nationalgrid

Environment and innovation report

2021/22

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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 2021/22 we have achieved the following improvements:

Environmental highlights

- Publication of the NGED Environment Strategy and Environmental Action Plan for RIIO-ED2.
- We continue to progress towards achieving zero waste to landfill throughout our four licence areas.
- Further reduction in our Business Carbon Footprint.
- Successfully maintaining our ISO14001 certification and responsible environmental management throughout the COVID-19 pandemic.
- Increased the percentage of electric vehicles in our commercial and leased fleet.

Innovation highlights

- 29 Network Innovation Allowance (NIA) projects delivered.
- 44 organisations took part in our NIA call for ideas.
- 484,000 impressions across four social media platforms.
- Over £34 million invested in NIA projects to data.
- 92 project partners and suppliers on our NIA projects.

Challenges

- Continue to improve and progress in our RIIO-ED1 business environmental outputs – specifically reducing fluid filled cable leaks and SF_6 emissions.
- The availability of SF_6 alternatives.
- Maintain and improve our environmental performance and compliance record with the environmental regulators.
- Ensuring we have prepared to successfully deliver our RIIO-ED2 core commitments.

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Section 1.0

Introduction

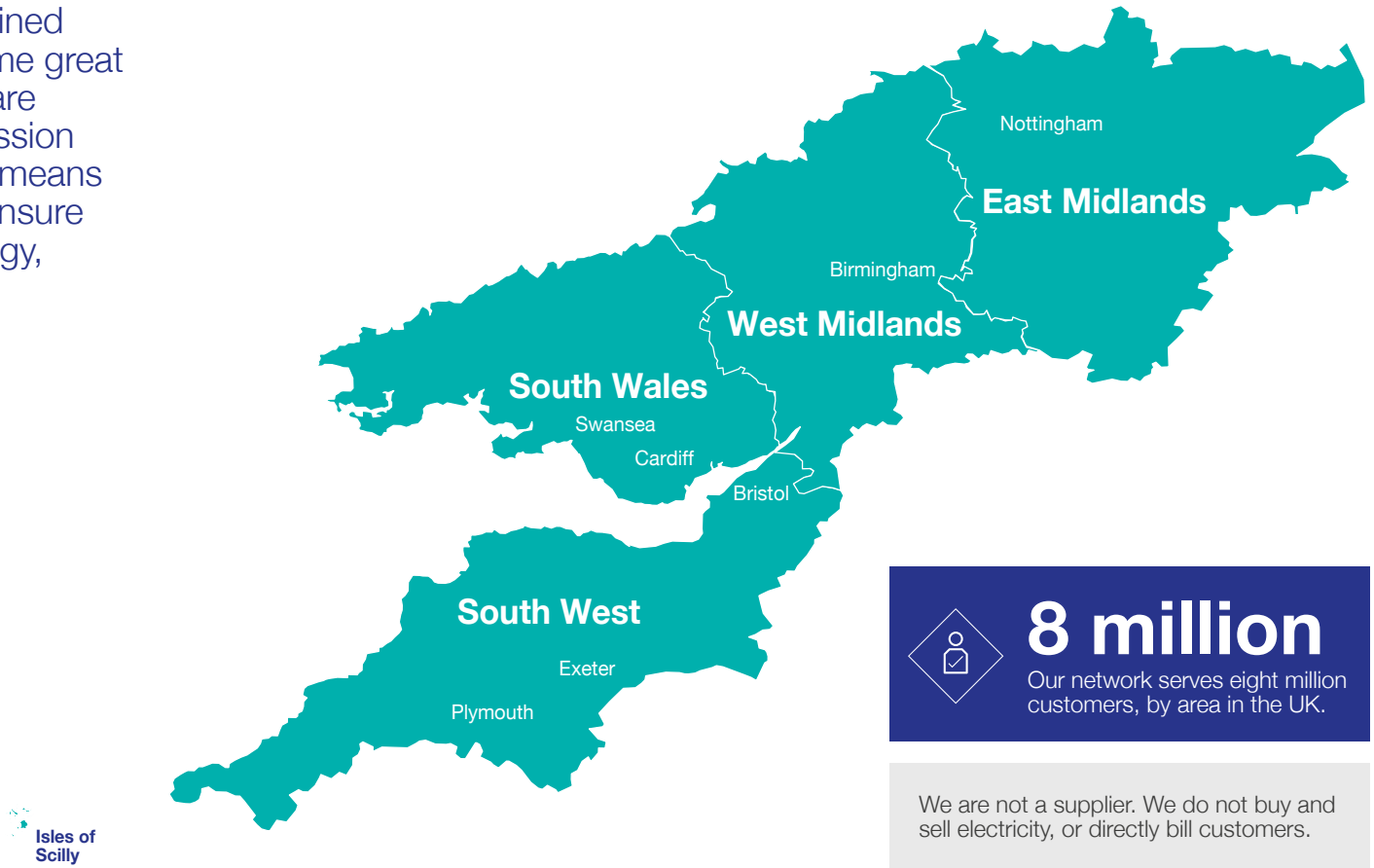
1.1 Who we are and what we do

Western Power Distribution (WPD) has joined National Grid. We will keep giving the same great service, just under a different name. We are 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.



8 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 2021/22, our costs account for around £100 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.

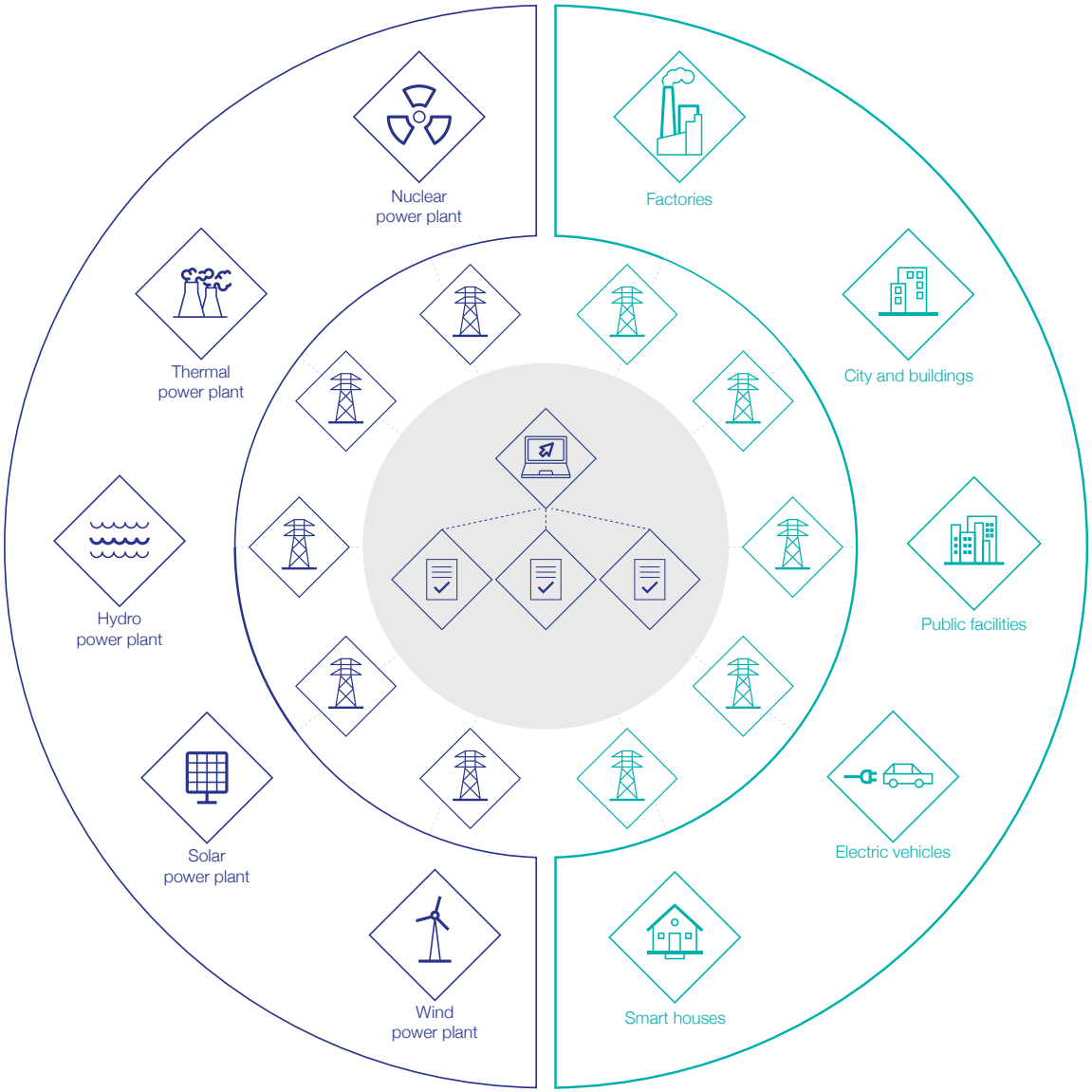
1.2 Our network

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	89,046
Underground cable	km	139,076
Transformers	Each	190,272
Switchgear	Each	305,956
Poles	Each	2,000,264
Towers (pylons)	Each	14,551
Customer numbers	Each	7,999,683



1.3 Improvement opportunities

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

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

- The introduction of electric vehicles (EVs) in to the NGED Operational Fleet.
- All new or refurbished NGED buildings achieving minimum rating of ‘Excellent’ for new build and ‘very good’ for refurbishment under the BREEAM* rating.
- Significant reduction in our scope 3 business travel emissions.

A reduction in the leaks from our equipment, specifically

- The leak rate of SF_6 gas that is released from switchgear.
- Installation of effective containment ‘bunds’ around plant containing high volumes of oil.

*Building Research Establishment Environmental Assessment Method

1.4 Stakeholder engagement

Engagement strategy

Effective engagement with stakeholders is crucial to the success of any business.

Engagement keeps us connected to the people and communities we serve and ensures we continue to deliver the level of service our customers and stakeholders want, deserve and expect. Frequent, challenging, high quality engagement drives improvement, ensures our commitments are well-justified, and allows feedback to meaningfully influence plans.

At NGED, we have a good track record of working closely with our customers and stakeholders – with a comprehensive stakeholder engagement strategy which has been in place since 2007.

The enduring nature of our strategy 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.

Our approach to engagement can be summarised by the following five key principles:

Inclusive
Our plans are designed to deliver for all stakeholders, and the methods we select to engage must be appropriate, making it as easy as possible for people to respond.

Transparent
This means sharing all the feedback we receive and the actions that have resulted from it.

Proactive
We identify and proactively reach out to stakeholders so they do not need to contact us.

Purposeful
Our focus is always on meaningful, two-way engagement that shares decision-making power with stakeholders that directly shapes our actions.

Expert-led
Our engagement programme is led by expert business owners, with significant experience who have direct responsibility for acting on insight.

The practice of engaging stakeholders is common to many companies, but the quality, range and impact is not. At NGED the aim of our engagement is always maximum positive impact, and the foundation provided by our strategy enables us to tackle an ever increasing range and depth of topics, and to manage the huge volume of feedback this delivers.

In the past year we have engaged with over 44,000 stakeholders, and their increasingly well-informed, granular feedback has pushed our ambitions as a business and encouraged us to devise better, more innovative ways of doing things differently.

Stakeholders said

"NGED shouldn't just enable customers to inform decisions, they should pursue the most mature, involved programme possible - working with stakeholders to collaboratively develop new concepts, solutions, action plans and services. This will bring fresh perspective on NGED's operations and ensure they always think 'outside the box' when making plans for the future."

1.4 Stakeholder engagement

Co-creation is key

As the scope and breadth of our engagement programme continues to expand to meet the needs of an evolving range of stakeholders, it is more important than ever they are given real, meaningful opportunities to provide input that shapes our plans in detail.

We have recognised the need to move significantly beyond the traditional 'informative' and 'consultative' approaches used by many, and are driving new standards for negotiated, co-created plans that truly reflect stakeholder needs, and deliver the best outcomes for customers.

Building our plans from the ground up with stakeholders ensures we are co-developing effective actions to address the significant changes facing our network. Over the past 12 months this has never been more important, as our industry faces unprecedented changes in light of net zero, our post-pandemic recovery, global energy price rises and a cost of living crisis.

For our local communities, the route to achieving net zero will be varied, as will the pace of change. NGED has a vital role to help stakeholders meet their targets, building regional partnerships and driving local strategies, which all relies on in-depth, purposeful engagement.

Some of the outcomes we have achieved in 2021/22, driven by stakeholder insights are:

We heard

"NGED should lead the way in reaching net zero by decarbonising its own operations."

We did

We are reducing carbon emissions across our operations and have committed to making 89% of our commercial van fleet electric by 2028.

We heard

"We expect more from NGED than just a reliable supply at a reasonable price. You should go further to deliver wider social, environmental and economic benefits within communities."

We did

We were the 1st DNO to publish a Social Contract – co-created with stakeholders – with an annual action plan. This includes 36 specific actions that take us significantly beyond our core business purpose, delivering major social value.

We heard

"Flexible services must be rolled out as extensively as possible. Participation in flexibility must extend beyond large commercial customers."

We did

Total flexibility contracted is now 709MW, deferring £48.5 million in reinforcement. Improved flexibility offerings have enabled 318 flexibility providers to participate in tenders, including domestic electricity suppliers and aggregators.

1.4 Stakeholder engagement

Strategy development workshops

Our strategy development workshops are specifically designed to allow for in-depth conversations and exploration of designated topics. Attendees are subject-matter experts and provide us with feedback, challenges, scrutiny and recommendations in relation to our current actions and future plans.

Thanks to the expertise of these stakeholders, we are able to play back the overarching views received from more generalist stakeholder workshops, and ask this audience to use their detailed knowledge to co-create specific plans to address these priorities and challenges.

Led by the NGED senior managers responsible for the specific topics being discussed (and for delivery of the resulting strategies, commitments and action plans agreed), these independently facilitated workshops provide a constructive, collaborative forum that encourages candour and open debate.

September 2021 workshops – what stakeholders told us:

The purpose of these workshops was to seek feedback from stakeholders on our first RIIO-ED2 Business Plan submission to Ofgem, following two previous draft publications for stakeholder consultation.

Stakeholders told us	How we acted upon this
Innovation	
Simplicity and transparency throughout the connections process is crucial.	We are digitalising the customer connection journey, developing self-serve online tools and a customer portal to manage the end to end connections process, including allowing customers to self-assess their connection requirements, obtain a cost of connection and enter into connection offer agreements.
Integrate more learnings and solutions from trials and innovation projects into day-to-day activities.	We have committed to dramatically increase our innovation activities in the RIIO-ED2 period. Our Business Innovation Programme will focus on the rollout of previously proven innovation and projects that can enable our business to operate more cost efficiently and deliver new and enhanced services to customers on an enduring basis. As part of this we will also create an Innovation Coordination Rollout Team with dedicated resources to drive ambitious business wide change.
Distribution System Operator	
It is important to support the low carbon aspirations of customers and make it as easy as possible for them to adopt and connect new technologies and participate in new services (such as flexibility).	Through the continual expansion of flexibility products and constraint managed zones across our network we will ensure that we widen the range and frequency of flexible connection alternatives to conventional reinforcement, therefore facilitating quicker connections at a lower cost.
Decarbonisation initiatives must be effective, fair and affordable for all customers.	As part of our 'Smart and Fair?' project we are developing a Capability Lens and offering profiling tools, enabling us to model the capabilities of vulnerable customers to participate in a smart, low carbon future. These will be used to: improve access to existing smart energy schemes and services (including flexibility products) and design and implement new interventions to support wider participation in a smart energy market.
Environment and sustainability	
NGED's commitment to enhancing biodiversity on its network should include a net gain target to increase accountability.	We have included a core commitment within our Plan to achieve a 10% net gain in biodiversity on all new projects in line with UK government's Environment Bill.
NGED should share its best practices around business footprint decarbonisation, which could then be passed down the chain to its suppliers and partners.	We have committed to utilise data insights to build a 'green supply chain' and share more data with suppliers to help to reduce their own carbon footprint.

In total, we are now proposing 42 core commitments in our RIIO-ED2 Business Plan which represent significant actions and services improvements that stakeholders have told us they want.

1.5 Our social contract

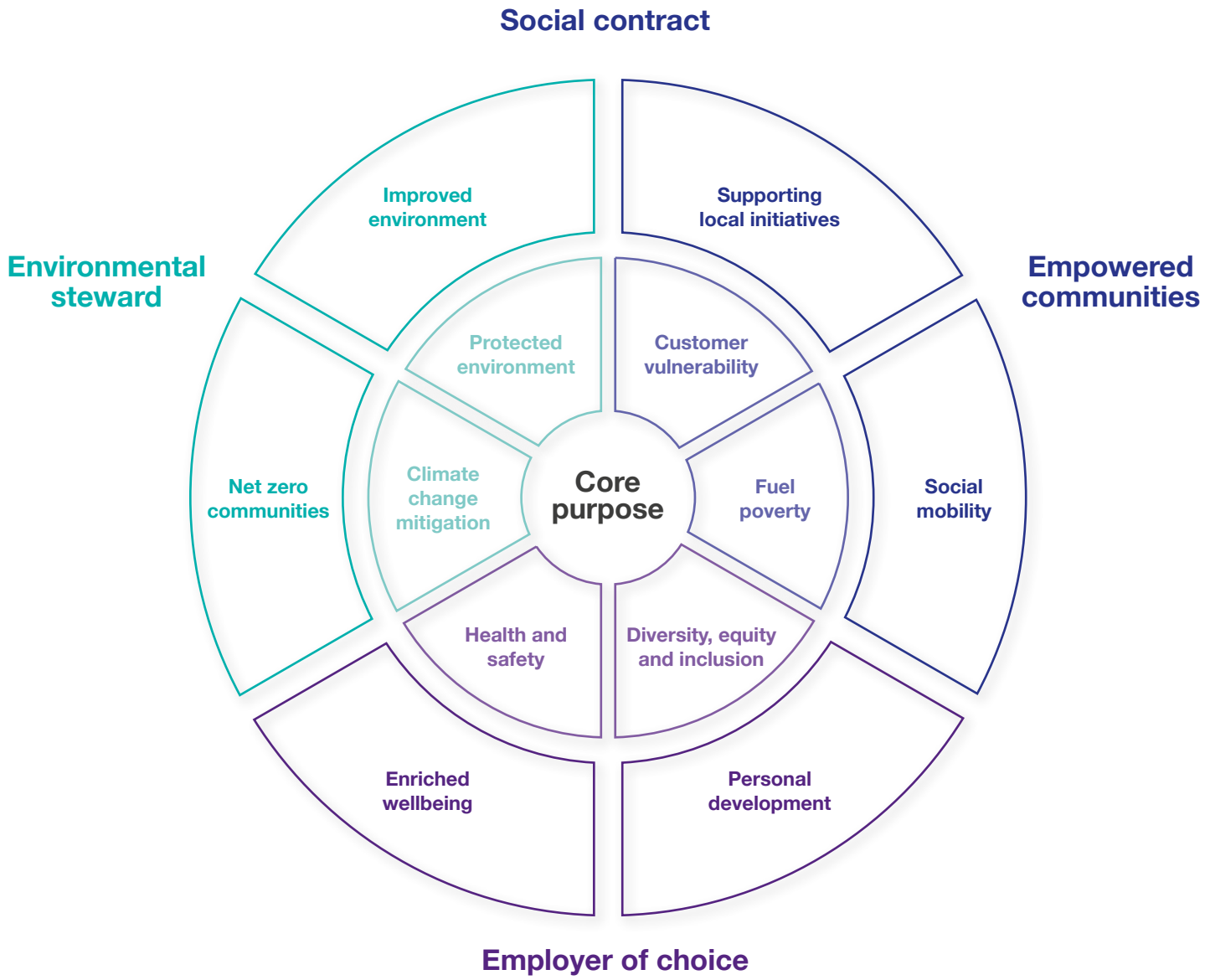
To demonstrate our commitment to act as a good corporate citizen and deliver positive contributions to society, our employees and the environment, NGED is the first DNO to develop and publish a social contract in July 2021.

The document provides a framework for ongoing responsible business practice that enables NGED to demonstrate the delivery of our purpose, and is the first time our efforts have been consolidated and formalised within a single strategy.

The three focus areas: “Employer of choice”, “Empowered communities” and “Environmental steward” each contain key actions for NGED 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 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 delivering the net zero transition.

To ensure these promises are meaningful and impactful, the Social Contract is a ‘living document’ defined by ongoing engagement and improvement to meet the evolving needs of our communities, with a report and action plan published annually.



Section 2.0

Managing our environmental impact

2.1 Introduction

We are 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 helps us 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. 2021/22 has been another challenging year as we continue to recover from the Covid-19 pandemic however our responsibility to protect the environment has not wavered and we have continued to work successfully with our supply chain, environment regulators, local authorities and local interest groups.

2.2 Protected landscapes

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

While overhead lines are widely accepted as being part of the countryside, there are a number of protected landscapes, including National Parks and Areas of Outstanding Natural Beauty ("AONBs") across our geographical footprint where removing our overhead lines and replacing them with underground cables would visually improve matters.

We coordinate the undergrounding of overhead lines with established steering groups consisting of representatives from AONBs and National Parks who help us identify and prioritise where work will take place.

We provide information and appropriate assistance to stakeholders to help them in scheme selection including budget costing and feasibility assessments.

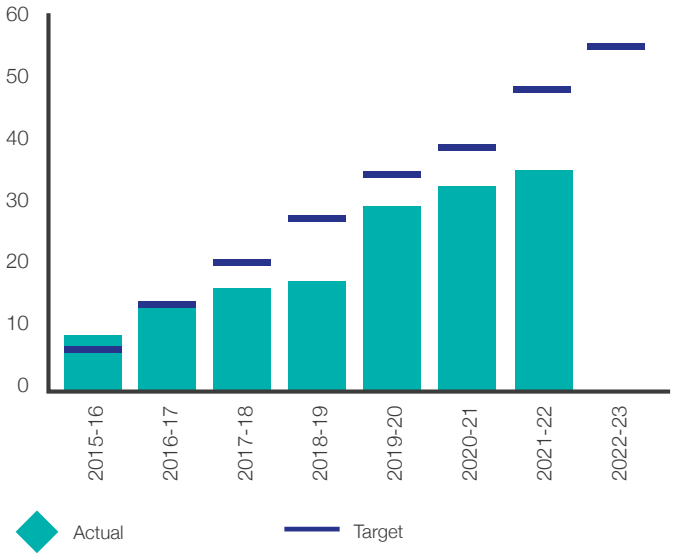
During the RIIO-ED1 period we committed to underground 55km of overhead lines within National Parks and AONBs.

We rely on the steering groups to nominate suitable undergrounding schemes and during the RIIO-ED1 period so far we have completed 35.5km (64%) of undergrounding overhead lines within National Parks and AONBs, see Fig 2.2 opposite.

Table 2.2 Undergrounding in National Parks and AONBs (km)

	Target for RIIO-ED1	Completed (to date)
South Wales	10.0	2.9
South West	21.0	8.8
East Midlands	10.0	9.7
West Midlands	14.0	14.1
NGED Total	**55.0**	**35.5**

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



Further details regarding our undergrounding schemes in National Parks and AONBs can be found in Appendix A.

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. We are also putting 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.

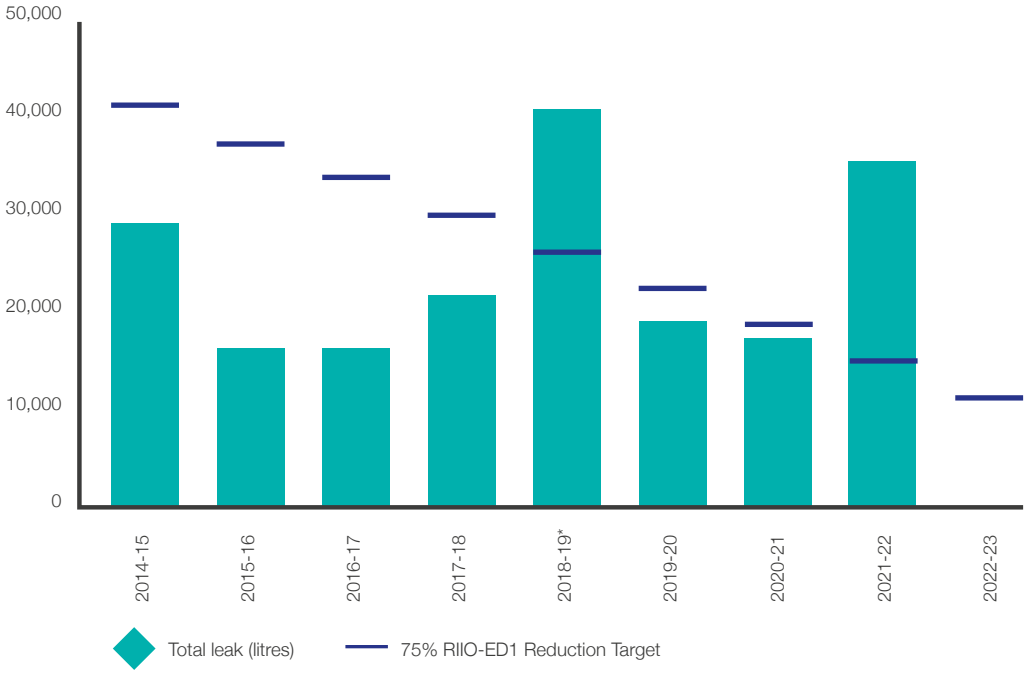
To minimise environmental damage we aim to ensure that:

- 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. Monthly reports of fluid filled cable leaks are submitted to both the Environment Agency and Natural Resources Wales.

Fig 2.3 NGED Fluid filled cable leaks vs. RIIO-ED1 reduction target



*2018/19 - 5 circuits accounted for 60% of the volume of fluid lost

There were 81 oil mitigation schemes covering cables, operational and non-operational activities reported for 2021/22, of which 13 were in South Wales, 44 in West Midlands, 10 in East Midlands and 14 in the South West.

In 2021/22, we had a significant incident in the South West where the deterioration of one cable was attributable to 39.7% of the total cable fluid lost throughout our four licence areas.

The cable had previously been PFT tagged but the leak itself took time to locate with large sections alongside the cable excavated to identify the source of the leak. A series of repairs were carried out and we continue to work with the Environment Agency to put in place appropriate mitigations to capture the lost oil where possible.

2.3.1 SF_6 mitigation schemes

During RIIO-ED1 we have undertaken 14 SF_6 mitigation schemes, of these 7 have been in the South West, 1 in South Wales, 5 in West Midlands and 1 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 2.4.1 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
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
	Buildings – other fuels	1	207.6	193.1	192.5	220.2	246.48	211.46	216.45	387.51
	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
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
	Rail	1	0.0	0.0	0.0	0.0	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
	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
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
	Rail	3	21.6	20.6	21.97	21.8	20.66	18.84	0.02	13.14
	Sea	3	0.0	0.3	0.97	0.1	0.00	0.04	0.00	0.00
	Air	3	106.4	41.5	92.37	124.1	241.05	179.61	3.98	2.45
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
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
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
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
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**

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

During 2021/22 NGED's total BCF (excluding losses and including contractors) across all four licence areas has increased by 1.4% compared to 2020/21 but decreased by 35.3% compared to the base year performance in 2014/15.

Since 2014/15 our annual BCF (including losses) has reduced by 57.5% or 1,154,294.6 tCO_2e – the approximate equivalent carbon footprint of heating 427,517 average UK households.

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

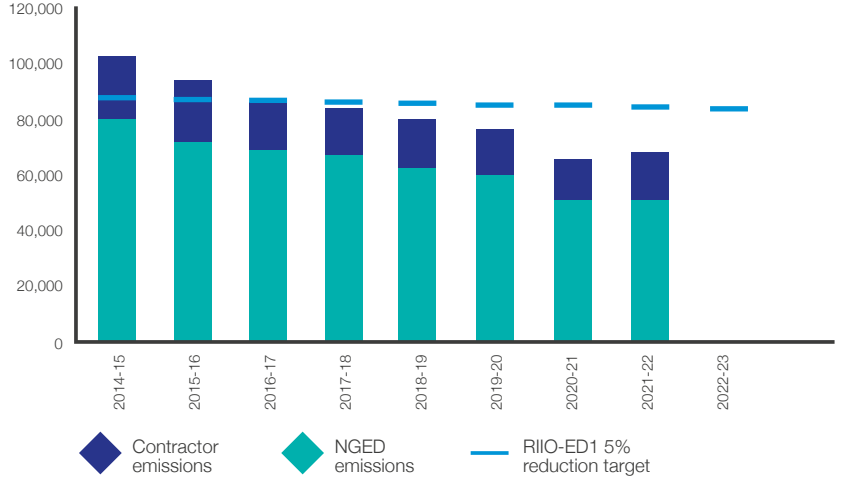


Fig.2.4.1b Annual BCF (tCO_2e) including network losses

59%

Since 2014/15 our scope 2 carbon emissions (excluding losses) has reduced by 23,820 tCO_2e or 59%.

63%

Since 2014/15 electricity usage in offices and depots has reduced by 63%.

2.4 Carbon impact and climate change

2.4.1 Business Carbon Footprint

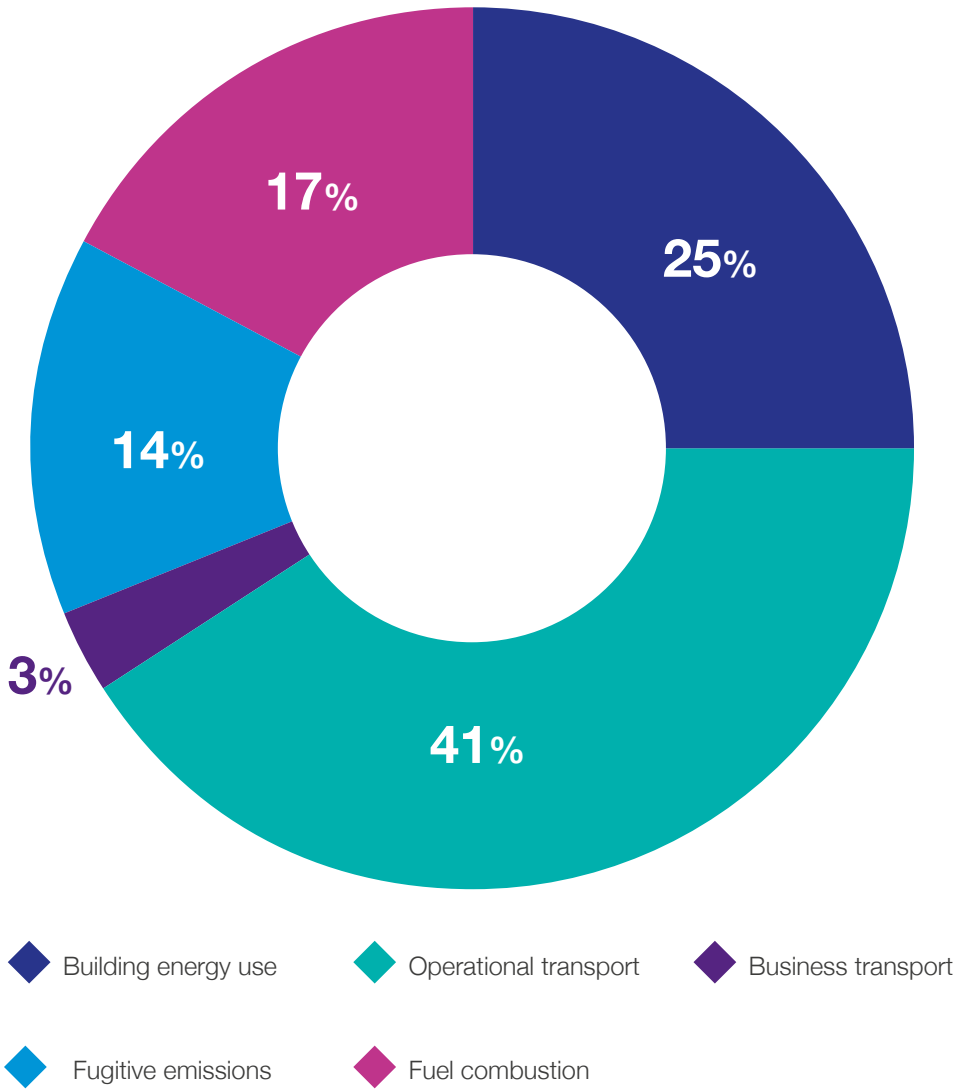
Figure 2.4.1c shows the proportion of activities that make up our Business Carbon Footprint. Similar to previous years, the main contributors to our Business Carbon Footprint (excluding losses but including contractor emissions) is Operational Transport (41%) and Building Energy Use (25%), although building energy use has reduced by 5% compared to 2020/21.

Throughout the remainder of RIIO-ED1 we will focus on reducing the impact which both operational transport and building energy use (including energy use at substations) 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% of the total BCF for 2021/22 an increase of 1% on the previous year. We continue to remain committed to investigating and finding alternatives to SF_6 and 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 25% of 2021/22 BCF, a decrease of 5% on the previous year. 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 41% of our overall 2021/22 BCF, with no change since 2020/21. 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 the roll-out of our company wide Driver Behavioural System (DBS). Furthermore throughout 2021/22 we have started 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 (excluding losses)



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.

In line with our core commitments, the RIIO-ED2 Business Plan stands to replace 89% of our existing commercial van vehicle fleet with electric vehicles by 2028. Whilst 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.

During the remainder of RIIO-ED1 there is a programme of replacing smaller vans with an electric vehicle equivalent. To date, 166 small vans have now been replaced with the electric Nissan ENV200.

We will also replace at least 35 of our worst polluting mobile generators during RIIO-ED2, as part of our commitment to net zero.

These will be replaced with modern, more efficient, improved emission versions.

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).

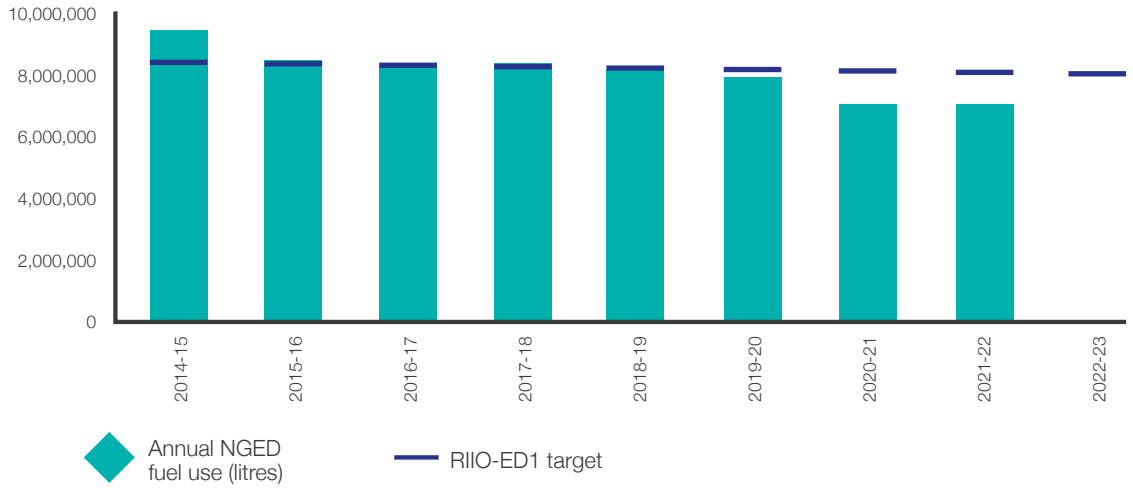
We have performed well during 2021/22 with reductions in both the litres of fuel used per NGED vehicle and the total volume of fuel used for operational road vehicles across the business, better than our RIIO-ED1 target level.

By continuing with our vehicle replacement programme and raising awareness of the impact of driving style and the continued roll-out of our Driver Behavioural System (DBS) we will continue to make progress towards meeting our RIIO-ED1 5% reduction target for annual fuel use whilst having a positive impact on our vehicle emissions.

We have introduced a Driver Behavourial System (DBS) in to our operational vehicle fleet. The DBS influences individual driver style and fuel efficiency and has 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.

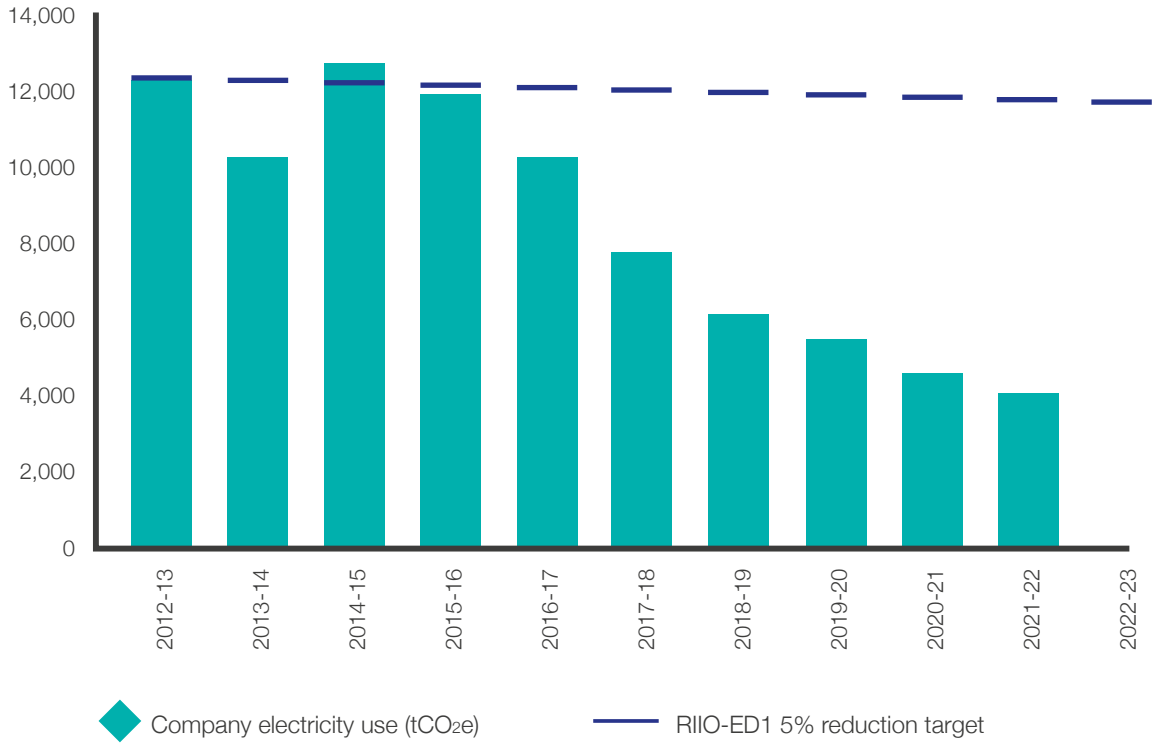
Local improvements include:

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

Property redevelopments improve employee awareness and energy efficiency measures and lead to energy savings. This is evident in the electricity usage we recorded in our overall BCF reporting. We propose to save around 5% of carbon associated electricity used in offices and depots over the RIIO-ED1 period. As demonstrated we are more than meeting this target with a reduction in excess of 63% 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.

In 2021/22 we have delivered our overall target to reduce the amount of SF_6 gas that is lost from switchgear by 17%. On a like-for-like basis, targets have been achieved in all licence areas. Whilst there are limited options available for suitable equipment at 33kV and below, we are in the process of trialling air insulated switchgear for 132kV live tanks.

During 2021/22, we have installed SF_6 free equipment at two 132kV sites in the South West with no performance issues identified to date. We hope that the trial of these live tanks will lead to the adoption of SF_6 free equipment as standard for this particular asset category. We are also actively working with multiple manufacturers on their development of SF_6 free apparatus at all voltages.

Fig. 2.4.2a shows that our annual SF_6 leak rate (like-for-like top ups only) is 0.10% and in relation to our baseline year we are meeting our RIIO-ED1 target.

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)

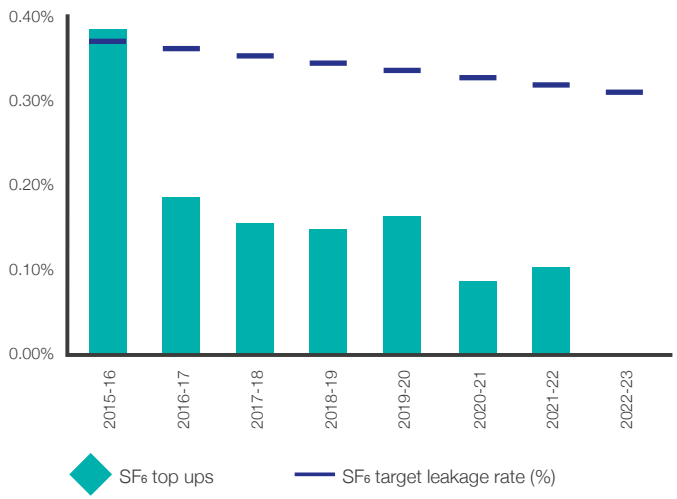
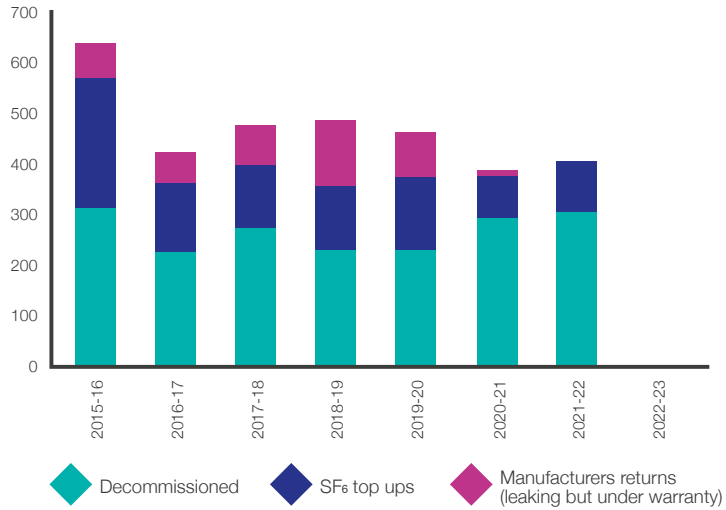


Fig. 2.4.2b Annual SF_6 losses (kg)



SF_6 leakage rates continue to reduce, 2021/22 leak rate (like-for-like top ups only) is

0.10%

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 due to operational issues
- units returned to manufacturers for further investigation.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

NGED's 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 SMETS2 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.
- 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 are undertaking the:

- pro-active replacement of 1,996 distribution transformers for those with increased efficiencies
- 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 licence areas of NGED
- introduction of three phase service cables and three phase cut-outs, where reasonably practicable, for all new builds and service alterations as BAU.

Some highlights from 2021/22 include:

- the continued pro-active replacement of 1,996 distribution transformers
- the design intervention for losses on new installation of 8,184 distribution transformers and 11,880 kilometres of underground cables
- completed installation of 88 amorphous cored 25kVA single phase PMTs
- the on-going development of the losses page on the NGED website
- continued membership of the ENA Technical Losses group
- ongoing voltage reduction across NGED
- the Installation of three phase LV service and cut outs for new connections and upgrades became BAU or network planners
- Twerton 33/11kV transformer change completed in preparation for the conversion to 11kV (from 6.6kV) to free up 30% capacity on the network
- electric vehicle charging – roughly 52,000 domestic EV chargers connected to our network
- large scale connection of heat pumps – roughly 10,000 installed on our network.

From July 2021, all newly manufactured small, medium and large power transformers were required to meet EU Ecodesign Tier 2 Regulation 548/2014, which ensures that transformers meet defined standards of efficiency.

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Asset replacement

NGED's work to uprate assets continued through 2021 and will continue 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, have 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.

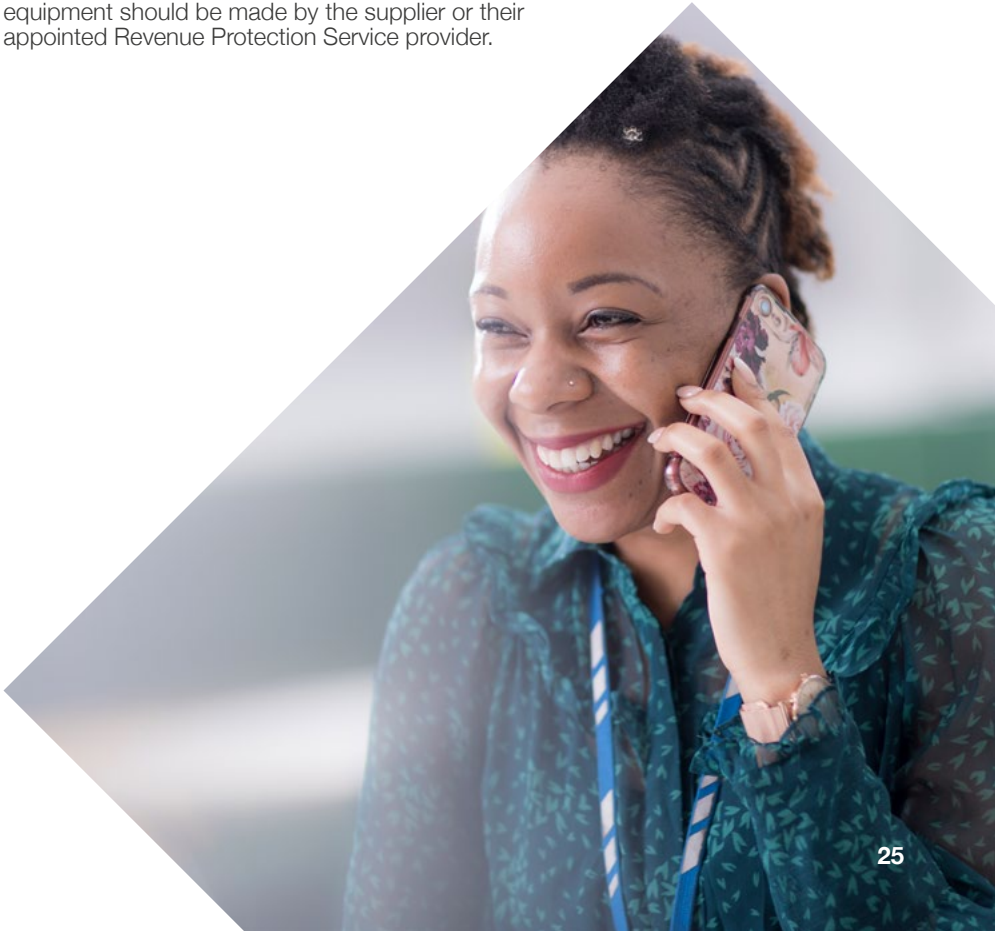
(b) Pursue Customers for the value of units stolen where there is theft in conveyance and we have the right to pursue the Customer.

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

Plans for 2022 and beyond

NGED plans for 2022 are to build on the work done so far and move the company's focus to new areas of potential increased losses. NGED will continue to increase focus towards LCTs and, in particular, the effects of de-carbonisation of transport with EV charging and the de-carbonisation of heating with the installation of HPs.

Continued and future actions are as follows:

- continuation of the asset replacement scheme started at the beginning of RIIO-ED1
- HV phase imbalance and power factor
- desktop studies of the LV network and customer connections using data supplied by installers of domestic solar, electric vehicle charging and heat pumps
- conversion of legacy networks i.e. Bath 6.6kV to 11kV at Twerton due to start following completed substation upgrades. This will free up 30% of capacity, thus reducing losses
- assessment of other legacy 6.6kV networks that may be converted to 11kV
- continued monitoring and analysis of the three phase housing estate in Parc Eirin, South Wales
- continue building the enhanced network for partners Pobl and Sero Homes in retrofitting the Blaen-y-Maes Housing Estate. Our teams are installing new substations, laying new LV mains circuits and de-looping the houses to enable the connection of LCTs
- installation of pad mounted low loss transformers to support car park EV charging installations
- continuation of installation of three service cables and cut-outs as BAU
- continuous improvement of processing and systems for smart meter data to enable effective analysis and real-time network monitoring.

Parc Eirin LCT Connected Estate

Work on site has recovered following the pandemic and more residents continue to occupy the estate.

It should be noted that all the devices on the estate are single phase with the exception of the EV charger.

The housing estate is being fully monitored on the 11kV and LV side with a view to ascertaining the losses and load balancing on a "hybrid" three phase connected housing estate, when compared to the single phase connected houses in the Losses Investigation Project on the Isle of Man.

Initial findings, by Loughborough University show that losses are reduced by using three phase service cables on new build properties. At this time, we are looking for another project where all devices are three phase.

Retrofitting housing with LCTs

According to the Centre for Ageing Better, 21% of all homes in the UK were built before 1919, 38% were built before 1946, and only 7% after 2000, making the UK housing stock the oldest in the EU[1].

Large sections of NGEDs existing 11kV and LV mains networks were designed for 1950s, 1960s and 1970s where the electricity usage assumptions and building fabric standards at the time of installation were lower than the building standards first introduced during the 1990s.

As stated, NGED are involved in the design exercise of the Optimised Retrofit Project (ORP) with the Welsh Government, Pobl and Sero Homes at Blaen-y-Maes. Roughly 700 homes will be retrofitted with LCTs and the structure of the buildings brought up to an EPC A rating.

Our teams are installing new substations, laying new LV mains circuits and de-looping the houses to enable the connection of LCTs. The Innovation team in NGED are now looking at undertaking an innovation project which would use information from the ORP to incorporate building fabric into electrical system design.

1 Clarke, S. More than 1m over 55s living in hazardous homes Home Care Insight study finds. 09/05/2019. **homecareinsight.co.uk/more-than-1-million-over-55s-living-in-hazardous-homes-study-finds/**

2.4 Carbon impact and climate change

2.4.3 Distribution losses

Plans for 2022 and beyond

Small size pole mounted transformers

The iron losses for an amorphous cored 25kVA single phase transformer compared to an identical CRGO cored 25kVA single phase transformer using the following formulae shown below:

no-load losses = no-load loss in watts *relevant hours

The total iron loss for 1 year are:

Amorphous 25kVA transformer= 140W
CRGO 25kVA transformer = 569W

This gives an iron loss saving of 429W per year per transformer when using the single phase 25kVA 11kV amorphous cored transformer. Using the Ofgem price of 48.42 £/MWh for losses, this equates to a cost saving of per transformer per year of £20.78 (iron losses only). For the 88 that we have installed, this results in a total saving of £1,828.64 per year. Across a lifetime of 40 years, that equates to £73,145.60.

Car Park EV Charging

To support the facilitation of EV charging infrastructure, we are working with Schneider Electric in Leeds to specify and offer a 1.6MVA Metalclad Distribution Substation to chargepoint operators (CPOs) as a single customer.

This will allow the CPO to connect more or larger chargers at LV than a typical 1MVA supply and enables an LV connection rather than HV. In addition, this solution will offer a reduced footprint with a single point of contact for the customer, along with reduced installation and commissioning time.

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
Total annual losses (GWh)	4,125	3,651	3,713	3,918	3,548	3,807	3,997	3,713
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

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 2021/22 we successfully achieved recertification 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 intend to start the roll out of a companywide Competent Management System (CMS) which will replace the current WAMITAB competence qualification at our permitted sites.

For the first time since 2014, no major nor minor non-conformances were raised during our 2021/22 ISO14001 recertification audit.

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

We work closely with all of our waste contractors ensuring that wherever possible waste streams are diverted from landfill, applying the principles of the waste hierarchy throughout.

During 2021/22 the total tonnage of waste produced has marginally increased by 3% compared to the previous year.

For the fourth 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.

During 2022/23 we will continue to target zero waste to landfill across all four of our licence areas, furthermore we will aim to reduce the amount of waste which we produce, 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.

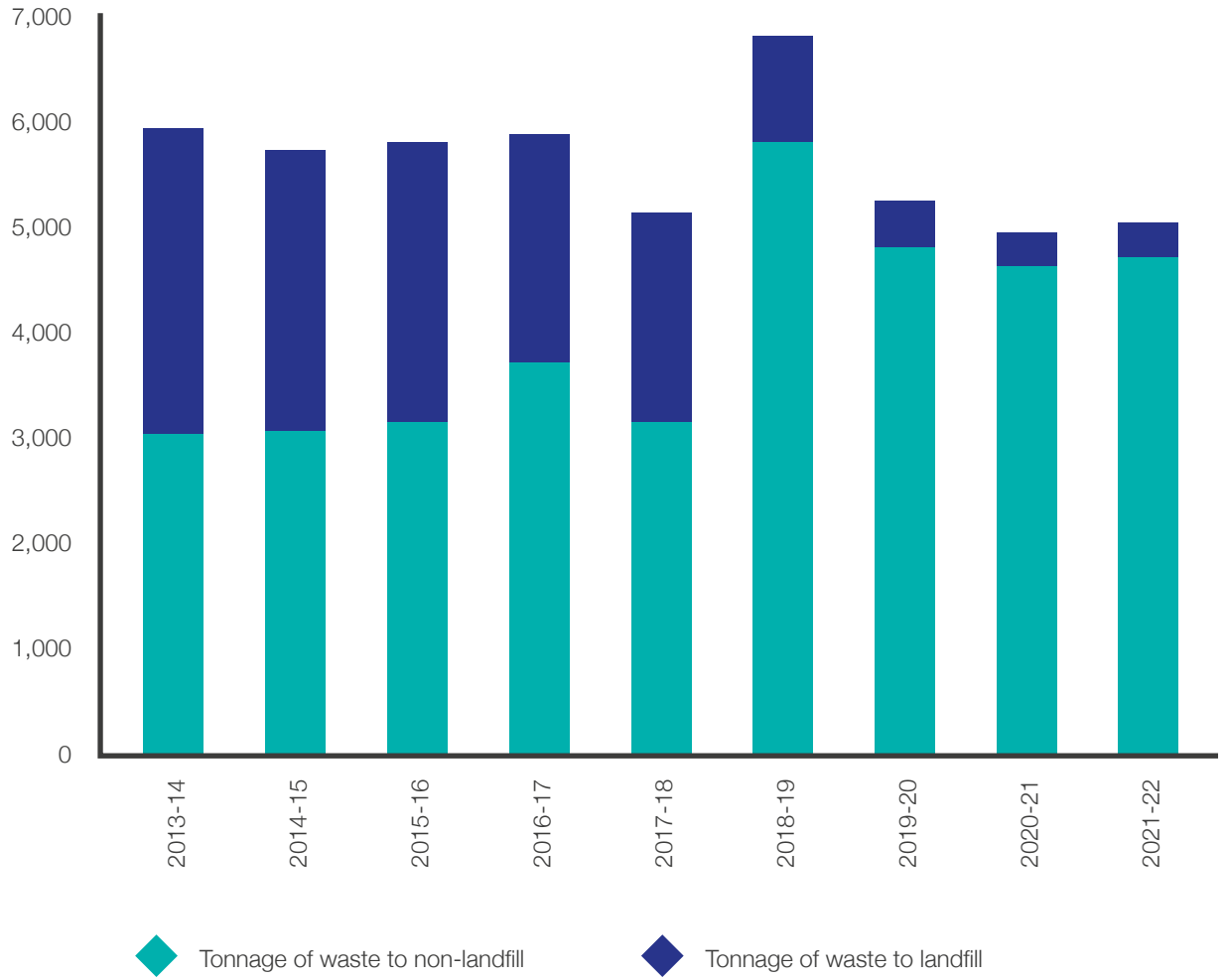
We met the initial 20% reduction target from 2015/16 to 2017/18 and we have continued to outperform the 5% reduction target year on year. In 2021/22, we disposed just 8.8% of our waste to landfill.

The overall tonnage of waste produced by NGED in 2021/22 has increased by 145 tonnes from our 2020/21 total of 4,885 to 5,030 - see **Fig. 2.5.2a.** This slight increase is to be expected following BAU resuming after the COVID-19 pandemic.

This 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 2021/22, our distribution licence areas in South Wales, East Midlands and also West Midlands have routinely achieved zero waste to landfill. Our aim for 2022/23 is to reduce further the waste we dispose to landfill in our South West distribution licence areas and continue to improve our recycling percentages across the entire business and reduce our reliance on energy to waste disposal.

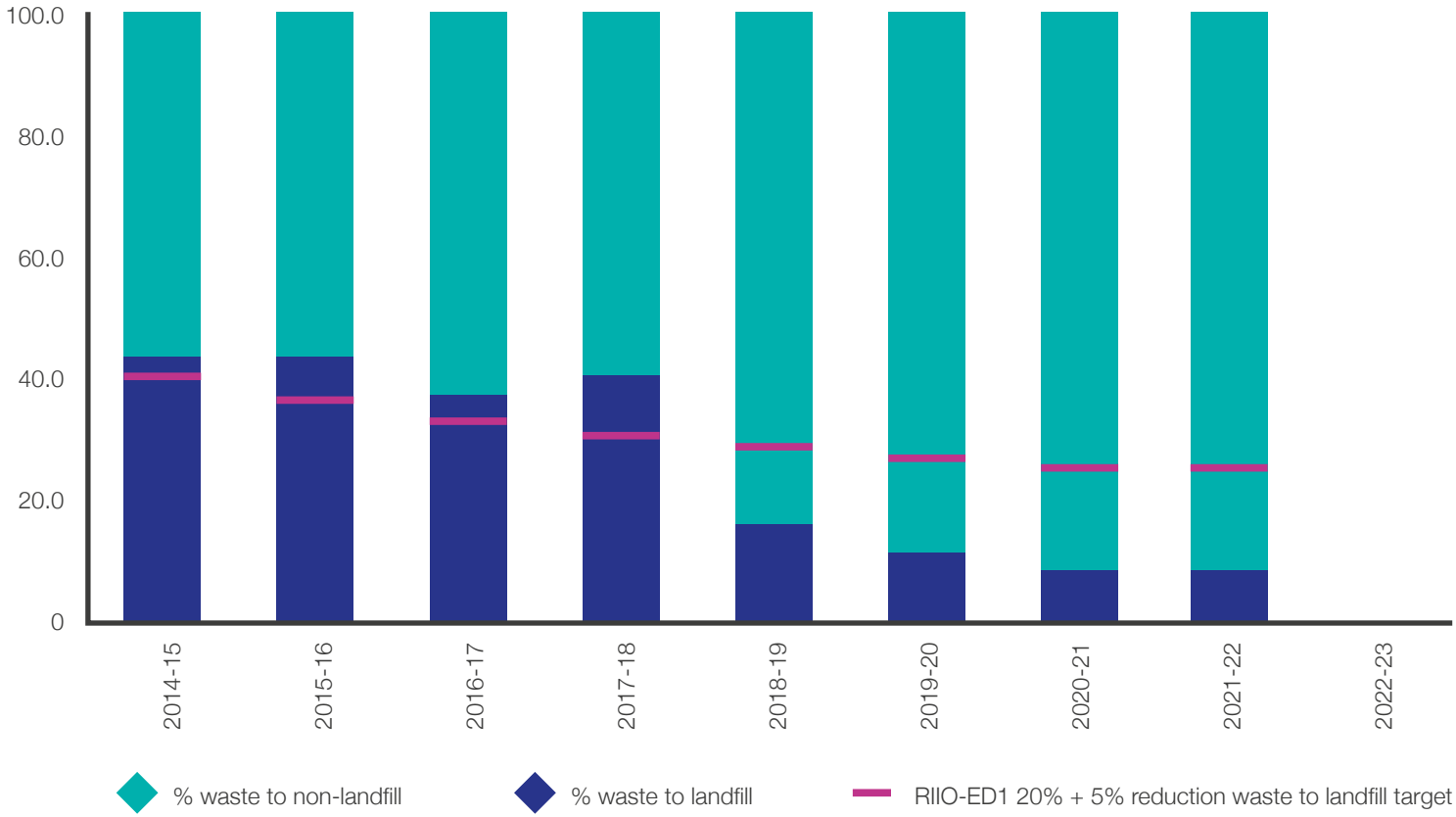
Fig. 2.5.2a Total tonnage of waste – non-landfill vs. landfill



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 waste target for the last four years.

2.5 Other environment related activities

2.5.2 Waste management

Although the overall tonnage of waste and tonnage to landfill has slightly increased in 2021/22, we are still on track to achieve our RIIO-ED1 target.

Waste initiatives

During 2022/23 we must continue to 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 reduce further our reliance on both landfill and recovery disposal.

Single use plastics

Our stakeholders are keen for us 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 further evaluation of our incoming goods is expected to yield more opportunities and examples where items may be substituted.

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

This will give us a platform from which we will 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 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, and in turn their significant negative effects on human health 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 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 2021/22

136 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).

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

14,271 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 and that of NGED could potentially have on the environment is a key requirement of our environmental management system.

As we move out of the COVID-19 pandemic we have continued to deliver environmental awareness training throughout the organisation, while spending more time in the business engaging directly with staff and colleagues. This includes recording a selection of podcasts and informational videos for both internal and external use on topics such as net zero, biodiversity and waste.

Safety, Health and Environment (SHE) Conferences
2021/22 NGED SHE Conferences have been held, both online and in person at locations across each of our four licence areas. Each Conference has been well supported by NGED senior management with both NGED employees and many of our contractors attending.

Environmental sustainability is now a well established agenda item at every NGED SHE Conference and during 2021/22 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 2021/22 and despite the Covid-19 pandemic we have continued to deliver, albeit remotely, 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
- 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 NGED 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 NGED's 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. In 2021/22, we have worked in partnership with Groundworks Wales and The Conservation Volunteers and supported them to plant 2,123 trees.

The recent environmental initiatives that we have supported through our community funding include:

Saltwells Nature Reserve

Around 2,000 trees have been planted with the help of TCV in Saltwells Nature Reserve near Dudley. Tree planting and associated woodland management tasks, including the removal of bramble and ground ivy which is suffocating the woodland floor, was carried out.

These areas will allow for more light to reach the ground to allow bluebells, wood anemone, primrose, and other plants to flourish. This site is a great example of breathing new life into former mining land.

Volunteers at Saltwells nature reserve

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.

The three new community orchards are based at Parc Slip Nature Reserve, Bryngarw Country Park in Bridgend and Dare Valley Country Park in Aberdare. A new orchard at the 500-acre Dare Valley Country Park, near Aberdare, will be managed by volunteers and will host events themed around the fruits grown.

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.

Sirhowy Valley Woodlands Group volunteers and Coleg Gwent students

Volunteers at Bryn Bach Park

In addition, Sirhowy Valley Woodlands Group volunteers and Coleg Gwent students gained an Agored Cymru qualification in tree planting in the course of planting 25 trees at Sirhowy Hill Woodlands in Blaenau Gwent. More mature trees were chosen for this site and will hopefully bear fruit this year so an apple pressing day for the community can take place this autumn.

Coleg Gwent students also planted 20 new trees at Parc Bryn Bach nature reserve in TredegarIn Merthyr Tydfil at Cyfarthfa Park Primary School, fruit from nine trees will be sold as snacks by pupils at the popular Big Bocs Bwyd. It will also be used in educational activities, such as creating bird feeders from fallen or rotten apples that cannot be eaten, illustrating how waste can be minimised.

At nearby Cyfarthfa Park, the new community orchard will be looked after by conservation volunteers, education groups and the public. Produce from 20 trees will make cakes and juices for the Hive café run by local environmental group Merthyr Naturalists.

At Cwmcarn forest in Caerphilly County, 20 fruit trees have been planted within easy access of camping and caravan sites. The site is popular with cyclists and outdoor enthusiasts.

2.5 Other environment related activities

2.5.5 Community environmental support and awareness

Wildflower planting in Bristol school

Children from St Barnabus Primary School in Bristol have planted 100 native wildflowers in an effort to bring more nature into their school grounds.

Lucy Hellier, Avon and Wildlife Trust learning manager, explained: "Lots of schools are embracing the idea of attracting wildlife to their school grounds but need some help to maximise the best of the space available. We were able to offer advice on what to plant to create a wildflower meadow which will provide vital habitat for pollinators and be an enjoyable area for the children to explore and identify local wildlife."

This project supports schools in their vital role in giving children enriching experiences in nature and ensuring that children learn about the importance of wildlife and taking action to protect it.

One of the students at the school taking part in the planting

Energy savings promotion

Energy efficiency is another key contributor to preserving our environment, so we featured a campaign promoting ways that NGED 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 in January 2022. A dedicated webpage was also set up and developed to offers tips and signposting further agencies for support: **nationalgrid.co.uk/customers-and-community/energy-saving-tips**

In September 2021 we launched the new and improved Power Discovery Zone website having revamped many of our teaching resources and developing our new super hero characters to appeal to school children by engaging them in activities in an interactive and interesting way.

The 'Circuit Squad' includes our renewables and energy efficiency mascot Ecobot, who has been given a new look and extra resources to be used online and in schools to promote ways of saving energy, a quiz on renewables and more.

Since its release in September 2021, the new Power Discovery Zone has seen 9,062 unique visits with 2,322 direct interactions with our games up to March 2022.

Some of those interactions have been entire classes playing together on a big screen in the classroom.

To view the downloadable resources and tasks about renewable energy and how to save energy, visit: **powerdiscoveryzone.nationalgrid.co.uk**

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 eventually race electric kit cars with the assistance of NGED 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.

NGED supplied the kit cars, the STEM ambassadors and will eventually provide transport to the race day events, ensuring the project comes at no cost to the schools. NGED have two teams based in the South West who are currently working towards their race days this summer.

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 2021/22, we have been researching which BNG metrics are most suitable for NGED.

Natural England 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.

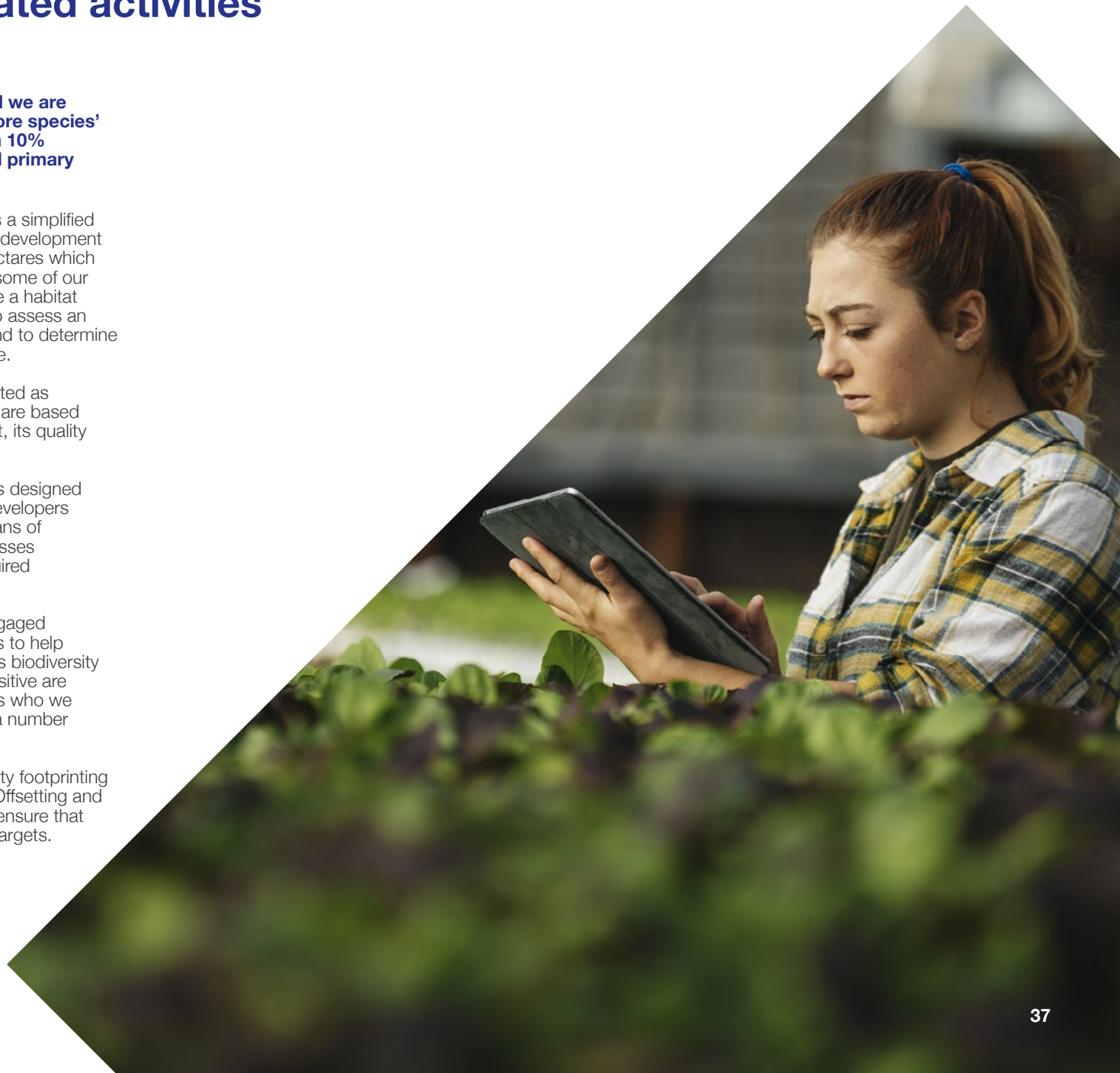
The Small Sites Metric is a simplified version for use on small development sites of less than 0.5 hectares which could be applicable for some of our projects. The metrics are a habitat based approach used to assess an area's value of wildlife and to determine a proxy biodiversity value.

This value will be presented as biodiversity units, which are based on the size of the habitat, its quality and location.

The Biodiversity Metric is designed to provide ecologists, developers and planners with a means of assessing biodiversity losses or gains and will be required for mandatory BNG.

In 2021/22, we have engaged with external consultants to help guide us in achieving this biodiversity commitment. Nature Positive are environmental specialists who we will be working with on a number of key areas.

For example a biodiversity footprinting exercise and a Carbon Offsetting and Biodiversity Strategy to ensure that we meet our RIIO-ED2 targets.



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.

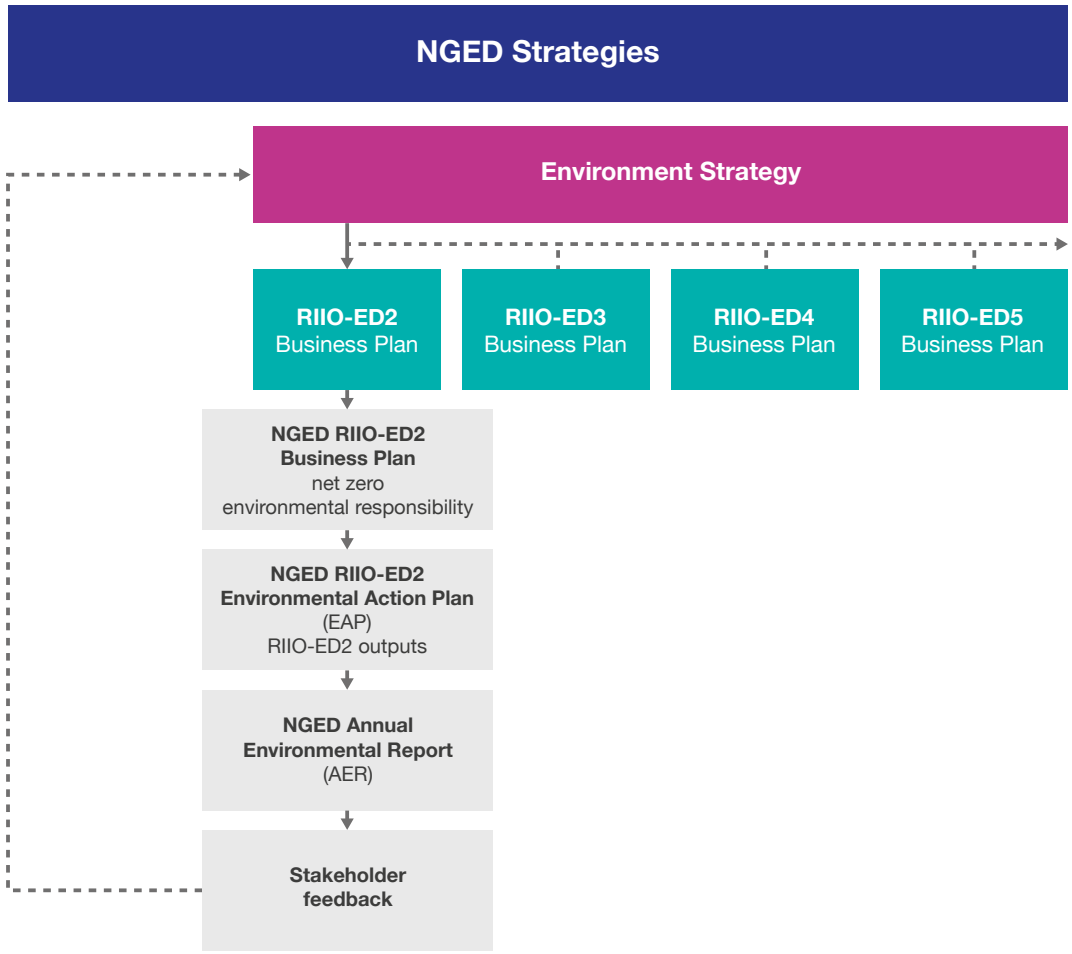
The two core strategic business areas that our strategy is based on are:

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

We are beginning to align 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 not just positive environmental impacts but also beneficial social and economic impacts too. 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

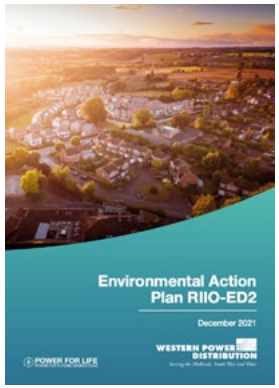
Ensuring sustainable consumption and production patterns. The onset of the global coronavirus pandemic (Covid-19) offers an opportunity to develop recovery plans that will reverse current trends and shift our consumption and production patterns to a more sustainable course. A successful shift will mean 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 EAP sets out our ambitions and core commitments:

- achieve net zero in our internal business carbon footprint by 2028 (excluding network losses) and follow a verified Science Based Target of 1.5°C to limit the climate impact of our activities
- 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
- significantly 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
- significantly 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

Innovation is core to our business strategy. We innovate to adapt to the changes in our network, facilitate the delivery of net zero and continue to improve our network performance and customer service.

To ensure that our network remains affordable, we are continuously providing more flexible solutions that are better, cheaper or quicker than the current ways of doing things.

Our Innovation Team is dedicated to working with our business experts, external partners and customers to identify problems, find solutions and trial them through our innovation projects.

Our commitments

We recognise that as a Distribution Network Operator 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 29 active Network Innovation Allowance (NIA) projects. Two key projects providing significant learning have been the **VENICE** project which is helping ensure no one is left behind in the transition to net zero and the **FLOWERS** project which is working across utilities to explore the potential capacity on South West Water's network for flexibility in the time difference between when the water is pumped, stored and used.

Following the success of our previous NIA Third Party Calls, we ran our fifth call, where we received 66 submissions from 44 organisations. We took two of these ideas forward into our new NIA project, **DEFENDER**.

This project is enabling us to accurately assess the impact of energy efficiency retrofits on current and future network demand, and is also helping us understand the business case for investment in retrofit as an alternative to reinforcing the network.

3.2 Progress of the innovation strategy

Our Innovation Programme

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

NIA Projects	
ACCELERATED (Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution)	NEAT (Network Event and Alarm Transparency)
ACE (Active Creosote Extraction)	Optimal Co-ordination of Active Network Management Schemes and Balancing Services Market
ALARM (Automatic Location of Arc-faults through Remote Monitoring)	Overhead Line Power Pointer
ALPACA (Approach for Long term Planning Accounting for Carbon Assessment)	Peak Heat
ARC-Aid	PNPQA (Primary Networks Power Quality Analysis)
DEFENDER (Demand Forecasting Encapsulating Domestic Efficiency Retrofits)	Pre-Fix
DynaCov (Dynamic Charging of Vehicles)	Presumed Open Data
EDGE-FCLi (Embedded Distribution Generation Electronic Fault Current Limiting Interrupter)	SEAM (Spatially Enabled Asset Management)
Electric Nation - PoweredUp	SHEDD (System HILP Event Demand Disconnection)
EPIC (Energy Planning Integrated with Councils)	SMITN (Smart Meter Innovations and Test Network)
FLOWERS (Flexible Operation of Water Networks Enabling Response Services)	Take Charge
Future Flex	Temporary Event Charging
Harmonic Mitigation	VENICE (Vulnerability and Energy Networks, Identification and Consumption Evaluation)
Intraflex	Wildlife Protection
LTE Connecting Futures	

NIC Projects		
EFFS (Electricity Flexibility and Forecasting System)	DC Share	EQUINOX (Equitable Novel Flexibility Exchange)

In the period between April 2021 – March 2022 we have been delivering 29 NIA projects and 3 NIC projects.

3.2 Progress of the innovation strategy

3.2.1 Key projects

The Flexible Operation of Water Networks Enabling Response Services (FLOWERS)

The Flexible Operation of Water Networks Enabling Response Services (FLOWERS) project is analysing the potential capacity on South West Water's network to embed flexibility capacity within the time difference between when drinking water and waste water is pumped and stored.

Water networks are one of the largest demands for electrical power supplied on distribution networks, estimated at 1TWh across our four licence areas.

Currently Water and Sewage license holders only deliver limited flexibility to help manage their electrical demand.

FLOWERS will explore methods of delivering flexibility and analyse the feasibility of implanting it on South West Water's system.

It will define the regulatory requirements for the creation of a flexibility product which can be embedded within electricity network control rooms.

Lessons learned

A potentially large unforeseen issue with modifying water network pumping capacity may be the infiltration of sea water into coastal water networks.

In some cases, the condition of the pipes results in an estimated 90/10 ratio between sea water and waste water in the water network pipes. As such, waste water pumping in these areas is near constant and potential to vary this may be slim.

South West Water's control room is entirely reactive, responding to alarms related to minimum and maximum set points for pumping stations with no forward forecasting or proactive pumping.

This presents an opportunity, as the introduction of proactive pumping could have electricity network triggers baked in, but would necessarily require additional software and equipment.

Customer benefits

It is anticipated that this project will develop a capacity for embedded flexibility with water networks.

It is conservatively estimated that this project can deliver 0.25% of water network demand as flexibility. This amounts to 750MWh of capacity extracted from South West Water's network yearly. Replicated across the breadth of the four licence areas, this could unlock upwards of 2.5GWh of flexibility capacity on water networks.

Using data from RIIO-ED1 to estimate the savings from flexibility, an alignment of only 5% of unlocked flexibility capacity with constrained zones would deliver an estimated £2.5 million of value to customers from South West Water's network, and £8.5 million from all water networks in NGED's licence areas.

Planned implementation

As the FLOWERS project is a feasibility study, its planned implementation is dependant on its final outcomes.

If successful, it is expected that the project will build and trial the system in a future innovation project.

This trial would include further exploring the commercial and regulatory relationships required, demonstrating the scale of flexibility possible and the benefits this brings, ensuring the technical specifications are ready to be used following a successful trial.

3.2 Progress of the innovation strategy

3.2.1 Key projects

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

Infrastructure is associated with over half of UK greenhouse gas emissions (Source: The Infrastructure Carbon Review, 2013), and 30% of this is made up of emissions that we have direct control over, such as construction, operation and maintenance of infrastructure.

Approach for Long term Planning Accounting for Carbon Assessment (ALPACA) is developing a way to measure the carbon dioxide we emit through our activities.

This project is working closely with other teams within our business and our regular suppliers to work out how we will record all the data required to find the total carbon impact, and develop a tool which can compare the carbon impact of different options.

Lessons learned

So far in this project we have looked at the best practices from various different sectors. This found a suitable and rigorous framework (called PAS 2080), but found that there will need to be more data made available to account for all the carbon which is emitted.

We have also found that the energy transmission companies, notably National Grid, Scottish Power, and Scottish and Southern Energy Networks, have formed a collaborative group to address the carbon emissions that arise with the maintenance and development of their networks.

There is the potential for collaboration with these groups as part of this project.

Customer benefits

Having a carbon accounting tool will provide a consistent approach to comparing the environmental impact of different design options, and will allow us to inform our network design, construction, and maintenance.

A reduction in carbon impact is expected to pass on benefits to consumers by a reduction in cost, as well as combatting climate change, which is a key priority for the nation.

In addition, the development of this tool could lead the way for other companies, both in the power distribution industry and wider, to create their own carbon accounting approach.

Planned implementation

This project is bringing a new process to our company, which will firstly provide us with an agreed whole-life carbon accounting system to see the actual footprint of our activities.

This will then allow us to weigh up the carbon impact of different options, and be able to choose our designs and products to minimise the carbon emitted wherever practical.

This will require us to gather and record more data about what we do, and require suppliers to report how much carbon is emitted from their work too.

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 System Voltage Optimisation (SVO) 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.

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.

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

Asset management

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

3.4 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 2021/22 period is provided in table 3.4.1.

Fig: 3.4.1 Smart meter penetration

Licence area	East Midlands	West Midlands	South Wales	South West	Total
No. MPANs	2,709,888	2,528,691	1,167,302	1,683,980	8,089,861
No. SMETS1	764,754	727,197	310,643	409,996	2,212,590
No. SMETS2	658,185	537,962	273,274	372,445	1,841,866
Total penetration	**52.5%**	**50%**	**50%**	**46.5%**	**50%**

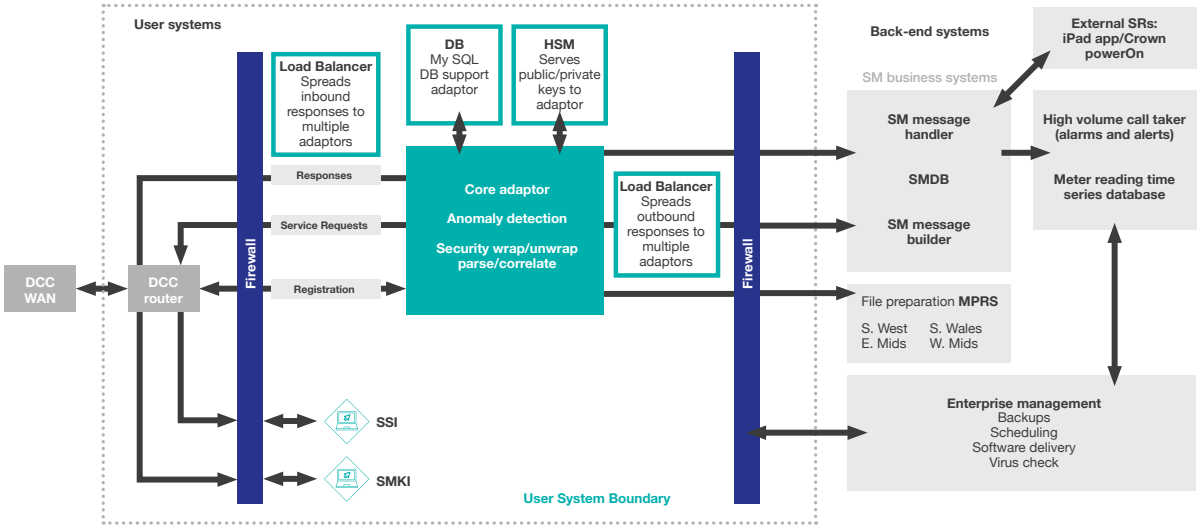
The Smart Meter Rollout is being managed by Energy Suppliers in the UK and although the initial programme of installations was due to end in 2020 this has now been extended until 2024.

3.4.2 Status of IT and communications investments (DS)

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

We have successfully completed the update and implementation of our systems in line with DCC R4.0 and the Enrolment and Adoption programme. In addition to proving system functionality we have successfully passed an independent audit to ensure our security architecture and environment meets the security requirements of the overall national programme.

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. Energy Suppliers are now targeting the remaining customers to join the program and this will only increase our overall penetration throughout the remainder of the rollout.

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.

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

Our innovative solutions allow customers to connect their assets (typically generation but demand can also be accommodated) at reduced cost and within quicker timescales, but in exchange for some form of curtailment, where cost-prohibitive network reinforcement would otherwise be required.

Soft Intertrip
Some networks are constrained due to a single upstream asset requiring reinforcement, or a single limit being infringed under certain conditions.

The Soft Intertrip solution utilises a Connection Control Panel, which provides two normally open contacts for the customer's control system to monitor: Stage 1 and Stage 2. When both contacts are open, the connection will be unconstrained.

The levels of curtailment corresponding to the operation of the Stage 1 and Stage 2 contacts are fixed at the planning stage and form part of the connection agreement.

Active Network Management (ANM)
This solution is a more sophisticated evolution of the Soft Intertrip solution and used mainly with larger new connections and primarily generation.

It involves the installation of an enhanced Connection Control Panel, which is installed and commissioned into a NGED central control system allowing for full dynamic control of the connected load.

Timed Connection
Based on time of day, day of the week or seasonal factors, these connections are offered based on historical data analysis. By understanding the conditions which would adversely affect the network and limiting a customer's loads during certain time periods, the connection can be permitted subject to local control mechanisms and retrospectively through metering data. No additional equipment or remote communications are required by NGED.

Export Limitation Schemes
These schemes measure the Apparent Power at the exit point of the installation and then use this information to either restrict generation output and/or balance the customer demand in order to prevent the Agreed Export Capacity from being exceeded. The equipment required is customer owned and provided, to NGED minimum standards.

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 2021/22
South Wales RRP Environmental Innovation 2021/22
South West RRP Environmental Innovation 2021/22
West Midlands RRP Environmental Innovation 2021/22

Appendix B

RRP Environmental Innovation Commentary 2021/22

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