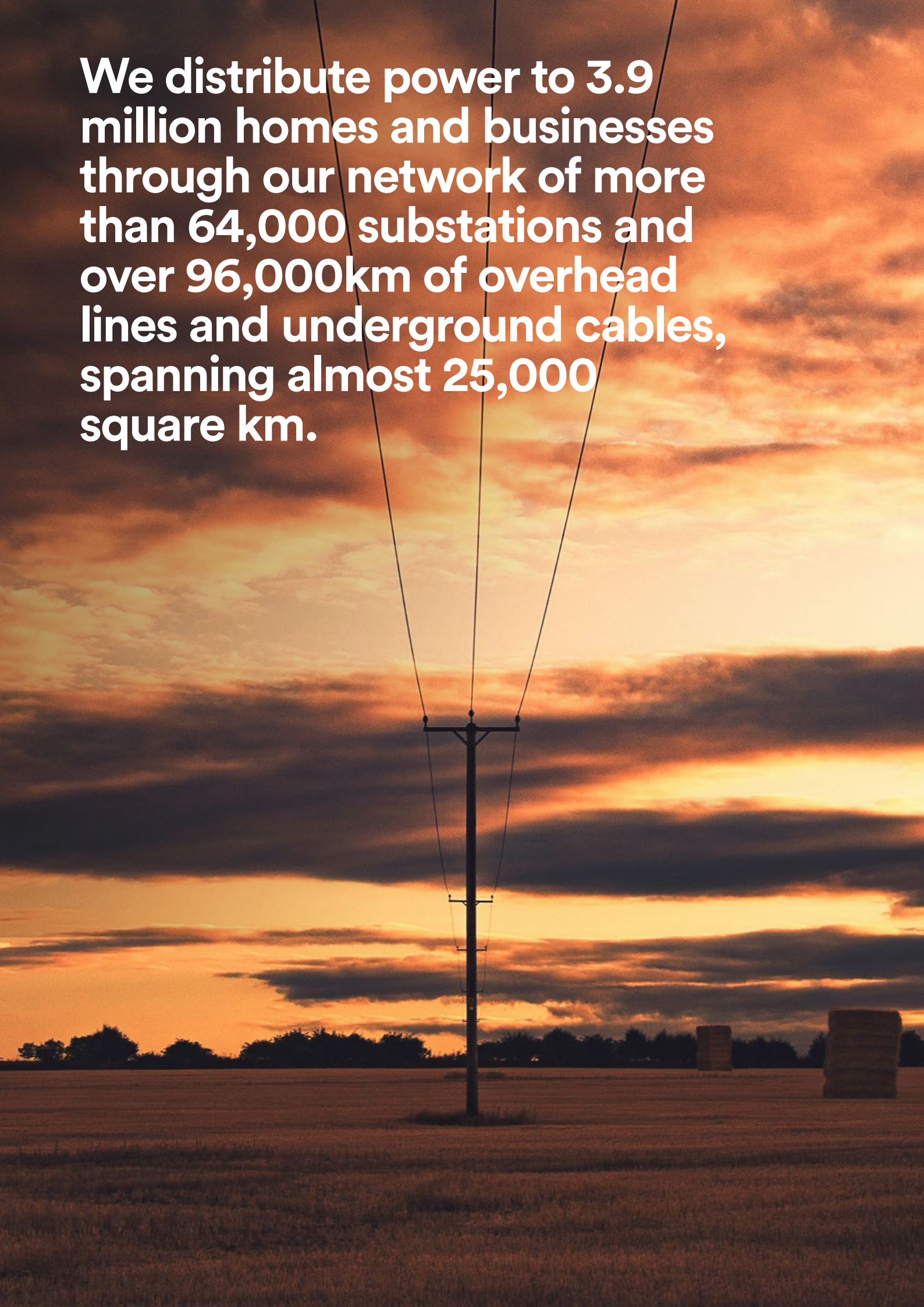
NORTHERN POWERGRID

Environment Report

2019-20



We distribute power to 3.9 million homes and businesses through our network of more than 64,000 substations and over 96,000km of overhead lines and underground cables, spanning almost 25,000 square km.

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1. Introduction

We continue to outperform on our environmental targets and expanding our diverse innovation project portfolio.

1.1 Executive summary

As we have commenced consulting our stakeholders on the environmental targets we should be setting for the next price control period (RIIO-ED2), we continue to be focused on delivering the best possible performance to our current price control (ED1) targets. We have outperformed all of the commitments we made in our ED1 business plan. Last year, we outlined how we've challenged ourselves still further by introducing stretch targets to drive even more environmental improvements, and we are on track for achieving these.

We have already achieved a 44% business carbon footprint reduction during ED1, and we have introduced a stretch target to drive further reductions. This year, we achieved our best ever performance in sulphur hexafluoride (SF_6) reduction, losing a very small amount of gas (0.17%) as a percentage of the total volume of gas we have contained.

We achieved the 90% smart meter intervention target for category B jobs with 91%, however the category A target was missed at 83%. As we receive more than double the reports forecasted our performance is measured against a significantly higher report volume.

Enabling the transition to meet the net zero emissions' target for our region is a major part of our focus. In December 2019, we published our Distribution Future Energy Scenarios (DFES), which set out a number of pathways, and the associated assumptions, for the decarbonisation of generation, transport, and heat in the area served by Northern Powergrid. The data published represent a regional interpretation of National Grid's scenarios and, to enable regional collaboration, we have published the DFES in an open data format, facilitated by the Open Data Institute in Leeds. In 2020-21, we will be updating our scenarios to reflect the latest emissions' reduction targets and the feedback from our stakeholders.

Innovation underpins the development of services for our customers and our support for the wider energy system transition low carbon. We continue to deliver innovation projects that are relevant for our stakeholders and support the energy system transition. In 2019-20, we invested £4.1m in 32 innovation projects.

Taking actions to support new flexibility markets is a key part of our work to support regional decarbonisation at least cost. In the year, we ran our first flexibility e-auction, seeking tenders for emergency response. Our approach is to scan for opportunities for flexibility and, during this period where our needs are limited, build capability, processes and systems.

Key facts
Environment and innovation in 2019-20

207MW
of renewable generation connected in 2019-20

44%
reduction of our carbon emissions in ED1 to date

68.7km
Total length of overhead lines removed from National Parks and Areas of Outstanding Natural Beauty

£4.1m
invested in 32 innovation projects in 2019-20

1.2 Our business

We are Northern Powergrid. We are responsible for the network that takes electricity from power stations and smaller generators to 3.9 million homes and businesses across the North East, Yorkshire and northern Lincolnshire. We are here 24 hours a day, seven days a week, 365 days a year to make sure that the electricity you need gets to you safely, whenever and wherever you need it.

If, for any reason, your power gets interrupted, it will be us who come to fix it and we will respond night or day.

We have c.2,600 employees responsible for more than 64,000 substations and over 96,000km of overhead power lines and underground cables, spanning c.25,000 square km.

The amount of revenue that we recover from our customers is defined by Ofgem through a price control review process and our performance is monitored on a yearly basis, from 1 April to 31 March. The current eight-year period is called RIIO-ED1 and lasts from 2015 to 2023[1].

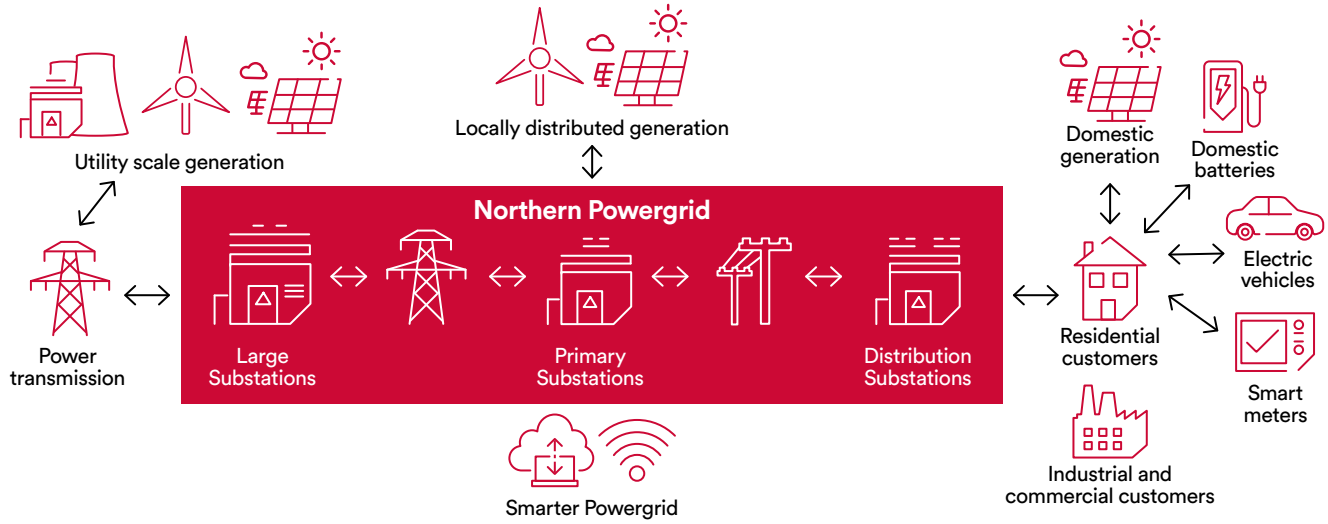
We are committed to promoting environmental awareness, best practice and legal compliance among all our staff. We take our environmental responsibilities seriously and manage the environmental impact of our activities very closely. This includes our carbon footprint, the risk of noise, water and land pollution, waste recycling and caring for wildlife. We also manage the visual impact of our overhead lines, balancing the requirements of running our network with our stakeholders' expectations.

Our Environmental Management System is certified to ISO14001:2015 and has been subject to two surveillance audits during 2019-20, both concluding positively.

Our regional structure enables our teams to best serve the local needs of our customers

[1] For more information, refer to: ofgem.gov.uk/network-regulation-riio-model/riio-ed1-price-control

Where we fit in the electricity industry



1.3 Purpose of the report

Environmental Respect is one of six core guiding principles for all Berkshire Hathaway Energy companies, including Northern Powergrid. We recognise the wider role and the impact our activity can have in the communities where our customers live and work because we live and work there too.

We believe our reputation and the trust held by our stakeholders, be they customers, special interest groups, the energy industry or partners, should be nurtured and this report shows how we turn words into deeds.

This report aims to provide stakeholders with an account of what we are doing to address environmental matters, including our role in the transition to a low carbon future. Throughout the year we meet with our stakeholders to discuss what they would like us to do; here, they are able to read about the progress we have made. We describe all of our innovation activity to provide stakeholders with a single source of information, even if it is not all directly related to the environment. We also provide the data and information that we submitted to our regulator as part of our annual regulatory reporting cycle. This information is included in the annexes to this report as well as published on our website, accessed using the links on this page.

The information presented in this report meets the guidance issued by our regulator. Significantly, the structure of the report is consistent with those produced by other Distribution Network Operators (DNOs) to aid comparison and cross-referencing between companies. If you have any views or additional questions, get in touch at yourpowergrid@northernpowergrid.com.

Environmental Respect

We are committed to using natural resources wisely and protecting our environment for the benefit of future generations. Our Environmental RESPECT Policy details this commitment in the areas of Responsibility, Efficiency, Stewardship, Performance, Evaluation, Communication and Training.

Associated documents:

— **Annexes 1 to 7 to the Environment Report 2019-20**, October 2020 – this is a copy of our submission to the regulator and consists of data tables.

— **Detailed commentary associated with the annexes to the Environment Report 2019-20, October 2020** – this is a copy of our submission to the regulator and consists of commentary associated with the data tables.

— **Cost benefit analyses** – these are numerous analyses that support net benefit calculations as submitted to our regulator.

All are available from northernpowergrid.com/your-powergrid/environment

— **The Stakeholder Annual Report, October 2020** – this report sets out the commitments we made and our progress against them, for the main areas of the business. It is available from: northernpowergrid.com/your-powergrid

Our performance measures*	2018–19 actual	2019-20 actual	2019-20 target	Status	2020-21 target	ED1 target	Trend
Carbon footprint excl contractors (tonnes CO_2)	17,723	**16,772**	**-**	Achieved	-	-	▲
Carbon footprint incl contractors (tonnes CO_2)	35,673	**33,365**	**56,869**	Achieved	-	33,500**	▲
SF_6 lost to atmosphere (kg)	65	**63**	**112**	Achieved	-	50**	▲
Oil loss from all sources (litres)	34,314	**33,810**	**48,681**	Achieved	-	28,325**	▲
Cumulative km fluid-filled cables replaced to reduce oil loss	94.7	**145.3**	**110.1**	Achieved	-	224.4**	▲
Cumulative km overhead lines undergrounded in protected landscape	55.1	**68.7**	**61.1**	Achieved	-	120**	▲
Street works inspection compliance (%)	93%	**96%**	**>90%**	Achieved	-	>90%	▲
Number of Environment Agency reportable incidents each year	12	**7**	**25**	Achieved	-	7**	▲
Smart meter intervention performance (category A)***	83%	**83%**	**90%**	Missed	90%	90%	▶◀
Smart meter intervention performance (category B)***	93%	**91%**	**90%**	Achieved	90%	90%	▼

KEY: ▲ performance has improved
▼ performance has worsened
▶◀ no change

* Reflects our ED1 business plan target unless otherwise stated

** Reflects a stretch target

*** Our smart meter intervention target is based on achieving an agreed level of service on Ofgem's 2% assumption of defect rates for all smart meter installations. The defect reports we have received is more than twice of the forecasted amount. Therefore, although we have formally missed the target by 1%, our performance is measured against a significantly higher report volume.

2. Managing our environmental impact

2.1 Introduction

We are committed to minimising the impacts our activities have on the environment. About a third of the total length of our cables and lines is overhead, and we work with our stakeholders to minimise the visual impact of these assets in National Parks (NPs) and Areas of Outstanding Natural Beauty (AONBs). Some of our cables are filled with oil, and we report here on what we're doing to reduce the risk of leakage.

We also explain how we manage our carbon footprint, particularly that coming from our use of the SF_6 gas, and losses from our network. Finally, we provide an overview of our climate change adaptation plans and highlight any specific activities taking place during the year.

Figure 1: Designated areas in our regions (National Parks and Areas of Outstanding Natural Beauty)

[2] For more information about costs and length of cables undergrounded, refer to Annex 1 (our annual submission to the regulator).

2.2 Visual amenity: Moving overhead lines underground to reduce their visual and environmental impact

Overhead electricity lines can have an impact on the appearance of the landscape and affect local wildlife. It's our statutory duty to bear in mind the purpose of NPs and AONBs (collectively known as 'Designated Areas') and conserve the biodiversity within them. We have a special programme of work dedicated to removing overhead lines selected by stakeholders and replacing them with underground cables in these Designated Areas. Four NPs and five AONBs fall either partly or entirely in our two licence areas. The lengths of overhead line within each area as of 31 March 2020 are shown in Figure 1.

	Designated area and stakeholder	Length of overhead line (km) – March 2020
1	North Yorks Moors	1,162
2	North Pennines	713
3	Nidderdale	581
4	Yorkshire Dales	587
5	Northumberland	342
6	Howardian Hills	259
7	Northumberland Coast	83
8	Lincolnshire Wolds	435
9	Peak District	200
	Total	4,363

In 2019-20 we spent £0.56m in Yorkshire and £1.77m in the North East[2] and put 13.6km of overhead lines underground. Our total budget for the eight-year regulatory period which ends in 2023 is £14.7m and this budget is split between the Designated Areas according to how much overhead line falls within its footprint (see Figure 1). **We're on track to meet our commitment to place 97.9km of overhead lines underground earlier than expected (by 2021-22) and then go on and remove a further 20km as a result of an additional £2m investment.**

In 2020, we are investing £1.25 million to enhance the stunning landscape in and around Fountains Abbey & Studley Royal World Heritage Site. Working in partnership with Nidderdale Area of Outstanding Natural Beauty (AONB) and the National Trust, which operates the Fountains Abbey & Studley Royal estate, we are replacing 8km of overhead power lines with almost 10km underground cable as well as building five new ground mounted substations, which will supply the local community.

Our stakeholder engagement and support

We work closely with stakeholders from each of the NPs and AONBs so that together we can improve visual amenity for the communities who live in and visitors who travel to these beautiful areas. Our programme steering group, made up of representatives from our stakeholders and members of our design, wayleaves and delivery engineer teams, meet up twice a year to identify and prioritise projects and discuss any other issues including policy development and publicity.

We maintain day-to-day control over this work and provide regular feedback to stakeholders. We appreciate that many of our stakeholders are facing pressures on their resources so we support them as best we can and work efficiently as we deliver this important work together.

Our strategy for project assessment and delivery, including analysis of costs and benefits

Our undergrounding programme is designed to meet the needs of representatives from the Designated Areas. We're aiming to make it easy for them to access the information and expertise they need to make an informed choice.

We invite representatives from the Designated Areas to state their preference for underground schemes, in line with the jointly agreed Assessment and Stakeholder Participation Policy. The stakeholders draw up a priority list of potential projects taking into account the characteristics of each site and the visual and environmental impact of the overhead line. This leads to each site being given a Stakeholder Rating which, alongside our own engineering wayleaves and value-for-money assessment, results in a project either progressing to authorisation or being deferred or cancelled. It's a thorough methodology which helps our stakeholders make informed decisions. For simplicity, we only report the resulting score in Table 1, where you will find the status of projects proposed by stakeholders.

"The undergrounding work by Northern Powergrid will significantly enhance the experience of the 600,000 people who travel to this special place every year, from the UK and across the globe. Every day we carry out vital conservation work that takes us closer to our goal of restoring the garden to its eighteenth-century heyday and this fantastic project helps us to fulfil that ambition."

Sarah France, World Heritage Site Coordinator at Fountains Abbey & Studley Royal

120km

Overhead line removal commitment in Designated Areas by 2023

13.6km

Length of overhead lines removed in Designated Areas this year

Table 1: List of schemes progressed by stakeholders against the 2015-2023 budget

Designated Area	Location	Length of line (km) for undergrounding	Stage in the process	Stakeholder Rating*
Howardian Hills AONB	York, Bulmer Village	1.5	5 – Complete	36
	Cawton	0.4	5 – Complete	60
	Crambe	0.2	5 – Complete	28
	Low Easthorpe	0.6	5 – Complete	98
	Ganthorpe	0.3	5 – Complete	39
	Nunnington West	0.3	5 – Complete	45
	York – Oswaldkirk 1	1.9	3 – Confirmed by stakeholder and ready to deliver	45
	Grimstone Top	1.2	3 – Confirmed by stakeholder and ready to deliver	60
	Beacon Banks, Husthwaite Lists	0.6	1 – Proposed for design and feasibility	48
	Castle Howard Guest	0.6	1 – Proposed for design and feasibility	60
	Yearsley	0.9	1 – Proposed for design and feasibility	24
	Welburn	0.7	1 – Proposed for design and feasibility	36
	Howardian Hills AONB Total	**8.9**		
Lincolnshire Wolds AONB	Tealby Village, Market Rasen	2.6	5 – Complete	135
	Stainton Le Vale	1.1	5 – Complete	126
	Grimsby, Irby	0.4	5 – Complete	105
	Market Rasen, Stainton Le Vale	0.6	5 – Complete	
	Hatcliffe – Waithe Beck	0.8	5 – Complete	48
	Hainton	4.0	5 – Complete	162
	Donington on Bain Mill to Welsdale Bottom	2.6	5 – Complete	288
	Louth, North Elkington	3.9	5 – Complete	204
	Stenigot Mast	2.5	3 – Confirmed by stakeholder and ready to deliver	228
	Louth, Withcall	2.4	3 – Confirmed by stakeholder and ready to deliver	153
	Withcall to Pokes Hole	3.0	2 – Proposed and awaiting land consents	288
	Market Rasen, Benniworth Donnington	3.2	2 – Proposed and awaiting land consents	
	Market Rasen, Claxby Village	5.2	2 – Proposed and awaiting land consents	
	Lincolnshire Wolds AONB Total	**32.3**		
Nidderdale AONB	Otley, Higher Carr	2.9	5 – Complete	
	Otley, Clifton Village	2.3	5 – Complete	90
	Weston, Eastwood Cottages	1.7	5 – Complete	10
	Ripon, Fearby	0.7	5 – Complete	
	Harrogate, Ramsgill	0.5	5 – Complete	
	Harrogate, Middlesmoor	0.5	5 – Complete	
	Harrogate, Wath	0.4	5 – Complete	
	Keighley, Denton Village	0.2	5 – Complete	150
	Harrogate, Thornthwaite	0.2	5 – Complete	
	Fountains Abbey – Various Sites	5.6	3 – Confirmed by stakeholder and ready to deliver	375
	Studley Cafe and Pheasantry SS's	1.2	3 – Confirmed by stakeholder and ready to deliver	
	Studley Royal	0.5	3 – Confirmed by stakeholder and ready to deliver	
	Fountains Centre	0.5	3 – Confirmed by stakeholder and ready to deliver	
	Studley Roger West	0.1	3 – Confirmed by stakeholder and ready to deliver	
	Timble	1.1	2 – Proposed and awaiting land consents	252
	Nidderdale Total	**18.5**		

*Stakeholders assess the impacts and benefits of a scheme using a consistent methodology which gives some consideration to the characteristics of the site and of the overhead line, as well as to the visual and environmental impact of the latter. The resulting scores are reported here as an indication of the prioritisation that the scheme is likely to be given relative to others in the same Designated Area. A higher score suggests the site has been given a higher prioritisation by our stakeholders (scores range between 10 and 420, with a median score of 115).

Table 1: continued

Designated Area	Location	Length of line (km) for undergrounding	Stage in the process	Stakeholder Rating*
North York Moors National Park	Saltburn, Hinderwell	0.8	5 – Complete	30
	Coxwold	0.6	5 – Complete	39
	Thorgill, Rosedale	0.3	5 – Complete	36
	Thimbleby	0.4	5 – Complete	
	Wass	0.4	5 – Complete	27
	Kildale	0.5	5 – Complete	18
	Rosedale Chapel	0.2	5 – Complete	33
	Thirsk, Boltby	0.8	5 – Complete	36
	Pickering, Low Dalby	0.7	5 – Complete	18
	Over Silton	0.6	5 – Complete	144
	Hinderwell West	0.2	5 – Complete	
	Fylingdale Sw – Hawsker Sea View	3.4	5 – Complete	391
	Hawsker York	0.2	5 – Complete	120
	Silpho	0.5	5 – Complete	126
	Danby Castle	0.3	5 – Complete	306
	Farndale Lowna	0.3	5 – Complete	280
	Ayton Garth	0.3	5 – Complete	209
	Ayton Yedmandale	0.2	5 – Complete	209
	Ainthorpe Davidson & Ainthorpe Brook	0.6	5 – Complete	110
	Pockley	0.6	5 – Complete	108
	Ainthorpe East	0.2	5 – Complete	110
	Ellerby 1	0.3	5 – Complete	108
	Mickleby	0.7	5 – Complete	77
	Staithes Bank Top SS	0.2	5 – Complete	272
	Newholme	0.4	5 – Complete	420
	Low Dalby Beck	2.0	5 – Complete	224
	Rosedale Chapel	0.1	5 – Complete	
	Dunsley village	0.3	5 – Complete	420
	Wass	0.1	5 – Complete	
	Egton Bridge West	0.4	5 – Complete	168
	Ellerby 2	0.1	5 – Complete	108
	Cowesby	0.4	5 – Complete	100
	Newholme North SS	0.3	5 – Complete	
	Whitby, Kildale Percy	0.3	5 – Complete	
	Hawsker Summerfield	0.2	5 – Complete	100
	Boulby Brow	0.2	5 – Complete	
	Danby	1.0	4 – Construction in progress	110
	Hawsker and Hawsker West	1.3	3 – Confirmed by stakeholder and ready to deliver	99
	Thornton Dale Westgate S/S	0.4	3 – Confirmed by stakeholder and ready to deliver	160
	Port Mulgrave	1.9	3 – Confirmed by stakeholder and ready to deliver	238
	Thornton Dale	0.6	2 – Proposed and awaiting land consents	160
	Low Mill South	1.0	1 – Proposed for design and feasibility	
	North York Moors National Park Total	**24.4**		
North Pennines AONB	County Durham, Rookhope Village	1.3	5 – Complete	
	Consett, Muggleswick	0.3	5 – Complete	
	County Durham, Consett	0.3	5 – Complete	
	Hexham, Catton Village	0.6	5 – Complete	13
	Middleton Teesdale	0.5	5 – Complete	15
	Westgate West SS, Bishop Auckland	0.3	5 – Complete	
	St Johns Chapel	0.5	5 – Complete	110
	Newbiggin Teesdale	0.1	5 – Complete	15
	County Durham, Rookhope Village	0.4	5 – Complete	
	Eastgate	0.9	5 – Complete	156
	Co.Durham,Yellocksike	0.5	5 – Complete	130
	Eastgate	0.2	5 – Complete	
	Co.Durham, Ireshopeburn	1.4	5 – Complete	168
	Ireshopeburn	0.0	5 – Complete	

Table 1: continued

Designated Area	Location	Length of line (km) for undergrounding	Stage in the process	Stakeholder Rating*
North Pennines AONB	Rookhope Head	3.8	3 – Confirmed by stakeholder and ready to deliver	
	Hexham, Allendale	1.2	3 – Confirmed by stakeholder and ready to deliver	
	Allenheads South	0.6	1 – Proposed for design and feasibility	
	North Pennines AONB Total	**12.9**		
Northumberland Coast AONB	Howick Village	0.7	5 – Complete	144
	Beadnell	0.3	5 – Complete	144
	Northumberland Coast AONB Total	**1.1**		
Northumberland National Park	Ingram Village	0.9	5 – Complete	99
	Hexham, Tarset, Low Eals	0.5	5 – Complete	90
	Morpeth, Harbottle	0.3	5 – Complete	
	Rochester SS	1.2	4 – Construction in progress	220
	Carvoran SW – Thirlwell Castle SW	1.8	3 – Confirmed by stakeholder and ready to deliver	253
	Linhope	0.5	3 – Confirmed by stakeholder and ready to deliver	140
	Northumberland NP Total	**5.1**		
Peak District NP	Sheffield, Brown Hill Lane	0.5	5 – Complete	96
	Hope, Hope Sewage	0.3	5 – Complete	88
	Moscar	1.8	5 – Complete	
	Sheffield, Redmires Road	1.2	2 – Proposed and awaiting land consents	
	Sheffield, Bolsterstone, Heads Lane	0.6	2 – Proposed and awaiting land consents	
	Sheffield, Dunford Bridge	1.8	2 – Proposed and awaiting land consents	
	Sheffield, Dunford Bridge, Harden Edge	2.4	2 – Proposed and awaiting land consents	
	Peak District NP Total	**8.5**		
Yorkshire Dales National Park	Richmond, Whaw	0.3	5 – Complete	
	Marrick	3.5	5 – Complete	216
	Oughtershaw – Cam Houses	4.7	5 – Complete	390
	Keld	2.2	4 – Construction in progress	252
	Barden Towers	0.8	3 – Confirmed by stakeholder and ready to deliver	250
	Skipton, Dribbles Bridge House	2.3	3 – Confirmed by stakeholder and ready to deliver	
	Reeth North	0.7	2 – Proposed and awaiting land consents	
	Grassington	2.4	2 – Proposed and awaiting land consents	260
	Hebden, Garnshaw	1.8	2 – Proposed and awaiting land consents	
	Gayle West End	0.6	1 – Proposed for design and feasibility	160
	Gayle and Gayle Blackburn	0.5	1 – Proposed for design and feasibility	160
	Yorkshire Dales NP Total	**20.1**		
	GRAND TOTAL	**131.7****		

x9

National Park Authorities and Areas of Outstanding Natural Beauty stakeholders consulted

125 schemes

Undergrounding schemes being evaluated in National Parks and AONBs

* Stakeholders assess the impacts and benefits of a scheme using a consistent methodology which gives some consideration to the characteristics of the site and of the overhead line, as well as to the visual and environmental impact of the latter. The resulting scores are reported here as an indication of the prioritisation that the scheme is likely to be given relative to others in the same Designated Area. A higher score suggests the site has been given a higher prioritisation by our stakeholders (scores range between 10 and 420, with a median score of 115).

** This total includes a number of contingency schemes that may be not be delivered before 2023, hence the total length is higher than referenced in the section above.

2.3 Prevention and remediation of oil leakage

Our target

We continue to be significantly ahead of our business plan commitment to reduce oil/fluid lost to ground by 15% by the end of ED1. We now forecast that oil/fluid loss will be reduced by 47% by 2023 due to investment in asset replacement and in new technologies such as perfluorocarbon (PFT) leak detection[3] and self-healing cable additives.

Our strategy for reducing and mitigating the environmental impact

Our management of fluid-filled cables compares well with other electricity DNOs in the country, although our exposure is still high because we have more fluid-filled cable on our network than most of the other DNOs. We're addressing this through our fluid-filled cable replacement programme. This year, we replaced 50.6km of fluid-filled cables. This has taken our total to 145.3km replaced in this regulatory period so far and means we have met our ED1 target three years early. In 2017–18, we set out a stretch target to our original ED1 commitment, providing for the replacement of additional 72km of fluid-filled cable. We plan to remove an additional 18km on top of that stretch target which will see the removal of 224.4km by 2023 – 68% more than originally planned.

During the year we have continued to participate in the innovation project research into self-healing fluid additives. The additive has been taken through laboratory tests on short sections of cable with positive results and a batch delivered in readiness for the field trial. The field trials are now planned on a selected out of commission cable in late 2020.

- All major GB electricity utilities have fluid-filled cable circuits on their distribution networks. These are mostly of the low pressure fluid-filled type, typically designed to operate at 1–4 bar pressure. Over time these cables may begin to leak cable fluid and subsequently the cable pressure may drop and the cable insulation system (fluid impregnated paper or paper-polypropylene laminate) may eventually fail. In some cases the leaks may cause environmental contamination.
- This innovative solution seeks to exploit the use of naturally occurring, environmentally friendly resins which, when added in measured quantities to the fluid in our cables, congeals around a variety of sheath defects and minor leaks, sealing the cable to prevent further fluid loss.

Our performance

Any fluid leak from our cables is classed as an environmental incident and we have thorough procedures in place to report these incidents to the Environment Agency and deal with them quickly and effectively to minimise the impact. To ensure effective remediation we have a 24-hour environmental response support contract in place to attend for any and all environmental incidents as required.

Whilst 2019-20, we achieved a 37% reduction in oil/fluid lost to ground against our ED1 business plan baseline. We're working to continue to reduce the number of reportable events ahead of our phased plan and we expect the number of these incidents to keep decreasing over the rest of the regulatory period to 2023.

In 2019-20, we have completed oil mitigation works at 55 sites, which include[4]:

- Remedial works at substations to ensure the integrity of the bund wall that retains any oil leakage and prevents contamination of the surrounding area.
- The installation and replenishing of oil spill kits which act as a temporary 'first aid' solution until the leak can be resolved or the plant replaced. All our field staff working with oil-filled equipment have had spill kit training and they carry spill kits in their vehicles.

Looking forward, we will continue to look for new ways to reduce our environmental impacts so we can outperform our targets. To help us achieve that, we have set a headline environmental goal to reduce the amount of oil/fluid lost in 2020-21 to 29,550 litres. To make this happen, we will:

- continue our progress towards replacing 224.4km of fluid-filled cable network by 2023.
- continue to pre-dose selected fluid-filled cables with perfluorocarbon tracer chemicals to speed up leak locations.
- deploy 'self-heal' additive to fluid-filled cable circuits in a field trial to evaluate the performance of the product.

Our performance in ED1 to date is strong and, looking forward, we expect this to continue.

[3] PFT cost-benefit analysis table is published on: www.northernpowergrid.com/your-powergrid/environment

[4] Further information is provided in Annex 2 (a copy of our annual submission to the regulator).

Figure 2: Reportable environmental events

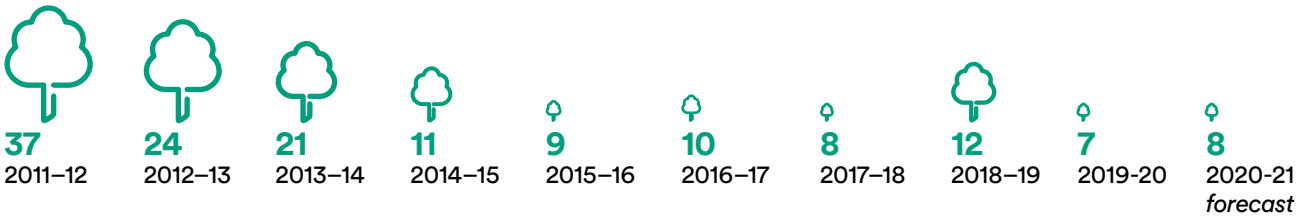
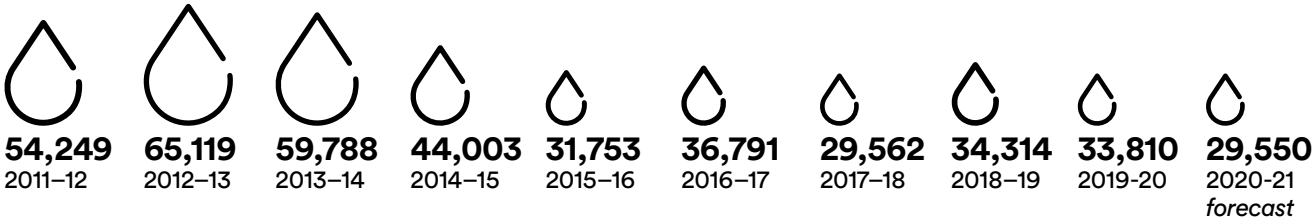


Figure 3: Leaks to ground (litres)



2.4 Carbon impact and climate change

The net zero targets introduced in 2019 have brought renewed focus to environmental outcomes. To help deliver these climate change goals our stakeholders expect more from us. In this section, we focus on what we are doing to reduce carbon in our own business operations. In section 3, we go to describe how we are facilitating society to decarbonise more rapidly with increased electrification.

2.4.1. Business carbon footprint

Our internal carbon footprint continued to fall during the Regulatory Year 2019-20, and so did the carbon footprint of Northern Powergrid combined with our contractors. If we exclude the contractors' contribution, our internal carbon footprint for 2019-20 was 16,772 tonnes, which is 5.4% lower than the previous year. We report our business carbon footprint in accordance with the Greenhouse Gas Protocol as shown in Table 2[5].

Overall, at the end of the Regulatory Year 2019-20, we had already achieved a 44% carbon reduction against our ED1 business plan baseline, significantly exceeding our business plan commitment of a 10% reduction in ED1. We continue to innovate across the business to continue to reduce our carbon footprint, including reducing fleet and business mileage and continuing to introduce electric vehicles into our fleet, continuing to use telematics systems in fleet vehicles[6], and investigating new insulating mediums in the equipment we purchase. We expect these initiatives will contribute to further reductions in our carbon footprint over the coming years.

2.4.2. Monitoring and reducing the emissions from sulphur hexafluoride

Sulphur hexafluoride (SF_6) gas has been used in a number of industries across the world for many years, including the energy industry where it is a commonly used insulator in high voltage electrical equipment and originally introduced as an alternative to oil. Industry and equipment manufacturers are already taking action to avoid the release of SF_6 to the atmosphere and to promote recycling. We have a strong record of deploying technology to tackle climate change and are also proactively supporting manufacturers to develop effective and reliable alternatives to SF_6 including conducting trials of alternative gas technologies.

It is also a potent greenhouse gas – one tonne of SF_6 gas is equivalent to 22,800 tonnes of CO_2. There is currently no economically viable substitute for SF_6 so we have no option but to continue to use it until a suitable alternative is developed by the equipment manufacturers. The nature of SF_6 means it's important to keep the amount that leaks out of our equipment to an absolute minimum. We monitor all SF_6 losses on a daily basis by measuring how much we have injected back into the equipment to replace gas which has leaked into the atmosphere. We report our SF_6 gas losses as one of our environmental key performance indicators. We estimate that annually 0.17% of the total SF_6 volume escapes into the atmosphere (refer to Table 3[7]).

If we discover, either by a remote pressure alarm or on-site inspection, that some gas has leaked, then we schedule maintenance and repair work. If the leak is persistent and maintenance and repair options aren't stopping it, we invest in replacing the equipment.

Our state-of-the-art infrared camera is able to detect very small quantities of SF_6 gas leaking from equipment. This has enabled us to accurately pinpoint leaks and target equipment for repair or replacement. As a result, we have achieved our best ever performance and reduced our SF_6 losses by 34% in ED1 to date. Its initial success has given us the confidence to more than halve our ED1 target to 50kg.

Table 2: Our carbon footprint 2019-20

Greenhouse Gas Protocol classification	Emissions sources	Tonnes CO_2e[8]
Scope 1 – sources owned or controlled by the company	Gas used for heating buildings	293
	Operational travel (own fleet vehicles)	4,537
	Leakage of SF_6	1,439
Scope 2 – from the generation of purchased electricity, heat and steam	Electricity used in buildings	1,862
	Electricity used in substations	5,299
	Losses from our network	550,009
Scope 3 – all others sources	Network losses from purchased electricity	608
	Business travel (car, rail, air)	2,734
	Operational travel (contractors' fleet vehicles)	8,120
	Fuel combustion (contractors' use of small generators)	8,472
Total		**583,374**
Total (excluding losses from our network)		**33,365**
Total (excluding losses from our network and contractors)		**16,772**

Table 3: Summary of performance in SF_6 leakage

SF_6 bank (kg)	36,195
Estimate of SF_6 emitted (kg)	63
SF_6 emitted as a percentage of SF_6 bank (%)	0.17%

[5] For more information about our carbon footprint, reported separately for North East and Yorkshire, refer to Annex 3 (a copy of our annual submission to the regulator).
[6] Telematics cost-benefit analysis table is published on: www.northernpowergrid.com/your-powergrid/environment
[7] For more information, see Annex 2 (a copy of our annual submission to the regulator).
[8] Tonnes of carbon dioxide equivalent.

2.4.3 Distribution losses

What are distribution losses?

Electricity networks incur electrical losses when transporting power. In 2019-20, roughly 6% of energy entering our distribution network was lost before it reached our customers. It is important to reduce losses because there is an environmental and an economic cost associated with them, accounted for in consumers' energy bills and the carbon footprint incurred to produce the energy that is lost. That is why reducing losses on distribution networks can have a significant effect on reducing the overall CO_2 emissions for the country.

There are four main types of distribution losses:

- **Technical losses** – the natural effect of network equipment heating up while transferring electricity. These losses vary in proportion to the amount of electricity transported and are an unavoidable consequence of the laws of physics.
- **Electricity consumed by network operations** – our equipment and substations require electricity to function. For example, transformer cooling pumps and fans, circuit breaker operation, supplies to power equipment such as electronic relays and heating to make sure equipment remains in a healthy condition.
- **Electricity theft** – activity conducted by people who access an electricity supply illegally.
- **Inaccuracies in metered and unmetered data** – our routine meter registration processes seek to prevent and remedy any misallocated data flows to ensure that electricity use is linked to customers and their energy suppliers.

Our strategy to manage distribution losses

We estimate that losses on our network amounted this year to 2,152GWh, equivalent to 550,009 tCO_2e (c. 94% of our carbon footprint – equivalent to supplying c. 144,000 homes with energy[9]). We have a losses strategy in place, dedicated to monitoring and reviewing our options to reduce electrical energy losses that occur on our own network[10]. Our forecast is that losses will reduce by up to 9% between 2015 and 2023 thanks to the effect of the general energy efficiency improvements of our customers' equipment, network density, transformer and cable choice and smart meters. It is important to note that the uptake of low carbon technologies, and the deployment of smart grid technologies to accommodate a more flexible network and increased network utilisation, present a more complex picture. Some solutions assist loss reduction objectives, but others will actually increase network losses but deliver whole system carbon reduction through the connection of low carbon generation making them worthwhile.

Figure 4: The inside of a LV 300mm² cable used to reduce losses on our network

The investment profile associated with activities to reduce losses falls into two categories: ongoing programmes and one-off improvements.

The ongoing activities that we are implementing are:

- **The policy of 'oversizing' conductors (relative to existing utilisation levels):** We install a minimum cable size of 300mm² at 11kV where practical (e.g. if bending radii and termination arrangements allow) and continue to install a minimum of 300mm² mains low voltage (LV) cables. Although these cables are of a larger capacity, the lifetime cost is lower than the smaller size option of 185mm², when taking into account the capitalised electrical losses within our designs (Figure 4). Using larger cables to deliver electricity will help us save up to 10,500MWh, enough to power 700 homes[9] for a year. In this price control period, we have been investing in larger electricity cables in order to reduce energy losses. This has led to a cumulative saving of 4,137MWh to date (refer to Table 4; figure might slightly differ due to rounding). Oversizing conductors and transformers is also a cost-effective way of preparing the network for the future.
- **Accelerated asset replacement:** We undertook a cost-benefit assessment for pro-active replacement of our older (pre-1958) ground-mounted distribution transformers. We have been replacing these transformer units as part of synergies with other investment drivers such as asset condition. In 2019-20, this led to a cumulative saving of 862MWh (Table 4).
- **Sizing the transformers for losses:** We will continue with our current distribution transformer 'oversizing' policy for pole- and ground-mounted transformers with demand customers connected. However, for distribution transformers with dedicated solar or wind generation connected, we do not oversize the transformer as the intermittent generation profiles do not justify the cost for an increased transformer size.
- **Procuring transformers with new, lower loss specification:** We will continue to purchase transformers that have lower electrical losses than the minimum cost units available, taking into account capitalised electrical losses in the assessment of lifetime cost rather than simply purchase price.

Losses Discretionary Rewards

Ofgem introduced the Losses Discretionary Reward (LDR) with an aim to encourage all DNOs to undertake additional actions to better understand and manage electricity losses on their networks on four criteria: understanding of losses, stakeholder engagement, processes to manage losses, and innovative approaches to losses management.

The reward was divided into three tranches between 2016 and 2021. We submitted our tranche 3 submission to Ofgem in March 2020. Despite Ofgem's decision not to recognise the actions and plans of any DNO in this area, we remain committed to delivering the remaining actions throughout this price control period, with improved understanding of impacts of losses on our network. This will also help us better prepare for the next price control review, RIIO-ED2. We have been placing emphasis on working with other DNOs on collaborative activities and undertaking particular actions collectively under the Energy Networks Association working group as well as liaising with academic partners and consultancies on holistic approaches to managing losses.

[9] Assuming a medium annual heat and electricity demand of 14,900kWh based on Ofgem's Typical Domestic Consumption Values. Alternatively, this is equivalent to providing 742,000 homes with electricity only, based on 2,900kWh annual consumption

[10] The strategy is available in full on our website document library at https://www.northernpowergrid.com/losses

Our performance

In 2019-20, we have been delivering actions spanning both our losses strategy and LDR. In addition to the activities already mentioned, we carried out the following activities:

- **Stakeholder engagement:** We have organised and have been actively involved in key events and dialogues to engage with the stakeholders and communities to present and discuss our losses initiatives. We have produced an animation to help educate customers on what network losses are and how they can be reduced. We also have a dedicated webpage on losses which we have updated with more information, news and updates on our activities www.northernpowergrid.com/losses.
- **Enhanced understanding of network losses:** We worked with Newcastle University on building a detailed and flexible electrical distribution network losses model. This builds on the analysis of present and future network operating scenarios and incorporating system and consumer data, along with consideration of both 'smart' and traditional business-as-usual network operation and management techniques. This project is now complete. We presented initial findings of the project across the industry to share learning and the project reports can also be found on our losses webpage.
- **Impact of battery energy storage system (BESS) on losses:** Our understanding on the impact of BESS on losses has improved through analysis of our own Rise Carr BESS and Distributed Solar and Storage Study (DS3)[11] project. We have learned that BESS could either reduce or increase network losses, depending on its mode of operation. Understanding this means that we may be able to utilise services from BESS for a whole system operation. Although this could adversely impact network losses, its operation should not be discouraged, in order to achieve an overall carbon reduction. This situation is akin to the operation of active network management schemes which provide low cost flexible connections for low-carbon generation but increase local network losses.
- **Boston Spa Energy Efficiency Trial:** We are undertaking an exciting innovation project that is seeking to use smart meter data in near-real time to optimise the voltage received by our customers in the trial area. This should save customers money by increasing the efficiency of appliances within the homes and businesses of our customers. This trial can therefore be thought of as tackling losses on the customer side of the meter; which we really think is important to working together to transition to Net Zero by focussing on the whole system.
- **Power Factor Advice:** Industrial and commercial (I&C) customers who consume significant amounts of reactive power will have something referred to as 'poor power factor'. The result of which is that these customers will suffer from high energy bills, and the poor power factor can increase losses on our network. We therefore created 'a guide to power factor', identified customers who could benefit from power factor advice, and contacted them, sharing this guide. We will continue our work on this important area.
- **Amorphous transformer trials:** We are collaborating with other DNOs and a transformer manufacturer to trial the super low-loss amorphous core transformers on the Northern Powergrid network using standard working procedures. This should help to allay technical concerns around brittleness, size, weight, harmonics and noise in preparation for Ecodesign[11] Tier 2 maximum loss levels for transformers which will come into force in 2021. We have successfully installed 3 out of 5 planned units as part of the trial, and we plan to install the remaining 2 units this year. We will share key learning next year.
- **Use of smart metering data:** We have been implementing the key findings from the Smart Data project (reported last year - delivered by University of Sheffield on behalf of Northern Powergrid). The findings have been used in our analysis to determine strategic losses initiatives for RIIO-ED2, and they remain topical to current industry discussions.
- **LV monitoring:** We have so far installed more than 480 units of low voltage monitors on our heavily loaded and likely losses hotspots. By the end of this price control period, we aim to have at least a further 800 units installed, targeting areas that we analyse and identify in having high LCT take-up in the future.
- **Network reconfiguration:** Since 2015, over 1,000 high voltage (HV) feeders have been assessed to optimise open points to balance load and customer numbers. In turn, this should reduce losses. In an extreme example when an open point is moved from an interconnected primary substation to the mid-point losses are reduced. An optimised typical feeder pair has estimated savings of 26MWh (or £1,300) per year.

[11] The Ecodesign regulation is a European legislation that imposes a maximum level of losses for transformers sold from 1st July 2015 onwards. Ecodesign aims for two major objectives on the Transformer product: 1. to reduce electrical losses and 2. to clarify and make more visible indication of performance.

— **Energy Networks Association (ENA) Technical Losses Task Group:** Working collaboratively with all DNOs under this working group, we commissioned a study to investigate the impact of low carbon transition on technical losses. This work looked at the losses impact of low carbon technology growth and of the losses impact of smart solutions compared to traditional reinforcement. The use of smart solutions as an alternative to conventional reinforcement is expected to increase losses; however Northern Powergrid will only implement smart solutions where they are economic from a whole system perspective. Last year, the group commissioned a work on proposing losses incentives for RIIO-ED2 to Ofgem, which has now been completed.

— **Staff training:** As part of a wider change management exercise driven by Northern Powergrid's Smart Grid Implementation Unit, all high voltage and extra high voltage design engineers have received formal training in how to incorporate losses into their designs. We have also embedded losses into the training module for our graduate and technical staff trainee training programme.

Tables 4 and 5 show the volume and impact of loss reduction activity. Due to the changeover to a new, fully digitised mains records system and the processing of system updates during that period, our data is incomplete and the required level of detail is presently unavailable. Therefore tables 4 and 5 are reflective of actual volumes up until 2017–18, but volumes for 2018–19 and 2019-20 have been estimated, based on the previous three reporting periods[12].

Table 4: Summary of losses costs and benefits from activities in RIIO-ED1*

		Regulatory Reporting Year 2019-20*			RIIO-ED1 (2015-23)
	Programme title	Distribution losses justified costs	Estimated reduction in losses	Estimated resulting reduction in emissions	Cumulative reduced losses to date
		£m	MWh	tCO_2e	MWh
NPgY	Oversizing cables (300mm) HV	0.3	234	60	1,155
	Oversizing cables (300mm) LV	0.3	358	92	1,792
	Replacing distribution transformers (pre-1958)	0.2	208	53	526
NPgN	Oversizing cables (300mm) HV	0.1	68	17	335
	Oversizing cables (300mm) LV	0.1	171	44	854
	Replacing distribution transformers (pre-1958)	0.1	83	21	337
Total		**0.9**	**1,039**	**265**	**4,999**

Table 5: Summary of amount of losses activities in regulatory reporting year and estimate for the following year[13]*

Programme title	Description of unit	Volumes in 2019-20*	Forecast volumes in 2020-21
Oversizing cables (300mm) HV	Length (Kilometres)	131	72
Oversizing cables (300mm) LV	Length (Kilometres)	150	69
Replacing distribution transformers (pre-1958)	Number of transformers	15	15

*2019-20 volumes have been estimated, based on the average length of cable (km) added in the previous three reporting periods.

[12] More information, including the Cost Benefit Analysis, is provided in Annex 4 (a copy of our annual submission to the regulator).
[13] We have here reported the activities where some of the costs incurred relate to managing distribution losses, but where losses are not the principal reason for the expenditure. This excludes activities that may help to manage losses but where distribution losses are not associated with the DNO's decision to undertake the activity and where any benefits of losses are purely coincidental (such as the product specification for new transformers, and the programme of voltage reduction which we report in Innovative Solutions). For an overview of all of our activities to manage losses, refer to our Losses Strategy located at https://www.northernpowergrid.com/losses

2.4.4 Climate change adaptation

The UK's climate is changing and weather events which we currently consider to be 'extreme' will become increasingly common. The climate change that will occur in the medium term has already largely been determined by greenhouse gas emissions, so we need to get ourselves ready to deal with the effect this will have on our weather patterns. In 2019-20, our region experienced three major incidents, where flood, lightning and strong winds caused power cuts to our customers, including a week in February where a sequence of Atlantic storms caused consecutive busy days which were just below major incident thresholds but needed raised awareness and additional staff available to respond.

From flood defences and vegetation management, to improved weather prediction systems and increased staff availability, we've developed a climate change adaptation strategy[14] that outlines the impact that we anticipate climate change will have on our business and, most importantly, how we propose to tackle it.

In our ED1 business plan, we committed to making our network more resilient to flooding by building new permanent flood defences in 141 sites and completing 15 sites that remained from the previous price control period.

Our programme is ahead of target. In 2019-20, we upgraded defences at 24 sites. This has taken our total number of permanent flood defence installations to 186 in ED1 to date, exceeding our original commitment (refer to Table 6).

Table 6: Annual number of permanent flood defences installed

2019-20 Actual	2020-21 Target	2015-23 Cumulative	2015-23 Target*
24	21	186	274

*Reflects a stretch target

Since making our business plan commitment, there have been a number of severe flooding events that triggered a national review of flood resilience as well as causing us to carry out our own analysis. As a result, we have expanded our programme, taking the total number of sites targeted for improvement during the RIIO-ED1 period to 274. We continue to re-assess the need for further upgrades in the coming years.

We continue to work with Defra to provide information for the National Adaptation Plan. We are also working to update both our own and an industry wide Climate Change Adaptation plan in line with the timescales agreed with Defra. In order to fully understand the impact of the UK Climate Projections released in 2018 on our industry, we have engaged in a detailed piece of work with the Met Office, the findings of which will contribute to our plans.

2.4.5 Eco-paint

DNOs traditionally use alkyd paints on transformers and pylons. We use thousands of liters of paint each year to protect 1,200 transformers. However, traditional solvent-based paints can emit more than half the liquid-weight as gases, known as volatile organic compounds, into the atmosphere during the drying process.

Following a successful trial over a 20-month period, we will deploy new eco-paint network-wide as part of our maintenance programme to protect our assets. Produced in the North East, Rosh Engineering's award-winning Greenovoc paint replaces the need for solvent-based paints. It will enable us to increase network resilience by significantly reducing time taken to carry out essential maintenance on assets, minimising downtime and enabling Northern Powergrid's expert team to focus on delivering more customer benefits[15].

We expect the paint to reduce asset downtime by 166 days a year, as its properties mean assets can be painted more quickly and come back online faster. Additionally, the reduced asset downtime increases network resilience by minimising the risk of power outages, while also enabling better value for money for customers. If rolled out across the UK electricity industry, the eco-paint could save more than 5.5 million tonnes of volatile organic compoinds from being emitted into local air.

[14] Available from: northernpowergrid.com/asset/0/document/2032.pdf

[15] For more information, see: https://www.northernpowergrid.com/news/northern-powergrid-demonstrates-commitment-to-sustainability-with-new-eco-paint-that-will-improve-local-air-quality-and-minimise-power-cut-risk

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

3.1. Introduction

Developing our innovation portfolio

As a company, we aim to improve our customers' experience through new understanding and processes across all parts of our business – both today and in the future. This year, we've made more progress on our mission to deliver new learning and in rolling out innovation projects into our everyday business. We currently have 32 active innovation projects, building on work that's already been done in the industry, to help us deliver our innovation strategy.

Changing markets and system operation

We are going through a revolution in the way that electricity is produced and consumed. Traditionally, the distribution network was designed for one-way delivery of electricity. Over the last few years, customers and the energy industry have made some big changes:

- **Decarbonisation of generation:** Less coal and more wind and solar are being used to power our homes.
- **Decentralisation of energy sources:** Electricity generation units are moving from the traditional model of large power stations on the transmission network to commercial and domestic generation connected to the local distribution powergrid.
- **Digitisation of technologies:** Most things are becoming 'smarter' in society (e.g. home entertainment and heating controls) and in industry (e.g. technology to automate processes and control network assets).

Traditionally, flexible electricity generation has been adjusted to meet demand (or use). However, low carbon generation is less flexible because the source is often weather dependent (for example, solar panels and wind farms) and is more intermittent. This means that the energy system needs to be more flexible to support customers by matching demand to available generation in a more dynamic network.

The industry is responding to this change by transitioning from a traditional DNO to a Distribution System Operator (DSO) model. For more information, please see our DSO v1.1 development plan available from www.northernpowergrid.com/DSO published in October 2019. DSO requires active management of the energy system in real time, agreeing contracts with customers to support the grid in flattening peaks of high demand on the system. Operating as a DSO means we will work with customers who are able to be flexible with when they generate or use electricity. In doing so we aim to support better utilisation of the existing low carbon generation, reduce system costs and improve overall energy system efficiency for all customers.

Smart meter foundations

Although energy suppliers are leading the roll-out of smart meters, network companies have an important role to play in supporting the roll-out and using smart meters as the foundation of a future smart grid which will deliver an improved service for our customers. The national smart meter programme has continued to experience delays but we are working to minimise the impact of the lower than anticipated volume of SMETS2 meters and data quality issues. You can read more about this in section 3.4.

Drivers and priorities

Our commitment to operational excellence and customer service means that we are always looking for better ways to do things, at a reduced cost for our customers. Our role is to provide an electrical network that is fit for the future. As UK energy landscape is changing, our network must be flexible and responsive in order to accommodate more demand for renewable electricity sources and the increase in low carbon technologies like electric vehicles and heat pumps connecting to our network. We need to manage the energy system so it continues to provide a secure supply of electricity. Developing trends present both challenges and opportunities for the electricity system and we keep it under review to make sure our approaches and priorities remain appropriate. Changes are driven by technological advances and the need to reduce carbon:

- **Customer engagement** – our priorities need to be linked to those of our customers and stakeholders.
- **Security of supply and cost remain a top priority.**
- **Local and intermittent generation** – renewables or flexible peaking plant.
- **Decarbonisation of heat and transport** – a heat pump or an electric vehicle charger can double the peak load on a domestic property with most impact when clustered in the same location on the network.
- **Digitisation** – the pace of technological change is leading to a rapid increase of data and functionality to engage customers in an actively managed network.

About a Distribution System Operator

By making the transition to a DSO, Northern Powergrid will deliver a set of balanced outcomes for customers through:

- creating a customer-led actively managed (and probably semi-autonomous) network.
- providing a cost-efficient, non-discriminatory and technology-neutral physical trading platform.
- supporting third parties in our region to participate in the electricity markets.

At Northern Powergrid, we want to be a leading voice in shaping the transition. Many of the projects we've worked on this year support this ambition – we're involved in activities that are scoping the future, pursuing low-regrets options (getting on with the transition) and building new capabilities.

Table 7: Low carbon technologies connected to our network in 2019-20

		Estimated capacity (MW)	Estimated volume
Load	Heat pumps	6	1,240
	Electric vehicle chargers	14	1,222
Renewable generation	Photovoltaic micro-generation	3	914
	Other distributed generation (mainly larger photovoltaic, onshore wind and biomass)	204	112

Our role in the low carbon transition

Carbon reduction targets have led to an increase in popularity for low carbon technologies (LCT) such as heat pumps, solar panels, wind turbines, and electric vehicles, with low carbon heat remaining an uncertainty. This places increased and new load on our network. Table 7 shows the amount of such connections on our network[16].

In terms of future volumes, the rate of LCT uptake is very sensitive to government policy and we expect a stable trend of distributed generation, depending on the market's ability to find profitable business models. In 2019, Feed-In Tariff was discontinued and we have seen a drop in PV connected to our network. Meanwhile, the plans to ban new petrol and diesel car sales were brought forward to 2035 at the latest and electric vehicle ownership has been steadily increasing.

These challenges are set against a backdrop of disruption to traditional energy markets where new entrants are blurring the established definitions of generators, suppliers, network companies, customers and other market participants. Added to this, customers expect that service standards and security of supply will continue to improve.

In our innovation strategy, we have set out four key priority areas where we are changing our services to provide benefits for our customers:
— deploy smart grids;
— maximise the value of smart meters;
— develop digital-enabled services; and
— address affordability.

We are involved in innovation in various ways, either leading projects or working with partners. Projects are funded through different sources. We have access to the Network Innovation Allowance (NIA) through the regulator Ofgem, which is worth up to £29m (in 2012–13 prices) over eight years, and we can also benefit from specialist funding sources (such as Innovate UK) through partnering with universities or other industrial partners.

In 2019-20, we successfully launched another three new projects to help us address issues of affordability, environmental protection and the deployment of smart grids[17].

3.2. Progress made on our innovation strategy

Our innovation strategy has been used to discuss our priorities with our stakeholders over the past year – most notably at our stakeholder panel and the Connections Customer Forum. We have actively contributed to developing the ENA Electricity Network Innovation Strategy last year, and we will use it to modify our own innovation strategy.

We have made good progress on our four strategic innovation priorities:

Smart grid development is largely focused on introducing flexibility so that the network can accommodate more intermittent renewable energy. In 2019-20, we:
— started a community energy innovation project looking at ways to increase energy efficiency and reduce customers' bills by optimising (reducing) voltage on our network, using smart meter data;
— trialled electric vans equipped with a battery payload as a cleaner, quieter method for restoring electricity supply after a power cut at single domestic or small business premises;
— continued our Customer Led Distribution System[18] innovation project which is exploring how we can optimise value for our customers in the changing energy system as we progress to net zero emissions in 2050;
— continued to explore new ways to optimise the whole energy system (electricity/gas);
— continued exploring innovative ways to increase resilience to vulnerable parts of the network through application of systems of technologies;
— rolled out new monitoring and protection equipment as part of our £4m project to revolutionise the way we will manage future replacement and repair on our low voltage network, and started to see the first results;
— continued the work on projects exploring vehicle-to-grid technology;
— continued exploring how the use of LCTs could provide a means to improve the capacity and resilience of the network;
— continued investigating the introduction of a health index which would reflect the degradation of energy storage connected to our network; and
— completed a project looking at the impact of the combination of PV and batteries in vulnerable customers' homes, and assessing the economic case for using them to provide services back to the network.

[16] For more information, refer to Annex 7 (a copy of our annual submission to the regulator).
[17] For more information on our portfolio of NIA projects, you can refer to our 2019-20 Annual Summary on: https://www.smarternetworks.org/annual-innovation-summary
[18] More information available from http://www.northernpowergrid.com/innovation/projects/customer-led-distribution-system-nia-npg-19

Our work related to maximising the value of **smart meters** remains focused on establishing solid foundations for the exciting new services and benefits that should be made possible by the national programme when data coverage becomes more comprehensive and the data is more reliable. In 2019-20 we:

— maintained the security compliance of our system to access the national system data;
— continued to pilot how we might ultimately utilise smart metering data operationally for the benefit of our customers; and
— made progress with projects to access and utilise smart metering data.

For **digital-enabled services**, we have improved the tools used by our operational and network teams in order to give our customers great customer service. Specifically, we have:

— launched a web-enabled tool[19] to allow customers to produce their own designs for straightforward connections to provide them with faster and more efficient customer service, co-designed with our stakeholders;
— completed the design of a web-enabled safety system to provide our engineers with spatial and temporal information of approaching thunderstorms and enable them to protect themselves and our assets; and
— completed the initial design of remote access management system for all of our assets to improve their security and the safety of our colleagues, and begun the work on real-world trials.

Affordability work has focused on cheaper supply models for electricity customers. In 2019-20, we:

— continued exploring a technology which should reduce interventions on the low voltage system, giving us a better view on when and where faults are developing, and allowing to intervene before the faults become permanent and impact our customers;
— continued a project that provides batteries for vulnerable customers reliant on electrically powered medical equipment to avoid the negative effects of a temporary disconnection; and
— completed a project exploring the ways to maximise the use of the existing switchgear assets by optimising their capacity.

3.3. Roll-out of smart grids and innovation into business as usual

Customer flexibility roll-out

In December 2018, we launched our Customer Flexibility Plan as a key step to our transition to the role of Distribution System Operator. This was our first step towards integrating customer flexibility into our business as an alternative to network solutions. It set out where our network was expected to require intervention and invited customers to express interest in providing flexible capacity that enabled us to compare alongside network interventions.

We identified almost 200 customers with significant assets, sited at seven key locations on our network and invited them to take part in a trial where they would be asked to flex their energy usage, in return for financial incentives.

Whist we now offer flexible connections solutions like Active Network Management (ANM) as business as usual, this is the first time we have sought to enter into contracted flexibility service arrangements with our customers.

In November 2019, we announced plans to procure local customer-led flexibility through an online e-auction. In order to secure the most value for the homes and businesses in our region, we chose the following platforms to procure customer flexibility:

— **Reverse Dutch eAuction:** Instead of submitting bids, this system raises the price incrementally, at set time periods. Providers can bid when the price reaches their expectations or Northern Powergrid can close the auction when the cost has reached what it is willing to pay.
— **Restore Flexibility:** This scheme was chosen as it is driven by network need. It pays providers a utilisation cost, if they can provide flexibility to the system during rare unexpected faults – this flexibility product does not offer availability payments. This scheme was chosen to provide the best deal for Northern Powergrid's customers as providers would only be paid for flexibility when it is needed in response to the uncommon occurrence of network faults.

Following interest expressed by 57 customers in providing flexibility, the e-auction closed in March without any bids:

— Network analysis indicated seven sites across Northern Powergrid's network where up to 100MW of Restore Flexibility could provide an additional means of managing the network during unexpected faults.
— We received interest from 57 potential providers, however only four responses were received, three of which were acceptable to progress to eAuction of a total capacity of c.30MW.
— Unfortunately, no bids were received during each of the eAuctions that took place across the 3 locations.
— We are now viewing emergency restoration as an additional flexibility service and not a service in its own right since the financial incentive is insufficient to encourage participation.

It is commonly recognised that our demand for electricity will increase as we strive for net-zero carbon emissions, e.g. for heat and transport such as electric vehicles. The bulk of our network was built between 1950 and 1980, when a significant amount of the power demand was from heavy industries, such as mining. Much of this power-intensive industry no longer exists. As a result, our network currently does not have many capacity constraints and major system risks are rare. This may change in the future, but at present is in stark contrast to other regions, where the need to procure flexibility may appear to be higher than on our own network, meaning that new capacity must be brought online or made available through flexibility before the load from heat and transport can be significantly increased. Any flexibility Northern Powergrid does need, we are committed to procuring at the lowest cost and highest return. This is because all costs are passed onto our customers, and we want to only buy flexibility that will reduce the bills for our customers. We also remain committed to investing customer flexibility or network reinforcement when we have a proven constraint on the network rather than investing ahead of need.

[19] Our AutoDesign tool is available from: https://www.northernpowergrid.com/auto-design

Roll-out of innovation into business as usual

Delivering innovative change is the only way we can continue to serve our customers and deliver the outcomes they value. This means that when we're considering innovation, our focus is as much on delivering change as it is on opening trials. Innovation comes through a variety of routes – from changes to how we run our business every day to collaborating with external parties and delivering projects we have funded through a variety of rates.

Inspired by new ideas promoted by third parties or by other network operators, and basing our decision on cost-benefit assessments, we deploy new solutions as standard practice. In 2019-20, we deployed (or continued to deploy) seven such solutions, and report on them in Table 8[20].

The connection of renewable energy was one of our main focus areas again this year and we connected a further 207MW. Our innovation in this area has progressed as set out in Table 8.

Distribution Future Energy Scenarios

The changes in customers' energy practices and legislation have an impact on the demand and generation connected to our network. In previous years, we reported on progress of an innovation project aimed at aiding our network planning decisions by improving our forecasting capabilities. In December 2019, we published the our Distribution Future Energy Scenarios[21], which set out a number of pathways, and the associated assumptions, for the decarbonisation of generation, transport, and heat in the area served by Northern Powergrid. The data published represent a regional interpretation of National Grid's scenarios and, to enable regional collaboration, we have published the DFES in an open data format, facilitated by the Open Data Institute in Leeds. Our publication is comprised of a geospatial visualisation tool to get to grips with the data published, data sets, as well as a summary document. This document outlines the purposes of the publication, explains our forecasting methods, and gives insight into the potential impact that different decarbonisation pathways would have on our network. Since then, we have been focused on updating our scenarios to reflect the latest emissions' reduction targets and the feedback from our stakeholders and will be updating our publication annually.

130MW

of battery storage capacity connected to our network (which has more than doubled since last year)

AutoDesign

In February 2020, we launched an online self-service tool for low voltage connections. The tool, AutoDesign[22], can provide a connection design and an indicative budget estimate within minutes, instead of the usual 10-day turnaround. The intuitive new system is underpinned by real-world network data to help users identify the best location for a new connection.

Voltage reduction

We continued to roll out our voltage reduction initiative at primary substations at a further 243 sites, creating an extra 2,187MW of headroom for new micro-generation.

Flexible connections

We now have 433MW of contracted flexibility in our four ANM zones. Within the year we finalised the systems to support those customers joining the system in Driffield. We are now issuing connection offers for other customers and expect the use of ANM to grow to other areas.

Battery storage

As of March 2020, our Contracted Capacity Register[23] shows that we had just over 130MW of battery storage capacity connected to our network (which has more than doubled since last year), whereas the accepted (but not yet connected) capacity had reduced since last year, falling to 427MW.

Rolling out the smart grid

In the year, we invested £10.7m in smart grid enablers, taking our total spend in ED1 to £24.3m (in 2012-13 prices). As part of this programme we have had to overcome more technical challenges than originally anticipated, including substantial recruitment and retraining of engineering staff. This has unfortunately been impacted by COVID-19 towards the end of the regulatory year and COVID-19 restrictions are being seen across all areas of this programme. A variety of mitigation measures are being introduced to continue programme delivery as far as possible.

Our ED1 business plan envisaged £52m of additional smart grid reinforcement would be required on the network (Figure 5). This level of investment has not yet been required as we have seen a lower uptake in low carbon technologies (LCTs) than forecast in our plan; we are however continuing to get our network ready for future rapid uptake. We're in the process of replacing looped-service cables (the cable used when two properties share a single electricity supply) and during the first half of ED1 we have replaced more than 13,000 of these at a cost of over £12m. We're also freeing up capacity on our network through voltage reduction at our major substations. This has released 3.2GW of capacity in the ED1 period to date.

[20] For more information on the cost and benefit analysis that guide our investment decisions, see Annex 6 (a copy of our annual submission to the regulator of related information). CBA tables are published on: www.northernpowergrid.com/your-powergrid/environment
For more information on network innovation projects, refer to www.smarternetworks.org/
We did not apply to Ofgem for a relevant adjustment for the purposes of the Innovation Roll-out Mechanism (IRM), hence we have not had anything to report on this measure. [21] Available from: https://odileeds.org/projects/northernpowergrid/dfes/
[22] https://www.northernpowergrid.com/auto-design
[23] Available at: http://www.northernpowergrid.com/contracted-capacity-register

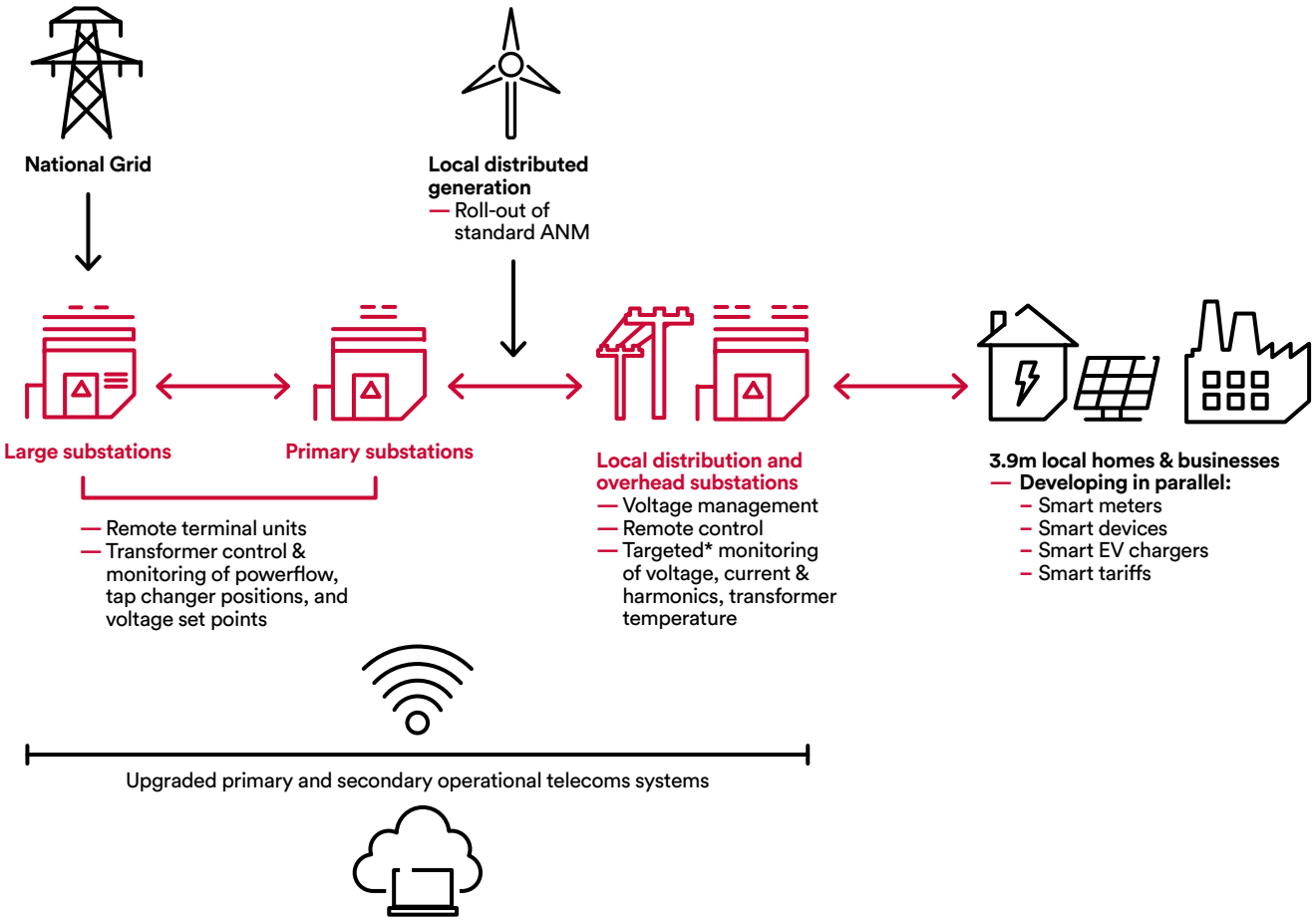
Table 8: Innovative solutions deployed

Innovative solution deployed (benefiting operational outcome)	Estimated benefits and impact 2019-20, resulting from the deployment	Deployment volumes 2019-20	Estimated deployment volumes 2020-21	Relevant innovation trial (when applicable)
Increase Network Capacity, Optimise Utilisation (Connections)				
Voltage reduction at primary Lowering the voltage on the HV networks creates headroom for the connection of rooftop solar panels on the LV system which would otherwise cause the voltage to rise above the upper statutory limit for penetrations greater than 30%.	Freed LV generation capacity: 2,187MVA	Deployed to 243 substations	20 substations	Customer-Led Network Revolution, Northern Powergrid and Voltage Reduction Analysis
Improve Connection Performance (Connections)				
Flexible connection agreements for generators Generation customers are offered an alternative connection quotation at a lower cost in exchange for occasional constraints on their export.	N/A	No new deployments this year	4	N/A
Improve Asset Life Cycle Management				
Transformer insulating oil online regeneration Treatment of the oil used as an insulator in a transformer to remove any acidity and moisture which extends its life.	Gross avoided costs: £0.98m	Deployed at 10 substations	14	N/A
HV Circuit breaker retrofit Reduces capital investment compared to replacement and extends its life.	Gross avoided costs: £1.5m	63 retrofits	65	N/A
Improve Network Performance (Reliability and availability)				
LV technology programme A proactive approach to LV network intermittent faults by using new technology which will automatically restore intermittent faults and locate faulty kit.	Avoided customer minutes lost: c. 4.5 million Avoided customer interruptions: c. 44,700 Gross avoided costs: £0.44m	No new units – continued re-deployment of existing 736 units	Continued re-deployment of the existing units	The Smart Fuse, ENW
Automatic Power Restoration System (APRS) Identifies the location of faults on the HV network and speeds up resolution.	Avoided customer minutes lost: c. 753,400 Avoided customer interruptions: c. 143,360	Deployed to 64 substations	30	N/A
Improve Environmental Impact (Environment)				
Fluid-filled cable leak detection by perfluorocarbon tracer Method to locate, with improved precision, a leak in our cables.	Avoided oil leakage: c. 3,000 litres Gross avoided costs: £0.2m	Deployed on 4 circuits	5 circuits	N/A

Smarter powergrid
A smarter network makes use of real-time information on network performance and energy consumption to respond to and manage demand and maintain a more efficient, affordable and low carbon flow of energy. By doing so, a smarter network will also enable the growth of new customer technologies such as electric vehicles, renewable generation and heat pumps, among others.

2,187MVA
generation headroom created by rolling out voltage reduction

Figure 5: Smart Grid Enablers programme snapshot



Enhanced functionality:

— Greater visibility of network and asset operating conditions
— Enhanced network control systems and distribution analysis system to make informed decisions (such as deploying customer DSR)
— Improved data analytics (such as ability to predict faults leading to less disruption to supplies and detect EV connection hotspots)
— Secure and resilient operational communications links to receive data and issue commands
— New access to information about our customers' energy use

Customer benefits:

The ability to efficiently connect an increasing amount of low-carbon technologies whilst experiencing improved network resilience

* We are targeting LV monitoring at:
— Highly utilised & high loss networks
— Commercial centres
— LCT growth hotspots

3.4 Getting the most out of smart meters for our customers

The first smart meters were connected to the central meter reading services in Q4 2017. We ensured we had our system in place and our people ready to start delivering a better service to our customers from the moment the first smart meter was connected; we achieved that goal[24]. We have been regularly reviewing our processes to ensure we continuously look for ways to better utilise smart metering data as meter numbers increase.

3.4.1 Progress towards mass roll-out

The roll-out of smart meters has continued and we expect it to carry on for the next few years and maybe into early 2025. We are continuing to support the roll-out of smart meters, in line with our business plan commitments and our smart meter roll-out strategy (see Figure 6).

Technical issues with the national smart meter service and a slower roll-out of second generation meters in our licence areas mean that the data, which we'll use to improve our network performance, isn't yet reliable enough, nor available in sufficient volumes, to be used operationally. This year we began to focus on validating the data we received and started working with other DNOs to assist industry parties to resolve technical defects relating to the format and delivery of voltage, outage and restore alarms.

3.4.2 Supporting the roll-out

The roll-out of the smart meters is being led by energy suppliers, but DNOs are essential enabler to the delivery of smart meters. We have:

- delivered defect repairs at customer premises in line with agreed industry service level agreements.
- been actively engaging with energy retailers and their meter operators to provide visibility of our performance and collaborating to ensure efficient resolution of any issues identified on our network that are preventing smart meter installations.
- extended the pilot of our online appointment booking tool for suppliers' agents, made enhancements and continued testing. The web tool will allow meter installers to arrange for defects to be dealt with directly with our service provider with the customer's agreement, allowing the installer to co-ordinate their return and avoid unnecessary disruption for customers.

Safety, planning and innovation underpin our approach to collaborating with energy suppliers and meter operators in order to make sure the UK's smart meter roll-out runs as smoothly as possible in our region.

- This year, we authorised just over 600 meter operator installers to work safely on our equipment, nearly 590 of them having been accredited at our own training facilities.
- When meter operatives encounter an issue meaning installation cannot go ahead on the initial visit, we've ensured that we've got the manpower in place to resolve the defect as soon as we can.

Table 9: Smart meter installations in 2019-20

	North East	Yorkshire	Northern Powergrid
Smart meters deployed by suppliers in the Regulatory Year 2019-20	123,268	194,415	**317,683**
Total meters eligible for transition to smart	1,583,298	2,269,361	**3,852,659**
% penetration	7.8%	8.6%	**8.2%**

15,295 smart meter defects
resolved within target timeframes

317,000+ smart meters
installed by energy suppliers

[24] For more information on the smart meter roll-out, refer to the government website www.smartenergygb.org

Figure 6: A summary of our strategic plan to support the smart meter roll-out and maximise its benefits

Optimise and develop

— Support SMETS2 roll-out, continue defect resolution
— Start benefits realisation tracking
— Refine organisational structure
— Innovation projects – support early benefits

Integrate and innovate

— Systems Integration Roadmap defined
— Remaining smart meter process in place
— Deliver enduring integration projects
— Develop benefits tracking
— Innovation projects – wider benefits

3.4.3 IT and communications investment

We've been busy making all the necessary changes to systems and business processes. This year we:

— remained compliant with our security obligations and continued to make progress on a series of projects to make sure customers benefit by ensuring our systems are ready for all meters as they are enrolled into the national infrastructure. Table 10 summarises the smart meter IT and data costs that are passed through to our customers that we have incurred this year[25].
— worked with the suppliers who operate in our region to ensure the safety of roll-out activities.
— monitored our business processes and where necessary improved our working practices to deliver the most benefits for customers.

3.4.4 Actions we expect to take next year

In 2020-2021, we expect to move from the Optimise & Develop phase to the Integrate & Innovate stage (Figure 6) as we expect meter volumes to increase from late 2020. We will be developing our process and organisational structure to meet the increased amount of work.

We look forward to progressing the benefit delivery actions that will underpin the customer benefits (Table 11) we are targeting. We will update the IT Gateway that we use to link to the national service so that we can communicate with SMETS1 early generation smart meters.

We are excited to be able to interact with those early generation smart meters that are being enrolled in the national service. We have started tracking benefits and will begin some innovation projects.

Table 10: IT and communications costs for 2019-20

	£m
Smart Meter Communication Licensee Costs (pass through)	4.04
Smart Meter Information Technology Costs	1.16
Elective Communication Services	0.00
Smart Meter Communication Licensee Costs (outside price control)	0.00
Total	**5.20**

Notes for Table 10

— Smart Meter Communication Licensee Costs: the charges paid by the licensee to the holder of the Smart Meter Communication Licence as a requirement for it to be a party to the Smart Energy Code.
— Smart Meter Information Technology Costs: any information technology costs that the licensee reasonably incurs and are necessary for them to use data from smart meters effectively for the efficient and economic operation and maintenance of its Distribution System.
— Elective Communication Services: Payments for discretionary data services purchased through bilateral agreements with the Data Communications Company (DCC). Elective Communication Services may now be requested by the DCC's customers, however as at the end of the 2019-20 Regulatory Year the DCC had not received any requests or entered into any Bilateral Agreements with its customers for Elective Services.

[25] More information is provided in Annex 5 (a copy of our annual submission to the regulator of related information) and in the 'Detailed commentary' document associated with it.

Table 11: Smart meter benefits actions in 2020-21

Actions	Benefits for customers
— Upgrade our IT systems to process smart meter data which may help us better understand power used by our low voltage electricity customers and how to measure network losses more accurately.	Avoided losses to network operators.
— Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams. — Integrate alerts in the redesign of our operational process to allocate staff to power cut repairs.	Reduction in the length of power cuts.
— Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams. — Integrate alerts in the redesign of our operational process to locate faults.	Reduction in operational costs to fix faults.
— Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams. — Integrate alerts in our distribution network outage management system. Although levels of inbound calls may drop, outbound contact with our customers will remain high as we proactively update customers about power cuts and the time they can expect their power back on.	Better power cut communication.
— Upgrade our IT systems to process smart meter data (including automated voltage alerts) and make it available to our operational teams. — Integrate the information flowing from the data in the redesign of our network planning processes relating to new connection design, reinforcement design and voltage quality assessment.	Better informed investment decisions for electricity network reinforcement for quality of supply.
— Upgrade our IT systems to receive smart meter data (including automated power cut alerts). — Integrate alerts in the redesign of our operational process to allocate staff to power cut repairs. — Integrate the information flowing from the data in the redesign of our network planning processes relating to voltage quality assessment. This is particularly exciting as it is an area where we currently hold very little data, other than when a customer notifies us of a voltage problem.	Avoided cost of investigation of customer complaints about quality of supply.
— Progress our request to Ofgem for half-hourly consumption data from smart meters to help us better understand the usage profiles of low voltage electricity customers and explore ways to save money on network improvements.	Network capacity investment savings from electricity demand shift.

Contact us regarding our plan

We believe that our customers and stakeholders are the best judges of our performance. We always want to hear your views and opinions on the services we provide and your ideas for what we could be doing. If you would like to comment, you can contact us in a number of ways:

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