and heat pumps are difficult, as the heating mix in many comparable countries in Europe includes significantly more direct electric heating. As a result, heat pumps will likely reduce electrical demand in these countries, rather than increase it.

Customer benefits

This project will benefit customers by considering our role in the uptake of heat pumps. It is analysing if there is a cost-efficient way to allow for widespread connection of heat pumps from our point of view, which would reduce the amount that customers pay in their energy bills.

The project aims to produce a tool which can produce pre- and post-retrofit demand profiles based on up to date smart meter data. The tool will be made open source and may be adapted by customers for a variety of potential benefits, such as for more accurately selecting the size of heat pump to be installed in a home.

More accurate forecasting may also produce a less pessimistic view of demand growth from low carbon heat, saving customer money through reduced future reinforcement costs.

Planned implementation

DEFENDER is first looking at developing a model of the effect of energy efficiency on the Heat Transfer Coefficient of homes, which is being trained on smart meter data. Clustering techniques will then be used to create demand profiles of archetypal homes in various stages of retrofit. A tool will be built around this which can repeat the algorithms with updated data.

The profiles created will then be used in a network investigation to understand the effect of accounting for energy efficiency in demand forecasting, using a methodology for incorporating energy efficiency assumptions into DFES developed in the project.

Concurrently to this, an economic analysis will use a real options approach to consider the relative costs and benefits of using energy efficiency measures as an alternative to flexibility and network reinforcement. It will appraise where there is the greatest certainty of these benefits and whether this justifies a greater DNO role in retrofitting UK homes.

3.3 Roll-out and innovation into BAU

We have been continuously building on the learning generated from our projects.

For example, fault currents were explored as part of a collaborative IFI project, demonstrated within FlexDGrid, an LCNF Tier-2 project, and now being refined and made suitable for small-scale rapid deployment as an output of our EDGE-FCLi NIA project.

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. Through the Network Equilibrium project we have developed and successfully trialled our voltage optimisation technology which has revolutionised the way we operate our network in real-time and proved the significant network capacity benefits it can offer. We are now planning the roll-out of voltage optimisation in RIIO-ED2 which will enable us to make the most out of our existing network.

Innovative solutions can also improve the security of electricity supplies by ensuring generation matches demand in local areas. Solutions could enable sections of the electricity network to be run in isolation for short periods of time. Distribution network technology will continue to advance and we can gain benefits by adopting it.

Our experience shows that new solutions available today will become standard in the near future. For example, Active Network Management (ANM) was bespoke when our Low Carbon Hub project started in 2011. ANM is now 'Business as Usual' and we have a framework agreement in place with three vendors, with multiple zones currently active. A critical evolutionary change is the increase of LCTs such as EVs and electrified heating solutions on the distribution network. Challenges and opportunities have been demonstrated by our Electric Nation and FREEDOM projects.

Our Lincolnshire Low Carbon Hub project developed a practical application of ANM 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 the new NGED 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.

The ENTIRE project explored the technical and commercial requirements to utilise flexibility as a service to avoid asset investment requirements. Through trialling over 47MWh of flexibility and generating policies and procedures, this enabled the Flexible Power brand to be developed and is now offering business as usual flexibility solutions to the whole business.

We ran the Wildlife Protection project to ensure that our assets did not pose unnecessary harm to wildlife, and also that none of our assets were at risk of getting damaged from wildlife. This was particularly relevant for our overhead lines, and an app was developed to assess the risk of these components. This has already had an impact on the design and construction of our overhead structures, where we have been covering some parts of conducting material, and changing the arrangement of items on the top of our poles to minimise the chance that birds will touch two phases at once.

3.4 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 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.

Smart meters have the potential to provide valuable data which could enhance our core business.

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 individual premises that has not been available before.

This is particularly impactful when 'last gasp' functionality is used at scale to identify when multiple customers on the same part of the network may be off supply, helping us identify network faults as well as single premise faults. Our Low Voltage Network Visibility (LVNV) project was recently set up to deliver several use cases of smart metering data to improve network visibility and our understanding of customer demand – where one of these use cases is focused on using smart meter 'last gasp' functionality to proactively identify and respond to LV or Feeder network faults. This enables us to identify, diagnose and respond to faults quickly and reduce Customer Minutes Lost (CML).

Additional functionality will allow the 'energisation status' of meters to be checked remotely, giving us a clearer indication of which customers are off supply, enabling us to better determine what type of fault has occurred (blown fuse, open circuit fault, single premise). This will help ensure we respond in the right way first time and improve our restoration times. In the case of a call regarding a 'single premise', 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, which 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 while customers may still be off supply. As smart meters record interruption and restoration times, fault management applications will become more effective as the density of installed smart meters increases and more information becomes available to provide a comprehensive view of the network.

3.4 Maximising the benefits of smart meter roll-out

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 HV source 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
- identify reverse power flows, which might require us to take action
- avoid unnecessary reinforcements or network issues from demand over or underestimation
- 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.

Aggregated load data from smart meters can also used by our Distribution System Operator (DSO) teams to build planning profiles that reflect the pattern of electricity usage for a particular customer segment. These updated planning profiles reflect modern customer behaviours and assets, which can enable more accurate forecasting, policy updates as well as optimised and efficient network reinforcement.

One of the use cases of our LVNV project is focused on building load profiles for a set of customer archetypes to inform network planning, modelling and forecasting activities.

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).

Asset management

Smart meters offer a wide variety of data that can be used by our Network Services team to manage and maintain network assets.

In particular voltage alerts and voltage readings from smart meters can be used to investigate and diagnose network supply issues.

For example one of the objectives of our LVNV project is making smart metering data available to our Network Services engineers, technicians and planners to help them respond to customer voltage enquiries or supply quality issues, as an alternative to installing voltage recorders in customer homes.

3.4 Maximising the benefits of smart meter roll-out

3.4.1 Smart meter penetration

The percentage penetration of Smart Meters in each of the DNO's Distribution Services Area at the end of 2022/23 period is provided in table 3.4.1.

Fig: 3.4.1 Smart meter penetration

Licence area	11 - East Midlands	14 - West Midlands	21 - South Wales	22 - South West	Total
No. MPANs	2,747,775	2,568,883	1,183,756	1,713,756	8,214,170
No. SMETS1	608,691	541,241	244,141	322,508	1,716,581
No. SMETS2	918,519	765,108	371,404	530,452	2,585,483
Total penetration	**56%**	**51%**	**52%**	**50%**	**52%**

The Smart Meter Rollout is being managed by Energy Suppliers in the UK and although the initial programme of installations was due to end in 2020 this has now been extended until 2024.

3.4.2 Status of IT and communications investments (DS)

Over the last year we have:

- replaced all of our HSMs to an upgraded version to ensure we remain secure and supported
- successfully passed the annual independent security audit to verify that we meet the required standard
- made numerous system enhancements and modifications to capture and provide data for innovation projects.

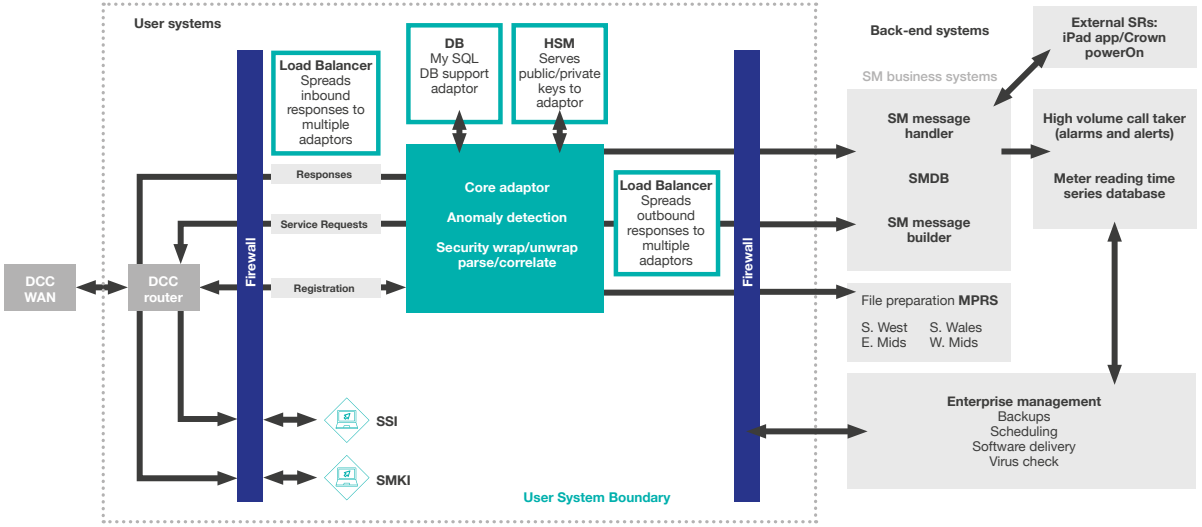
Current key projects include:

- a major migration of our back end message handling systems to a new platform to ensure we can meet the demand of increasing numbers of smart meters being installed
- development of a new consumption data aggregation process to allow us to capture and aggregate data for all four million+ smart meters.

Future planned work:

- upgrade to Adaptor software to meet the latest DCC release DUIS 5.1
- increase in the size of our connection with DCC so that we are able to capture data for every smart meter in our area.

Fig 3.4.2 Smart metering - user system environment



3.4 Maximising the benefits of smart meter roll-out

3.4.3 Maximising the value of smart meter data

While energy suppliers have been installing smart meters in our distribution area since 2012, the units installed until late 2018 were the SMETS1 type with no interoperability.

The deployment of SMETS2+ devices has increased steadily since Q3 2018 with NGED connecting to around 2,500 meters per day. The migration of SMETS1 devices has also commenced and we are seeing these volumes grow and expect a significant increase in these volumes in the next 12 – 18 months.

NGED continues to lead the way with in excess of 1.8 million SMETS2+ electricity units installed and 1.2 million SMETS1 electricity units migrated within the four licence areas as of Q1 2021.

This currently equates to approx. 39% of eligible customers connected through the DCC with SMETS2+ and SMETS1 meters. This rate will need to increase rapidly however if NGED is to begin realising benefits before the end of the rollout.

3.4.4 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 however 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 SMETS1 meters are being enrolled in to the DCC of which 58% within NGED have successfully migrated to date.

3.4 Maximising the benefits of smart meter roll-out

3.4.5 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 3.4.5a

	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
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**	**0.27**	**0.44**	**1.62**	**2.36**	**2.69**

Table 3.4.5b

Smart metering benefits for demand side response and active network management (£m)

	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
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 NGED RIIO-ED1 Business Plan was based on a number of assumptions which may no longer be valid.

- Commencement of mass rollout of smart meters was not delayed.
- Penetration of SMETS1 meters was very low.
- Customer numbers with no smart meter WAN coverage would be good.
- 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.

3.4 Maximising the benefits of smart meter roll-out

3.4.6 Forecast actions

Since Q3 2018 SMETS2+ meters have been installed across the network at a steady rate to the point where we now have approx. 25% penetration. During the early part of mass roll-out, while penetration levels are still below our expected level within the 2022/23 regulatory year, we continue 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.

During the early part of mass roll-out, while penetration levels are still below our expected level within the 2020/21 regulatory year, we continue 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.

Smart Meter Privacy Plan

We have an approved Data Privacy Plan from late 2020 and Privacy Impact Assessment that details how we collect, store, manage, maintain and share smart metering data to enable network teams to utilise this data in a way that is compliant with our Licence Conditions. This Data Privacy Plan describes how the smart metering data will be handled upon entering the NGED smart systems. Since then it has been realised that some alterations to our data systems are required and we have made some minor changes to the Privacy Plan, with approval from Ofgem.

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 the smart meter roll out continues.

Reduction in Customer Minutes Lost (CML)

The benefits in this area can be summarised as the ability for us to understand the nature of a loss of supply, either a single customer or multiple customers, by using data from multiple Smart Meters.

A secondary benefit which we have seen since acting on these alerts is that we are also aware when a third party might have inadvertently disconnected the supply or operated our equipment.

In these cases we can offer safety advice. These were not realised during the 2021/22 regulatory year due to the lack of penetration and reliability of alerts received.

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 therefore 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 Communications Service Provider systems
- customers being familiar with smart meter capabilities and having sufficient trust to rely on the meter to notify us about power loss.

3.4 Maximising the benefits of smart meter roll-out

3.4.6 Forecast actions

Smart meter voltage data
This benefit depends on: Voltage data from SMETS2+ and enrolled SMETS1 meters can be used to understand how our network is operating.

Data at the near or far ends of a network is especially useful as it can show trends in the demand or generation loadings of the network. For example, a high voltage at the end of a network can indicate high levels of embedded generation. Conversely low voltage can indicate a high level of load.

We can use this data as an early warning triage of our network. Substations with predominantly high or low volts over a long period of time can be identified and substation level monitoring can be installed.

The logic rules for voltage analysis have already been written and are currently being evaluated and tested.

Better informed investment decisions for electricity network reinforcement

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.

We have an approved Data Privacy Plan and Privacy Impact Assessment and plan to integrate our systems to enable network teams to utilise the data from late 2020.

Since starting to look at the configuration of consumption data from smart meters it has been realised that some changes are required to the privacy plan.

These changes are minor and only alter the technical wording of where and how the data will be handled upon entering the NGED smart systems. Ofgem have confirmed that the changes can be made and we are working on alterations to our data systems.

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.

Network capacity investment savings from electricity demand shift depend on the following:

- 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.

It was not possible for NGED to realise these benefits during the 2021/22 regulatory year. We intend to monitor developments in this area as smart meter roll out continues.

3.4.7 Innovative solutions to new connections

The drive to connect Distributed Energy Resources (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 therefore reduce connection timescales and costs we have an established suite of Flexible Connections 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.

3.4 Maximising the benefits of smart meter roll-out

3.4.8 Flexible Connections descriptions

The UK's 2050 net zero target is driving significant change in the electricity industry.

Not only are increasing numbers of renewable generation connections being made to the distribution networks, but customers are also increasing their demand for electricity as they decarbonise - for example switching from petrol or diesel cars to battery electric vehicles as well as from gas heating to electric heat pumps.

These changes all mean that the distribution networks are coming under increased pressure to allow new connections while at the same time minimising the costs associated with network upgrades.

NGED have been offering customers Flexible Connections at higher voltages (11kV and up) for some time now. Many parts of NGED's network are constrained and require reinforcement before new connections can be made.

Depending on the voltage level of the constraint compared with the voltage level being considered for connection, the cost of reinforcement triggered by a new connection application might fall on the customer or on NGED (or even both). In either case, the timescales associated with reinforcement can be quite lengthy.

Flexible Connections allow customers to connect to NGED's network ahead of reinforcement works being completed, subject to their import/export being curtailed by NGED when necessary. Where the customer is also responsible for the costs, reinforcement works (and therefore the costs associated with them) might be entirely avoided, again with the customer being subject to curtailment but on an enduring rather than potentially temporary basis.

OFGEM's recent Significant Code Review standardised these types of connections for customers submitting connection applications from the 1st April 2023 as "Curtailable Connections", with customers being entitled to certain rights under their connection agreements.

These rights include an upper limit (cap) on the extent of any curtailment they would be subject to over a rolling 12-month period as well as an agreed end date for the curtailable terms.

The customer can, however, choose to opt out of an end date in favour of an enduring curtailable agreement where there is a cost as well as a time saving to them. By contrast, previously offered Flexible Connections did not have contractual caps and end dates.

While Curtailable Connections provide more rights for customers, there are limitations on the eligibility for them. Key to this eligibility is that the minimum scheme connection offer must include reinforcement of NGED's network.

Any limitations on connections to NGED's network imposed by constraints on the Transmission Network, for example, do not entitle a customer to a Curtailable Connection offer as no reinforcement of NGED's network would be triggered.

Nevertheless, there would still be benefit to the customer if they could accept a connection to NGED's network that was subject to curtailment. For this reason, Flexible Connections will continue to be relevant for those customers that fall outside the scope of Curtailable Connections but for whom there would still be a benefit to being subject to curtailment.

3.4 Maximising the benefits of smart meter roll-out

3.4.9 RIIO Outputs that Flexible 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:

- **Connections and customer satisfaction**
  providing a faster service and engagement with major connections customers.
- **Reliability and safety**
  enhancing network resilience and doing so in a safe manner.
- **Environment**
  increasing the uptake of LCTs.

By allowing more Distribution Generation (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.

3.4.10 Benefits and impacts

Our Flexible 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 not require significant change to our business and so are able to be rolled out in a structured way.

Appendix

Appendix A

East Midlands RRP Environmental Innovation 2022/23
South Wales RRP Environmental Innovation 2022/23
South West RRP Environmental Innovation 2022/23
West Midlands RRP Environmental Innovation 2022/23

Appendix B

RRP Environmental Innovation Commentary 2022/23

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