RIIO-ED2 : Storm Arwen Re-opener

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1 Executive Summary

1.1 Our submission

This document represents our submission under the provisions of RIIO-ED2 Special Condition 3.2 part J for additional funding to be made available in the RIIO-ED2 (2023-2028) period to deliver a programme of targeted improvements to the storm resilience of our electricity network. These measures build on our existing activities and reflect the recommendations of the Storm Arwen reviews undertaken by BEIS and Ofgem following the eponymous storm of November 2021.

The programme comprises a range of proposals that collectively will deliver substantial and sustained improvements in storm resilience to vulnerable communities and customers in the North West of England. Together, it comprises a £28m package of measures, some of which will lay the basis for further resilience improvement programmes into RIIO-ED3 and beyond.

The table below sets out how the need for investment relates to the three key factors which drive our programme of proposals and how those proposals link to the Storm Arwen reports recommendations;

Needs statement	Key factors	No.	Proposal	Rec.	Costs (£m)
The programme is driven by the need to reduce customer exposure to long duration storm outages caused by the three key factors identified in the next column. Our seven proposals align to solutions which mitigate the risks posed by these three key factors. These proposals also address specific recommendations from the BEIS and Ofgem reports.	Resource overwhelmed due to high volume of HV faults requiring field repair	1	HV network strengthening predictive modelling	BEIS E2	0.8
		2	Targeted HV undergrounding /strengthening	BEIS E2	12.6
		3	Pennine and Borders Interconnection	BEIS E2	1.6
	Masked or nested LV faults only revealed on restoration of the associated HV fault;	4	LV automation enhancements	BEIS R1	5.5
	33kV overhead failures requiring long repair time in areas of limited HV backfeed	5	Coniston – HV interconnector	BEIS E2	3.1
		6	Alston – HV interconnector	BEIS E2	3.9
	Across all factors	7	ETR132 review	Ofgem 1	TBC
Total cost (£m - 2020-21 money)					**27.5**

Table 1-1 How our proposals relate to Needs and Recommendations

These measures build on the work we have already undertaken and committed to since Storm Arwen supporting our core aim to substantially and sustainably reduce the risk of extended long-duration outages following severe storm events through investing in material, long-term impacting measures.

In the immediate aftermath of Storm Arwen, we;

- Installed 750 LV monitoring devices in areas affected by Storm Arwen;
- Made enhancements to our Network Management System (NMS); and
- Provided a £500,000 community fund supporting resilience in rural communities.

We have subsequently made further enhancements to our website enabling customers to report damage, introduced a payments portal and given all our staff a dedicated 'storm role'. This has included an extra 300 staff being trained in call handling and establishing dedicated door-knocking teams to improve communications with vulnerable customers.

We are not requesting additional funding for expenditure already incurred in this area.

We propose that funding for our programme is made available via the form of a discrete Use-It-Or-Lose-It (UIOLI) allowance with associated obligations to publish the investment strategy and annual reporting of progress, modelled on the mechanism established for Worst-Served Customers in RIIO-ED2. This allows for the ring-fencing of funding together with implementing proportionate reporting requirements. We look forward to working with Ofgem on any associated licence drafting required to support our proposals under this re-opener application which we believe represents the best value and outcomes for customers and stakeholders.

Due to the lack of mature predictive models in the area of storm impacts modelling, key to our submission is the retention of flexibility to be able to adjust the mix of proposals in response to emerging data and analytical insight.

Included within this document is an assessment against the minimum re-opener requirements specified by Ofgem, along with a summary of the assurance process that our submission has been through. We also detail the engagement we have undertaken with customers and stakeholders, both in the aftermath of Storm Arwen and in the development of this submission. Their input has been invaluable in providing insights into the impacts of long duration storm outages and also in advising on the appropriate measures and scale of our proposed programme.

All values in this document are expressed in 2020/21 prices.

1.2 Storm Arwen

On 26 November 2021, Storm Arwen entered our region from the North East late in the afternoon bringing gust speeds of up to 74mph and sustained wind speeds of over 60 mph. The wind was accompanied by drifting snow and freezing temperatures across the region.

Wind speeds stayed above safe climbing limits until midday on 28 November when the eye of the storm passed out of the region through North Lancashire and into Derbyshire, inhibiting climbing and repairs until midday on Monday.

It is estimated that tens of thousands of trees fell under the sustained high wind speeds exacerbated by saturated ground conditions and ice loading. In addition to structural damage to power lines, the trees damaged many buildings, closing roads and railways across the region.

Ice accretion caused significant damage in East Cumbria, Lancashire and Derbyshire, adding to the faults caused by tree damage throughout the entire region. The highest wind speeds, snowfall and freezing temperatures centred on Cumbria, East Lancashire and north Derbyshire.

The network throughout these regions is predominantly overhead line.

The sustained high winds, coupled with snow, gave rise to 313 High Voltage faults and over 500 Low Voltage network faults. This equated to almost two months of business-as-usual fault activity in 24 hours.

Storm Arwen had such a significant impact on our network because of the wind direction, sustained length of the wind storm and because of the interaction with other weather types, particularly snow in the Peak District.

Given the significance of the Storm Arwen event, both Ofgem and BEIS (now DESNZ), commissioned reviews into the storms and network companies' response[1]. These produced a total of 67 recommendations which were followed up through the Storm Arwen Implementation Group (SAIG).

Many of these related to the sharing of best practice and its adoption into business-as-usual. In addition, companies have undertaken a range of initiatives to improve forecasting, preparedness, response and customer communications, alongside improving inter-agency collaboration.

A small number of the report recommendations related to resilience and the potential strengthening of the network itself to enhance its ability to withstand storm impacts. Responding to these recommendations through the implementation of a balanced portfolio of proposals is the core of our re-opener submission and one we have developed in conjunction with our key stakeholders and partners.

Westmorland and Furness Council are pleased to support Electricity North West's application for additional funding to increase the resilience of our communities and improvements to secure reliable electricity supplies for residents and businesses in the area. Such investment is vital for the welfare of our communities, our region's decarbonisation aspirations and the local economy. The frequency of storms in our region is increasing and a modern, resilient network is vital.

Angela Jones, Head of Place-based Services, Westmorland and Furness Council

My constituency of Westmorland and Lonsdale saw extensive damage during Storm Arwen in November 2021 and I therefore welcome measures that will see vital additional funding delivered to bolster the resilience of critical electricity infrastructure across the North West. Given the predominantly rural nature of my constituency, communities here often bear the brunt of severe weather incidents, resulting in prolonged power outages due to overhead line damage. The frequency of disruptive weather events has significantly increased across this region and is likely to continue. Therefore, it is vital that we proactively take steps to future-proof the network.

Tim Farron, MP for Westmorland and Lonsdale

[1] (a) published by Ofgem in the document titled "Final report on the review into the networks' response to Storm Arwen" published on 9 June 2022; and
(b) by the Energy Emergencies Executive (BEIS) in the document titled "Energy Emergencies Executive Committee Storm Arwen Review" published on 9 June 2022.

1.3 Ofgem Minimum Requirements

Appendix A sets out how this submission complies with Ofgem's RIIO-ED2 Minimum Requirements as set out in the "Re-opener Guidance and Application Requirements Document" published on 17 February 2023.[2]

1.4 Assurance

Appendix B includes details and evidence of our submission assurance process.

1.5 Document Navigation

Chapter 2 sets out the context to our re-opener submission, starting with our storm resilience strategy and then discusses this in the wider context of our climate change adaptation approach. It sets out the key causes of customer impacts during storm events and then explores these specifically in the context of Storm Arwen.

Chapter 3 reviews the high-level outcomes of the post Storm Arwen reviews; highlights the requirements of the associated Storm Arwen re-opener and then details the process we went through with our stakeholders to identify our proposed programme of works which is introduced at summary level.

Chapter 4 lays out the indicative detail of our programme and our approach to its costing and benefits assessment.

Chapter 5 sets out a number of alternatives in terms of funding through the RIIO-ED2 framework and proposes a model for reporting progress.

Chapter 6 provides a summary table of our proposals.

Chapters 7 to 12 provide further detail on each proposal and its application.

[2] https://www.ofgem.gov.uk/sites/default/files/2023-03/Reopener%20Guidance%20and%20Application%20Requirements%20Version%203.pdf

The table below references the supporting Engineering Justification Papers (EJPs) and Cost Benefit Analyses (CBAs) for each proposal;

Proposal	Chapter		EJP reference	CBA reference
1	7	HV network strengthening predictive modelling	ENWL-EJP-SA1	ENWL-CBA-SA1
2	7	Targeted HV undergrounding /strengthening		
3	8	Pennine and Borders Interconnection	These will be assessed on an individual proposal basis	
4	9	LV automation enhancements	LS EJP 5 LV Auto reclosers at PMTs	N/A
5	10	Coniston – HV interconnector	ENWL-EJP-SA2	ENWL-CBA-SA2
6	11	Alston – HV interconnector	ENWL-EJP-SA3	ENWL-CBA-SA3
7	12	Review of ETR132 standard	Not included as no additional expenditure currently proposed	

Table 1-2 Supporting EJP and CBAs

1.6 Contact

In case of any queries relating to this submission please use the contact below[3] in the first instance;

Jonathan Booth
Head of Asset Management

[3] Full contact details are provided in the cover e-mail sent to Ofgem with this submission

2 Contexts

2.1 Background to storm resilience

At Electricity North West we are responsible for maintaining and upgrading electricity infrastructure across the North West of England with a total replacement value of £14 billion (2020-21 money), 13,000 km of overhead power lines, more than 47,000 km of underground electricity cables and much more. We deliver nearly 20 terawatt-hours of electricity through our network, relied on by over five million people across an area of 12,500 square kilometres and invest over £1m per day to provide a reliable, affordable and sustainable network. This covers the diverse communities between the Lake District and the Peak District, including the city of Manchester and all the cities, towns and villages in between.

Electricity networks are built to withstand the majority of reasonably foreseeable weather conditions, and this is integral to their design standards. Severe storms however can present particular challenges to maintaining electricity supplies, particularly in areas served by overhead line networks.

We have managed the impact of storms for as long as we have had networks. These severe but infrequent events can cause significant damage. Combined with adverse weather conditions hampering recovery efforts and finite appropriately trained engineering resource to effect repairs, it can take many days for customers to be permanently restored in these circumstances.

Figure 2-1 Failed pole due to tree damage in storm conditions

Our storm resilience strategy revolves around four key pillars;

- PREVENT the storm event from having an impact;
- DETECT the faults from the storm quickly and precisely;
- RESTORE as many affected customers as possible using remote switching; and
- RESPOND to faults requiring repair through the efficient, targeted deployment of appropriately trained and equipped resources.

Underpinning this is managing and maintaining meaningful communications with customers, stakeholders and partners and offering appropriate support to vulnerable customers and communities in the recovery phase of an event.

Prevent	Detect	Restore	Respond
• Reduce damage from extreme weather through network investment	• Identify and locate damage quickly and precisely through remote monitoring and deployed recce resources	• Rapidly restore supplies through automated and manual network re-configuration to minimse the impact of damage	• Deploy trained and equipped resources to repair the network • Support vulnerable customers and communities • Maintain meaningful communications with customers, stakeholders and partners

Figure 2-2 Four key pillars of storm resilience

Storm Arwen was a significant event for our region but was neither the most damaging nor the longest-lasting storm in the last 25 years. Figure 2-3 below shows the impact of Storm Arwen in comparison to other storms in this period in terms of customers affected and duration in terms of time to restore the last customer.

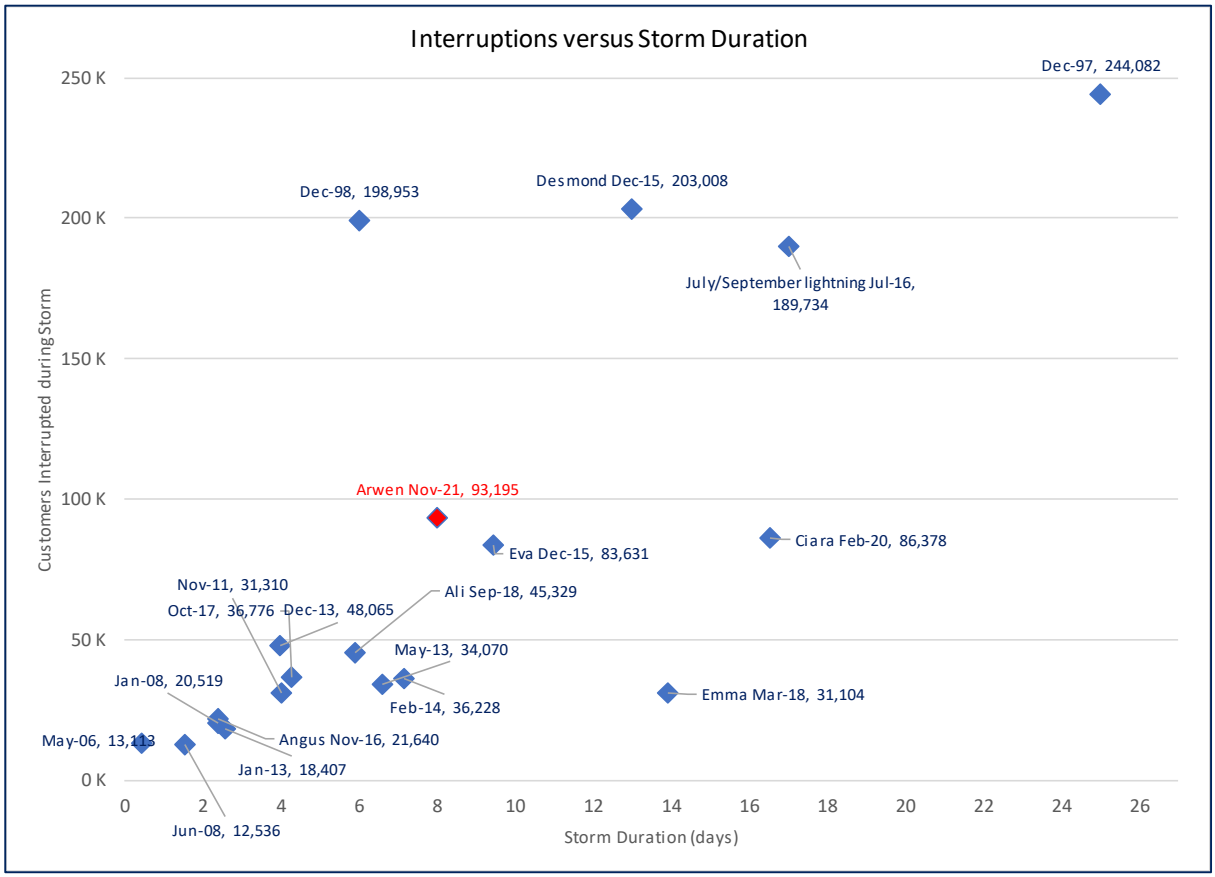

Figure 2-3 Historic storm impacts

However, against a backdrop of ever increasing dependence on electricity as part of our journey to Net Zero, customer and stakeholder expectations when considering long duration outages following storm events have significantly changed such that durations above five days are now deemed unacceptable. It is also of note that both cellular and landline public communication systems are increasingly dependent on mains power. This was evident during Arwen where customers were unable to communicate with Electricity North West or the emergency services due to the roll-out of Internet Protocol (IP) based telephony systems. This, combined with the increased reliance on online services in all aspects of daily life means that in extreme weather, power supplies are integral to maintaining public safety.

The post-Arwen challenge is to meet these new expectations with a network that was originally designed and installed many decades ago. All of the short-term improvements identified following Arwen have already been implemented and we have seen their positive impact in our ability to respond to subsequent storm events. Our most recent experience of storms Isha and Jocelyn in January 2024 have shown the effectiveness of early detection techniques and improved organisational readiness.

However, there are limits to how far we can mitigate the impact of future storms such as Arwen without strengthening and reconfiguring the most vulnerable parts of the network itself. These vulnerable parts of the network are often in rural locations with limited numbers of customers served from them meaning that under traditional Cost Benefit Analysis (CBA) they rarely meet a net benefit requirement to address the vulnerabilities to storm events. This will require a long-term rebuild programme of the overhead line network to modern design and construction specification; one which will span multiple price control periods but one which can start in RIIO-ED2 based on the highest priority areas identified by the latest predictive analytics.

This is the initial activity at the start of a longer term resilience strategy and is the core proposal in our application; one that complements other aspects of our RIIO-ED2 plan which will also contribute to improved overall storm resilience;

	Ongoing activities	RIIO-ED2 planned programmes	Storm Arwen re-opener
PREVENT	• Routine replacement and refurbishment • ETR132 resilience tree-cutting	• Worst-Served Customer reliability improvements • Increased tree-cutting • Marginal refurbishment enhancements	• Targeted line strengthening / undergrounding • Addressing priority 33kV vulnerabilities • Inter DNO HV interconnections
DETECT	• Fault-finding devices (eg EFIs)	• LineSIGHT HV detection programme	
RESTORE	• Advanced Network Management System with automated restoration (FLISR) • HV auto-reclosing • LV reclosing (PERCH)	• Additional HV auto-reclosing • Further development of FLISR algorithms and incorporation of remote fault passage detection	• Additional LV auto reclosing
RESPOND	• Incident management training • NEWSAC mutual aid	• Research	

Table 2-1 Current and proposed initiatives impacting storm resilience

This ensures alignment with our overall business strategy and commitments for storm resilience.

2.2 Impacts of a changing climate

Network operators have always been aware of the risks of damage to their networks from storms, so have worked to construction and maintenance standards designed to minimise this risk in reasonably foreseeable circumstances.

Since the Climate Change Act of 2008, we have worked with other network operators in the electricity and gas, transmission and distribution sectors, through the Energy Networks Association (ENA) to identify the risks posed by the changing climate and to identify strategies to manage these risks.

The results from these working groups were submitted to Defra in 2011, 2015 and 2021 as Climate Change Adaptation Reports. The ENA group produced an industry report and each individual company produced an accompanying report highlighting how the issues impacted their own area.

The three sets of reports that we have submitted can be found on the Electricity North West website[4].

The ENA document published in March 2021[5] shows the industry thinking on storms, which has been consistent throughout the three cycles of reporting:

> *Since there is currently no strong signal within the climate projections for a change to future storm intensity, the risk of strong winds was assessed in the current climate only*.

Information from the UK Climate Projections published by the Met Office in 2009 (UKCP09) and 2018 (UKCP18) showed an expectation that the frequency of storms would increase, but there were no indications that these storms would be of greater intensity than those that we have observed in the past.

Our own report for the third round of adaptation reporting was submitted in December 2021 shortly after Storm Arwen had hit our network[6]. In that report we noted that:

> *This report was completed as Storm Arwen impacted our network and events such as this give us the opportunity to learn in terms of network adaptation and preparedness actions. We look forward to the forthcoming Ofgem and BEIS reviews which will enable us to work with our colleagues in the industry and with climate experts to update our thinking on storms and their potential impacts.* (Page 1)

We committed to work with industry colleagues, academia and industry through the ENA Climate Change Resilience Group (CCRG):

> *Following Storm Arwen, a focus of the CCRG work will be to understand the potential impact of long duration storms and storms coincident with other climate risks* (Page 6).

[4] https://www.enwl.co.uk/future-energy/distribution-system-operation/climate-adaptation/
[5] https://www.enwl.co.uk/globalassets/future-energy/net-zero/climate-change-adaption-report/2021---climate-change-adaptation-report---annex--ena-report.pdf
[6] https://www.enwl.co.uk/globalassets/future-energy/net-zero/climate-change-adaption-report/2021---climate-change-adaptation-report.pdf

We have subsequently worked with the University of Birmingham on projects looking at the relationship between wind and network disruption, which has the potential to improve our response to storm events.

We are currently supporting bids from Newcastle University and the University of Birmingham to look in more detail at this type of relationship with the aim of developing predictive models. These would aid us in planning preventative measures and improving our operational response.

As part of our RIIO-ED2 Price Review Submission in December 2021 we published our first Climate Resilience Strategy[7]. This document was submitted five days after Storm Arwen had hit our network, so the impact of that specific storm was not reflected in this document. We do however note other work that we planned in the RIIO-ED2 period to improve restoration times in storms:

> *Response to storms is a high priority issue with customers. Section 4.4.2 of our RIIO-ED2 Business Plan sets out the measures we will be taking including enhanced resilience to flood and wind events, together with the roll-out of our innovative LineSIGHT technology which will detect damaged overhead lines more quickly and enable faster and more accurate despatch of repair crews.* (Page 15)

2.3 Storm impacts

The key customer impact during a storm scenario is the risk of long duration outages which result from three key factors:

- Resource being overwhelmed due to high volume of faults requiring field repair;
- Masked or nested LV faults only revealed on restoration of the associated HV fault; and
- 33kV overhead line failures requiring long repair time in areas of limited HV backfeed.

Storm Arwen typified these risks with the result that some customers were off for an extended period of time. This was in part due to the extended period of high winds preventing safe climbing and the subsequent snow and icing conditions that prevailed, hampering access.

This re-opener application is based fundamentally on measures to reduce the number and impact of LV and HV faults for any given storm (thus reducing the pressure on constrained resources) and also reducing the risk from 33kV overhead line failures in known vulnerable locations.

> *"I think we're beyond the point now of people saying 'oh this is a once in a generation storm, …we know with climate change…What is a once in a generation, that's going to be become the norm and I think there needs to be significant investment in more kind of worst-case scenario planning, and that being on a bigger scale because we can't have the excuse that we didn't see this coming."*
>
> Customer feedback post Storm Arwen

Our climate change adaptation reports highlight that climate change is predicted to increase the frequency of severe weather events during a period where dependence on a reliable electricity supply

[7] https://www.enwl.co.uk/globalassets/about-us/regulatory-information/riio2/december-final-submission/annexes-final/annex-11-climate-resilience-strategy.pdf

is only going to increase due to decarbonisation. This makes it more critical than ever that networks are strengthened to mitigate these customer impacts.

2.4 Customer experience of Storm Arwen

The start of the RIIO-ED1 period was marked for us by the catastrophic flooding events of Storms Desmond and Eva in December 2015. These had a major impact on customers served by a small number of flooded substations resulting in long duration outages. Significant investment was committed through RIIO-ED1 into improving resilience to low probability flooding events, and this programme continues into RIIO-ED2. RIIO-ED1 also saw multiple storm events with Storm Arwen being the one with the most significant and far-reaching customer impacts due to a combination of factors which resulted in extended outage times.

In total some 750,000 customers are fed from overhead line networks that were in the path of Storm Arwen. Of these only 10%, 75,000, lost power in the initial phase of the storm. Network resilience measures safeguarded some 440,000 customers and in addition some 213,000 customers were protected by our enhanced tree cutting and additional discretionary investments in network resilience (e.g. automation).

However, 313 HV and over 500 LV faults were experienced which affected 75,000 customers with half being restored within 12 hours and 69% within 24 hours. In total, 673 spans (37km) were rebuilt, 120 poles and 28 transformers replaced and 280 generator sets fitted.

Figure 2-4 below shows the outage duration curve for Storm Arwen;

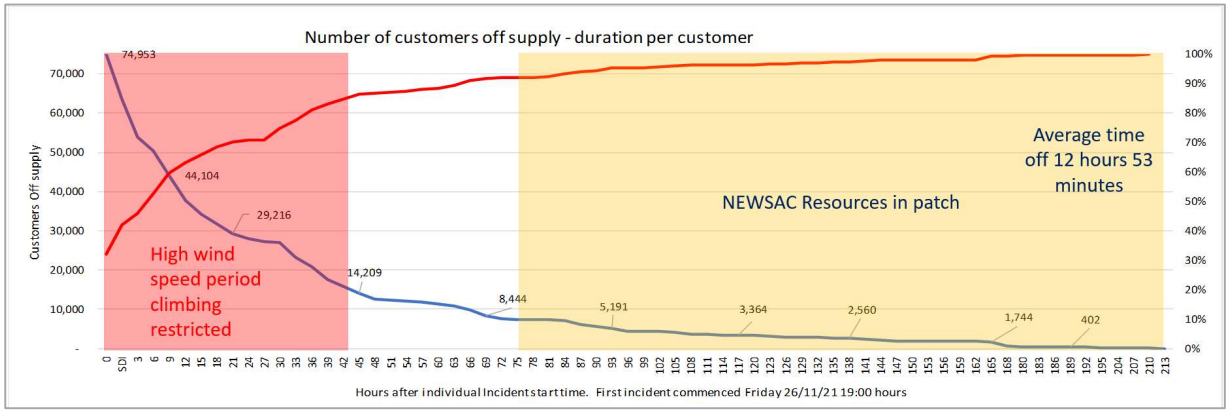

Figure 2-4 Outage duration curve for Storm Arwen

Despite the effectiveness of our automation and proactive measures, a limited number of customers were off for extended periods due to difficulties of access, ongoing prevailing weather conditions and resource limitations due to the scale of the event across the country. 3,364 customers were off for more than five days which was presented as the acceptability limit based on regulatory and political engagement at the time. Our longest duration outages stretched to nine days.

Storm Arwen also caused faults on our 33kV network which resulted in extended duration outages for some of the remoter communities in Cumbria. These remote areas have limited HV backfeeds and can be difficult to access in winter conditions. 33kV faults are particularly problematic as they can:

- affect large numbers of customers;
- be difficult and resource-intensive to repair; and
- result in other faults at lower voltages being masked and only revealed when the 33kV is re-energised.

Table 2-2 below shows the 33kV faults experienced in Storm Arwen;

Job	Damage	Output	Return to service	Number of Customers Affected	Time off Supply
Coniston 33kV Line Torver	Tree down on 33kV lines	Five 33kV Spans repaired Two 33kV Poles Replaced including cross arms	29/11/2021	1,325	3 days
Alston 33kV	Tree Down on 33kV Line Ice loading at Hartside brought down all three phases across multiple span	One Span repaired Four 33kV Spans repaired	28/11/2021	1,354	4 days
Ambleside to Troutbeck/ Windermere	Tree down onto 33kV Line	One 33kV Span Repaired	29/11/2021	None	

Table 2-2 33kV faults experienced in Storm Arwen

The faults on the Coniston and Alston 33kV infeeds highlighted the vulnerability of these communities. As a consequence, we have included proposals to improve the resilience of the supplies to these communities in our application and provide further details in Chapters10 and 11. A broader review of the potential vulnerability at 33kV will be undertaken and considered for inclusion in our RIIO-ED3 resilience improvement programme.

At the heart of this analysis are the customers whose lives were severely impacted. Traditional assessment of the impacts of loss of electricity (e.g. Value of Lost Load, or VoLL) ignores the second and third order impacts that usually result. Work on Social Return on Investment (SROI) developed as part of the RIIO-ED2 submission offers a valuable additional quantitative approach to address this but still does not consider the particular impacts of long duration outages. As such, whilst a significant number of customers were impacted, the number of customers supplied is lower than supplied by most 33kV circuits, so it is difficult to justify the relatively high cost of intervention on the 33kV network based on a limited Cost-Benefit case using traditional analyses, and it was for this reason that we were unable to include the proposals within our RIIO-ED2 business plan.

We have consulted with many of our stakeholders on this and are aware of significant appetite and ongoing efforts to develop models which better reflect these impacts, however there is no current standardised approach. Our modelling of impacts in the Cost Benefit Analysis spreadsheets (CBAs) provided alongside this submission therefore considers:

- traditional analysis;
- SROI insights; and
- additional factors specific to long duration outages identified as part of this submission.

Further details are provided in section 4.2 and Appendix C. We have also included customer voices in this submission which echo the perspectives from Ofgem's own customer insights work following Storm Arwen[8].

"When the electricity goes down, as it did, we couldn't have water to drink or to cook with. Not only does it get pumped into the house, but it has to also go through a filter and ultraviolet light. All of those are down. So, you're reduced to going to a stream to get a bucket of water to flush the toilet."

Customer feedback post Storm Arwen

[8] https://www.ofgem.gov.uk/publications/customer-experiences-storm-arwen

3 Submission development

3.1 Storm Arwen reviews

Given the significance of the Storm Arwen event, both Ofgem and BEIS (now DESNZ), commissioned reviews into the storms and network companies' response. These produced a total of 67 recommendations which were followed up through the Storm Arwen Implementation Group (SAIG). The results were categorised as follows:

Category	Scope
Resilience	The resilience of the network to withstand severe weather events, i.e. physical damage and organisational resilience to prepare and respond.
Restoration and response	Weather forecasting, fault identification and damage assessment, repair, resourcing, mutual aid agreements, the deployment of temporary generators, the sharing of good-practice and industry reporting.
Customer communication	Physical customer communications systems and staffing, accuracy and accessibility of content such as estimates of restoration times, communications resilience if landline/internet failure.
Compensation	Mechanisms and communication of payment of compensation.
Emergency Planning	Pre-planning and preparation with and by Local Resilience Forums and other sectors to assess the direct and indirect impacts of electricity incidents (i.e. telecoms, emergency services, water and vulnerable persons).
Customer welfare & Local Resilience Forum	Provision of welfare and coordination with Local Resilience Forums.
Information sharing	Joint winter preparedness and information sharing arrangements with Local Resilience Forums.

Table 3-1 Storm Arwen review recommendations

The majority of these recommendations have been actioned and implemented into business-as-usual practice. We additionally committed to deliver short-term improvements at the end of RIIO-ED1 through the early introduction of LV auto reclosing on overhead lines and enhancements to our Network Management System (NMS) system, reporting these as complete to Ofgem at the end of March 2023.

A copy of the letter confirming the completion of these alternative action arrangements can be found in Appendix D.

Within Electricity North West, we have seen the benefits of these changes in our response to subsequent storm events through 2022 and 2023.

Recommendations relating to the fundamental nature of overhead line networks are much more costly and expensive to implement however. This re-opener application includes initiatives which represent the start of resilience enhancement programmes which will extend through RIIO-ED3 and beyond, with the most immediately urgent issues addressed in RIIO-ED2. It also includes proposals to enhance data and forecasting of impacts which will deliver greater efficiency and productivity as we are able to utilise the modelling outputs in a more targeted and informed way.

Key to the review's findings with respect to network design standards was that the current standards are broadly technically appropriate. They are not however retrospectively applicable so routine asset replacement and refurbishment will only secure at best minor incremental improvements as poles will only be replaced in the current location rather than relocating poles to reduce span lengths in line with current specifications. Our core proposal is to commence a programme of targeted network strengthening (overhead line rebuilds or undergrounding) in the most vulnerable areas to substantially reduce exposure to storm impacts on an enduring basis.

3.2 Storm Arwen re-opener

As part of the RIIO-ED2 Final Determination, Ofgem established the Storm Arwen Re-opener under Special Condition 3.2 Part J;

Part J: Storm Arwen Re-opener (SAR_t)

3.2.66 This Part establishes the Storm Arwen Re-opener.

3.2.67 The Storm Arwen Re-opener may be used where the costs incurred or expected to be incurred by the licensee in operating its Distribution Business have changed as a direct result of the Storm Arwen Recommendations, including actions taken as a result of those recommendations.

In our Storm Arwen actions closedown report, we undertook a comprehensive triage process against each individual action to identify;

- whether there were any further actions that could be taken; and
- whether they would be eligible against the requirement set out above.

In addition to the actions committed to in the immediate aftermath of Storm Arwen, we have also put in place additional enhancements to improve our ability to communicate with customers in the event of a storm. These include;

- The ability to report damage through the Electricity North West website;
- Introducing a winter payments portal to ensure proactive and accurate payments; and
- Identification of a role for each member of staff during storms which provides
    - Additional call handling capacity for incoming calls;
    - Additional capacity to make proactive outbound calls; and
    - Door-knocking teams to visit vulnerable customers.

We are not requesting additional funding for these enhancements which have been delivered and have already proved their worth in subsequent storm events.

3.3 Stakeholder Engagement and Support

Arwen wasn't the first or largest storm that we have experienced and it certainly won't be the last. Ahead of the RIIO-ED2 submission we included enhanced storm resilience as an option in our customer research and it scored strongly, ranking third of 24 options. Our aim was to include a programme of targeted interventions to complement our programmes of asset renewal, LineSIGHT rollout and tree-cutting.

Appendix C has further details.

Due to the data and analytics available at the time, it wasn't possible to identify a robust and costed proposition that we could be confident would offer both significant improvements on the ground and value for money to customers. Historic storm impacts data can be patchy and is a function of the specific historic events experienced which may not be a good guide to future probabilities.

Post Storm Arwen, significant engagement was also carried out with affected customers and stakeholders. Much of the feedback centred on customer communications and recovery activities but there was also a clear appetite for further investment to reduce the exposure of overhead line networks to future storm events.

We have refreshed our stakeholder panel structure for RIIO-ED2 and are fortunate to have access to informed regional leaders who are able to provide advice, input and challenge on our operations and plans. We have made use of these panels to inform this submission, specifically our;

- Economic Growth Advisory Panel (EGAP) – This panel focusses on businesses and how RIIO-ED2 will affect them with panel members including business leaders, local authorities, National Farmers Union, and voluntary sector leaders;
- Stakeholder Insight Advisory Panel (SIAP) - This panel is the voice of the North West including local council and authority leaders; and
- Independent Oversight Group (IOG) – This panel covers all external stakeholder groups and was used as part of the final sign -off for this submission.

Aside from the external stakeholder groups, we have also engaged bilaterally with the relevant Local Authorities and Members of Parliament including;

- Westmorland & Furness Council
- Cumberland Council
- Tim Farron MP for Westmorland and Lonsdale
- Neil Hudson MP for Pennine and The Border

Specific letters of support from these partners are included as part of our re-opener application. This engagement encouraged us to progress an application under the re-opener provision within the RIIO-ED2 licence and as part of the preparation for this submission, we have engaged extensively with our new stakeholder panels as well as following up bilaterally with many of our panel partners.

We explored the impact of long duration outages on rural customers with the National Farmers Union. This provided significant insight into the effects that storms have on rural communities with prolonged power cuts. As many rural properties and farms are off-grid for water this means that power cuts also result in interruption to their water supply. Similarly, with landlines moving to broadband this means that a loss of electricity supply also means a loss of communication as the most rural communities have a limited mobile coverage. Further, the impacts for farmers are significant during winter as any generators which are available are used for livestock management with animal health and welfare

being a priority. Added to this is the fact that day time working hours are much reduced during mid-winter which means that prolonged power cuts are a significant concern for farmers.

With Cumbria Council for Voluntary Service (CVS) we looked at the impacts that prolonged power cuts have on rural communities, for example in larger towns and cities it is often easier to travel to another area which has not lost its electricity supply. For communities which are extremely remote, there are difficulties in getting generators to these areas which means that community hubs will also be without electricity making it difficult for people to have hot food or charge their phones.

3.4 Preferred options

Following the triage process noted in section 3.2, our re-opener application includes a portfolio of proposals which collectively will secure significant improvements in storm resilience for our customers. These are presented in more detail in chapters 7 to 12 but are summarised below. The relative scale of each proposal is intended to be dynamic so we can respond to the evolving data insights on the most vulnerable areas and the most effective means to address them. Further review may also identify cost-effective alternative interventions in specific areas.

Proposal 1: HV network strengthening predictive modelling

The majority of storm impacts come from faults on the HV overhead line network, either due to direct exposure to weather (lightning strikes, conductor sagging due to icing, pole snaps due to wind etc.), or the impacts of debris being blown into overhead lines (trees, branches, trampolines etc.). As a result, most of our initiatives focus on this part of the network.

We plan to commence a proactive programme of overhead line strengthening and undergrounding in areas vulnerable to storm damage. We considered including a similar programme in our RIIO-ED2 submission and included it in our customer and stakeholder research where it scored very highly (third ranked option out of a total of 24). However, we found it difficult at the time to identify a justified programme of specific mitigation work due to limitations in the data, limitations which still exist.

It is relatively easy to look at the impacts of any particular storm (although data quality can suffer during extreme events) but this backwards-looking approach only points to newly-repaired parts of the network and offers limited insight into future vulnerabilities, especially as significant storms are rare events so even an area affected by multiple previous events may not necessarily be particularly susceptible to future damage. As such, aggregating the impacts of previous storms gives coarse findings, for example identifying vulnerable HV feeders, which do not support the targeting of investment where it would be most effective.

Recent developments in analytics and the availability of highly granular meteorological data combined with network model data and consideration of the impact of storms on the road network open up the possibility of developing models which can assess the risk of customer impact from future extreme weather events at the individual support level. This approach also permits the comparison of different solutions to identify the most effective approach on a pole-by-pole basis. This is the focus of our first proposal.

Proposal 2: Targeted HV undergrounding / strengthening

The second proposal is to start to implement the findings of proposal 1 approach by strengthening or undergrounding the highest priority locations identified.

Proposal 3: Pennine and Borders interconnection

Our third proposal considers the option of increasing the flexibility of the very remotest edges of our network by looking over the border into our neighbouring DNOs and collaborating with them on appropriate solutions on a cross network basis. We have identified a range of possible sites where there is mutual benefit in considering a new HV interconnection between our rural fringe networks which will help mitigate the impacts of future storm damage in either DNO.

Proposal 4: LV automation enhancements

As noted, we incurred more LV faults than HV during Storm Arwen and many of these faults were transient in nature, only requiring a fuse replacement. As part of our programme, we will review and extend the rollout of LV reclosing facilities to automatically restore LV transient faults which will reduce the demand on field staff in storm conditions. This follows on from the PERCH programme implemented in RIIO-ED1 as part of our immediate package of post-Arwen actions.

Proposals 5 and 6: Coniston and Alston HV interconnectors

We have developed two planned resilience improvement schemes for Coniston and Alston where we have communities each served by single 33kV overhead circuits which are vulnerable to storm damage and extended restoration times due to the difficulties in effecting repairs to these circuits.

Proposal 7: ETR132 review

Finally, we have included discussion of the current review of the ETR132 standard which includes resilient tree cutting procedures. This review is not complete at the time of submission but may amend the current prioritisation criteria within the standard which may in turn change the vegetation management programme within RIIO-ED2.

3.5 Needs statement

The table below sets out how the need for investment relates to the three key factors identified in paragraph 2.3 and drives our programme of proposals and how those proposals link to the Storm Arwen reports recommendations;

Needs statement	Key factors	No.	Proposal	Area	Recommendation addressed
The programme is driven by the need to reduce customer exposure to long duration storm outages caused by the three key factors identified in paragraph 2.3 and listed in the following column. Our seven proposals align to solutions which mitigate the risks posed by these three key factors. These proposals also address specific recommendations from the BEIS and Ofgem reports.	Resource overwhelmed due to high volume of HV faults requiring field repair	1	HV network strengthening predictive modelling	Resilience	BEIS E2
		2	Targeted HV undergrounding /strengthening	Resilience	BEIS E2
		3	Pennine and Borders Interconnection	Resilience	BEIS E2
	Masked or nested LV faults only revealed on restoration of the associated HV fault;	4	LV automation enhancements	Restoration	BEIS R1
	33kV overhead failures requiring long repair time in areas of limited HV backfeed	5	Coniston – HV interconnector	Resilience	BEIS E2
		6	Alston – HV interconnector	Resilience	BEIS E2
	Across all factors	7	ETR132 review	Resilience	Ofgem 1

Table 3-2 How our proposals relate to Needs and Recommendations

4 Programme proposals

4.1 Investment Detail and Cost Information

We are proposing a package of measures in RIIO-ED2 which will substantially and sustainably improve storm resilience for our most exposed communities. Table 4-1 below sets out the indicative breakdown of our proposed £28m Storm Arwen resilience improvement programme;

Proposal	£m 20-21 prices	FY24	FY25	FY26	FY27	FY28	ED2	ED3
1	HV network strengthening predictive modelling	0.0	0.1	0.7	0.0	0.0	**0.8**	0.0
2	Targeted HV undergrounding /strengthening	0.0	0.0	2.4	3.1	7.1	**12.6**	TBC
3	Pennine and Borders Interconnection	0.0	0.0	0.0	0.8	0.8	**1.6**	0.0
4	LV automation enhancements	0.0	0.0	0.8	1.6	3.1	**5.5**	TBC
5	Coniston – HV interconnector	0.0	0.0	0.2	1.3	1.6	**3.1**	0.0
6	Alston – HV interconnector	0.0	0.0	0.2	0.6	3.1	**3.9**	0.0
7	Review of ETR 132 standard	TBC	TBC	TBC	TBC	TBC	TBC	TBC
		0.0	**0.1**	**4.3**	**7.4**	**15.7**	**27.5**	

Table 4-1 Indicative breakdown of our Storm Arwen resilience programme

The network modelling, interconnection and HV interconnector initiatives will be wholly delivered in the RIIO-ED2 period, whereas the LV automation programme will extend into RIIO-ED3 and the network strengthening programme is likely to continue for several price controls.

4.2 Benefits assessment

The benefits assessment for this re-opener application is different to that which was used in the RIIO-ED2 submission due to the inclusion of a wider set of benefits than has traditionally been used in a CBA for electricity distribution. We have utilised the SROI (Social Return On Investment) resource, developed by DNOs in RIIO-ED1, which provides data and allows for the use of factors such as avoided medical costs to customers which draws on research done by Electricity North West and the ENA.

The benefits assessment also considers the full impacts of the Interruptions Incentive Scheme (IIS) (ie without exceptional event exemptions) and enhanced Guaranteed Standard of Performance (GSOP) payments. In long duration events, these customer redress payments are significant.

Our assessment also considers whole community impacts which are additional to the sum of individual customer assessments. A lot of the insight for this comes from the work carried out in the aftermath of the Storm Desmond flooding events in 2015, particularly the resultant loss of power to the city of Lancaster for an extended period. The Royal Academy of Engineering report[9] published in the

[9] https://raeng.org.uk/media/xrrigg0m/raeng-living-without-electricity.pdf

aftermath of the Lancaster flooding includes a detailed assessment of the broader societal impacts of extended duration outages. Although the context was different, we have used the insight to apply a multiplier to the aggregated customer benefits analysis that reflects whole-community impacts.

The benefits which are specific to Coniston and Alston were also reviewed with an economist from Cumbria Local Enterprise Partnership (CLEP) providing input. This considered the businesses in the areas and the use of second homes or holiday lets for which, during a storm, we would not have any contact details for. In addition, this also considered the impact on the visitor community and any community hubs which could be used in the case of a storm and how other businesses would be affected.

Appendix E has further details of our approach to benefits assessment.

4.3 Customer impacts

Table 4-2 below gives indicative numbers for the potential customer impacts of the proposals in our submission. Further details are given in the descriptions of each proposal.

Proposal		Customers benefitting	Note
1	HV network strengthening predictive modelling	20,000 estimated	33,000 served by most at risk HV feeders; 700,000 ENWL customers fed by circuits including HV overhead line
2	Targeted HV undergrounding /strengthening		
3	Pennine and Borders Interconnection	Up to 1,000	11 specific proposals
4	LV automation enhancements	7,500+	750 units on LV circuits with 10 or more customers
5	Coniston – HV interconnector	1,300	Full population supplied from Coniston primary
6	Alston – HV interconnector	1,300	Full population supplied from Alston primary
7	Review of ETR 132 standard	TBC	

Table 4-2 Indicative customer impact of our Storm Arwen resilience programme

4.4 Costings

In terms of proposed costings, our Storm Arwen programme comprises established activities (pole changes, cable installation, tree-cutting etc.) which can be reported against the delivered unit costs and compared to business-as-usual costings and other benchmarks as required. As set out in section 5.3, the existing RIGs structure can be readily adapted to provide appropriately detailed reporting of costs and activities undertaken as part of this programme.

Our core costings have been based on the Modelled Costs for Asset Replacement used by Ofgem in their RIIO-ED2 Final Determination assessment. These were established in 2022 based on historic reported costs from DNOs and give a validated source assumed to represent efficient practice at the

time. They do not however represent subsequent Real Price Effect (RPE) impacts and the specific challenges of working in some of the planned locations.

For our network strengthening proposal, we have applied an uplift of 30% to the Modelled Costs. This allows for the additional costs of rebuilding overhead lines on adjacent routes (rather than in situ replacement which drives the majority of historic costs), higher specification woodpoles, costs of moving or re-siting pole-mounted plant etc.

We have also factored in the installation of higher numbers of poles than disposed for the overhead solution (due to shorter span lengths), and similarly for a higher length of replacement cable than disposed overhead line in the undergrounding solution. This is due to cable routes having to take account of features such as field boundaries in their route planning whereas the legacy overhead line often takes the shortest straight line route.

For our Coniston scheme, we have included an uplift to these costs to reflect the difficult terrain for cable routes in particular. The area is densely agricultural, rocky and in the heart of the National Park. The Alston scheme is planned primarily in public highway so does not require an equivalent uplift. Both schemes include additional amounts for the enabling works required for large cable lay projects including trial holes and wayleave purchase.

Both Coniston and Alston have been tendered for flexibility services at least once a year since 2019. The latest tender was in Spring 2023[10] including for the full RIIO-ED2 period to see if any providers wanted longer contracts. No bids were received in either case – there are limited customers already within these regions, and there is no headroom to connect further assets to provide new flexibility.

Further details of the costings of each proposal are provided in the accompanying BPDT tables and commentary, together with the supporting EJPs.

The financial effects can be huge too. If a cow can't be milked then a vet will have to be called in to provide support for the animal's welfare. This could be needed for a couple of weeks during which time any milk that the cow produces will have to be disposed of correctly as it can be toxic if it gets into the water supply. For some farmers they are not insured for lost milk yields and the financial consequences can be catastrophic.

NFU official post Storm Arwen

[10] All the results of previous tenders are available publicly on our website here for transparency: https://www.enwl.co.uk/future-energy/flexibility-hub/previous-requirements/

5 Regulatory outputs

5.1 Allowances

We propose that the allowances made available under the Arwen re-opener are granted on a Use-It-Or-Lose-It (UIOLI) basis. This follows established regulatory precedent for discrete programmes including Worst Served Customers and Undergrounding for Visual Amenity in the RIIO-ED2 framework. This ensures clarity of purpose and clear delineation from baseline allowances.

Given that there remain uncertainties in the mix and balance of the proposals in our application and that we wish to retain flexibility to adjust the funding between proposals within the programme to reflect the best benefit suggested by emerging data analytics, we propose below three potential funding options for Ofgem's consideration, all with a core funding mechanism of a UIOLI categorisation.

Funding mechanism	**Option 1 – single Arwen window**	Option 2 – utilise HVP process in 2026	**Option 3 – second Arwen window in 2026**
UIOLI allowance	£28m	£21m	£12m
HVP process	n/a	£7m	n/a
Second Arwen window 2026	n/a	n/a	£16m
Total	**£28m**	**£28m**	**£28m**

Table 5-1 potential funding options

Option 1 is our preference as it enables us to commence all the proposals within the programme with the certainty of funding. As set out in section 5.3, we propose that the RIIO-ED2 Worst Served Customers (WSC) framework is used as the model for governance. We are happy to work with Ofgem on any associated licence drafting requirements to support this.

The combined value of the major HV interconnector projects in our application is currently estimated at £7m. Combined, this remains some way short of the £25m eligibility threshold for the High Value Projects re-opener in January 2026 however Option 2 proposes that these projects are treated under that mechanism. This would allow for further detailed design and development work to confirm scope and costings whilst allowing the other elements of the programme to progress immediately through a lower UIOLI allowance. It would require derogation from the current HVP threshold by Ofgem to allow the use of the RIIO-ED2 HVP mechanism in this way.

If Ofgem were to require greater prescription in terms of funding between different component initiatives, we suggest a UIOLI allowance via the current application process of £12m to enable the delivery of the FY25-FY27 elements of the programme, to be followed by the granting of a second application window in January 2026. The licence provides for the Authority to specify a second window, and we would expect the assessment process to be able to be accelerated due to the work already completed under the first window. This forms Option 3.

The different funding options are illustrated in Table 5-2 below;

£m 20-21prices	FY24	FY25	FY26	FY27	FY28	ED2	ED3
HV pole strengthening predictive modelling	0.0	0.1	0.7	0.0	0.0	**0.8**	0.0
Targeted HV undergrounding /strengthening	0.0	0.0	2.4	3.1	7.1	**12.6**	TBC
Pennine and Borders Interconnection	0.0	0.0	0.0	0.8	0.8	**1.6**	0.0
LV automation enhancements	0.0	0.0	0.8	1.6	3.1	**5.5**	TBC
Coniston – HV interconnector	0.0	0.0	0.2	1.3	1.6	**3.1**	0.0
Alston – HV interconnector	0.0	0.0	0.2	0.6	3.1	**3.9**	0.0
Review of ETR132 standard	TBC	TBC	TBC	TBC	TBC	TBC	TBC
	0.0	**0.1**	**4.3**	**7.4**	**15.7**	**27.5**	

Table 5-2 Alternative funding options for Storm Arwen resilience programme

Our submission only includes proposals where we have a high degree of confidence in the need, and where the supporting evidence and the link to the recommendations from reports following Storm Arwen are established. However, we are aware of other areas where we believe confidence levels will increase within the RIIO-ED2 period. Because of this, we would support a second re-opener window for Storm Arwen expenditure which can be used if other areas can be fully developed into high-confidence proposals that will deliver on the Storm Arwen recommendations. For clarity the proposals in this submission and our options set out above do not cover these additional items and these would form part of a separate submission in addition to this document should a second window be needed for that purpose.

For example, DNOs have agreed that the national shared power cut map, known as the National Energy Outage Platform (NEOP), is not yet developed enough for inclusion in this current Storm Arwen re-opener window. As this project develops, costs would directly relate to recommendation 11 from the Ofgem Arwen report and could potentially be captured under a later Storm Arwen re-opener window.

5.2 Interaction with baseline allowances

Our Arwen re-opener application is additive to the baseline allowances granted through the RIIO-ED2 Final Determination and largely comprises unique activities not represented in our baseline programme (e.g. line strengthening, cross border interconnection), or activities that are distinct in terms of their geography (e.g. HV interconnectors). The proposal summaries in chapters 7 to 11 detail any interactions with baseline allowances that will be considered in work planning and reporting.

5.3 Reporting and evaluation

Given that we are proposing a portfolio of proposals within the overall Storm Arwen programme, and that we wish to retain flexibility over the programme composition to respond to evolving data insights, we propose a reporting framework modelled on that in place for Worst Served Customers (WSC)[11] in RIIO-ED2. This would require us to publish our methodology for the identification and assessment of potential investments and to provide a bespoke annual report on our delivered outputs and benefits.

This reporting could include the following for each element of our programme.

Proposal	Initiative	Potential reporting measures
1	HV pole strengthening predictive modelling	Progress against milestones
2	Targeted HV undergrounding /strengthening	Volumes delivered and unit cost to deliver
3	Pennine and Borders Interconnection	Number and value of successful projects
4	LV automation enhancements	Number of devices installed; customers protected etc.
5	Coniston – HV interconnector	Progress against milestones and outputs delivered
6	Alston – HV interconnector	Progress against milestones and outputs delivered
7	ETR132 tree-cutting	Already reported

Table 5-3 Potential reporting metrics for Storm Arwen programme elements

Annual reporting could be integrated within the existing RIGs reporting packs through either:

- Adding new tables to existing reporting packs for Arwen-specific activities;
- Introducing new memo tables within existing packs whilst retaining the current table structure; or
- Introducing a new reporting pack specific for the purpose.

All of the component activities can be easily identified with reference to the current definitions of standard activities as set out in RIGs Annex A[12]. We can also support Ofgem in any associated licence drafting requirements based on our proposals set out in this re-opener application.

[11] https://www.ofgem.gov.uk/sites/default/files/2022-12/Associated%20Documents%20%26%20explanatory%20documents.zip
[12] https://www.ofgem.gov.uk/sites/default/files/2023-06/RIIO-ED2%20regulatory%20instructions%20and%20guidance.zip

6 Conclusions

This table summarises all the elements of our proposals.

Needs statement	Key factors	No.	Proposal	Area	Report ref.	EJP reference	CBA reference	Customers benefitting	Reporting measures	Indicative costs and profile					
										FY24	FY25	FY26	FY27	FY28	ED2
The programme is driven by the need to reduce customer exposure to long duration storm outages caused by the three key factors. Our seven proposals align to solutions which mitigate the risks posed by these three key factors. These proposals also address specific recommendations from the BEIS and Ofgem reports.	Resource overwhelmed due to high volume of HV faults requiring field repair	1	HV network strengthening predictive modelling	Resilience	BEIS E2	ENWL-EJP-SA1	ENWL-CBA-SA1	20,000 estimated	Progress against milestones	0.0	0.1	0.7	0.0	0.0	**0.8**
		2	Targeted HV undergrounding /strengthening	Resilience	BEIS E2				Volumes delivered and unit cost to deliver	0.0	0.0	2.4	3.1	7.1	**12.6**
		3	Pennine and Borders Interconnection	Resilience	BEIS E2	These will be assessed on an individual proposal basis		Up to 1,000	Number and value of successful projects	0.0	0.0	0.0	0.8	0.8	**1.6**
	Masked or nested LV faults only revealed on restoration of the associated HV fault;	4	LV automation enhancements	Restoration	BEIS R1	LS EJP 5 LV Auto reclosers at PMTs	N/A	7,500+	Number of devices installed; customers protected etc.	0.0	0.0	0.8	1.6	3.1	**5.5**
	33kV overhead failures requiring long repair time in areas of limited HV backfeed	5	Coniston – HV interconnector	Resilience	BEIS E2	ENWL-EJP-SA2	ENWL-CBA-SA2	1,300	Progress against milestones and outputs delivered	0.0	0.0	0.2	1.3	1.6	**3.1**
		6	Alston – HV interconnector	Resilience	BEIS E2	ENWL-EJP-SA3	ENWL-CBA-SA3	1,300	Progress against milestones and outputs delivered	0.0	0.0	0.2	0.6	3.1	**3.9**
	Across all factors	7	ETR132 review	Resilience	Ofgem 1	Not included as no additional expenditure currently proposed		TBC	Already reported	TBC	TBC	TBC	TBC	TBC	TBC
										0.0	**0.1**	**4.3**	**7.4**	**15.7**	**27.5**

Table 6-1 Summary of proposals

7 Proposal summary – predictive modelling of vulnerable circuits

7.1 Our proposal

In this chapter we explain our proposals to develop predictive modelling of vulnerable circuits and the indicative programme of what this will deliver in the RIIO-ED2 period.

Our proposed expenditure is as follows:

		Cost £m (2020-21 money)					
No.	Proposal	FY24	FY25	FY26	FY27	FY28	ED2
1	HV network strengthening predictive modelling	0.0	0.1	0.7	0.0	0.0	**0.8**
2	Targeted HV undergrounding /strengthening	0.0	0.0	2.4	3.1	7.1	**12.6**
		0.0	**0.1**	**3.1**	**3.1**	**7.1**	**13.4**

Table 7-1 Indicative costs of proposals 1 and 2

7.2 Construction standards

It is useful to differentiate overhead line designs between "historic" pre-1988 (approx.) and "modern" post 1988 designs as there was a major step change in design standards following bad weather events during the winter of 1981-82.

Figure 7-1 failed pole following storm damage

Following the issue of the Baldock Report which covered the storms, new designs were introduced from 1988 which are more resilient to high winds and ice loads.

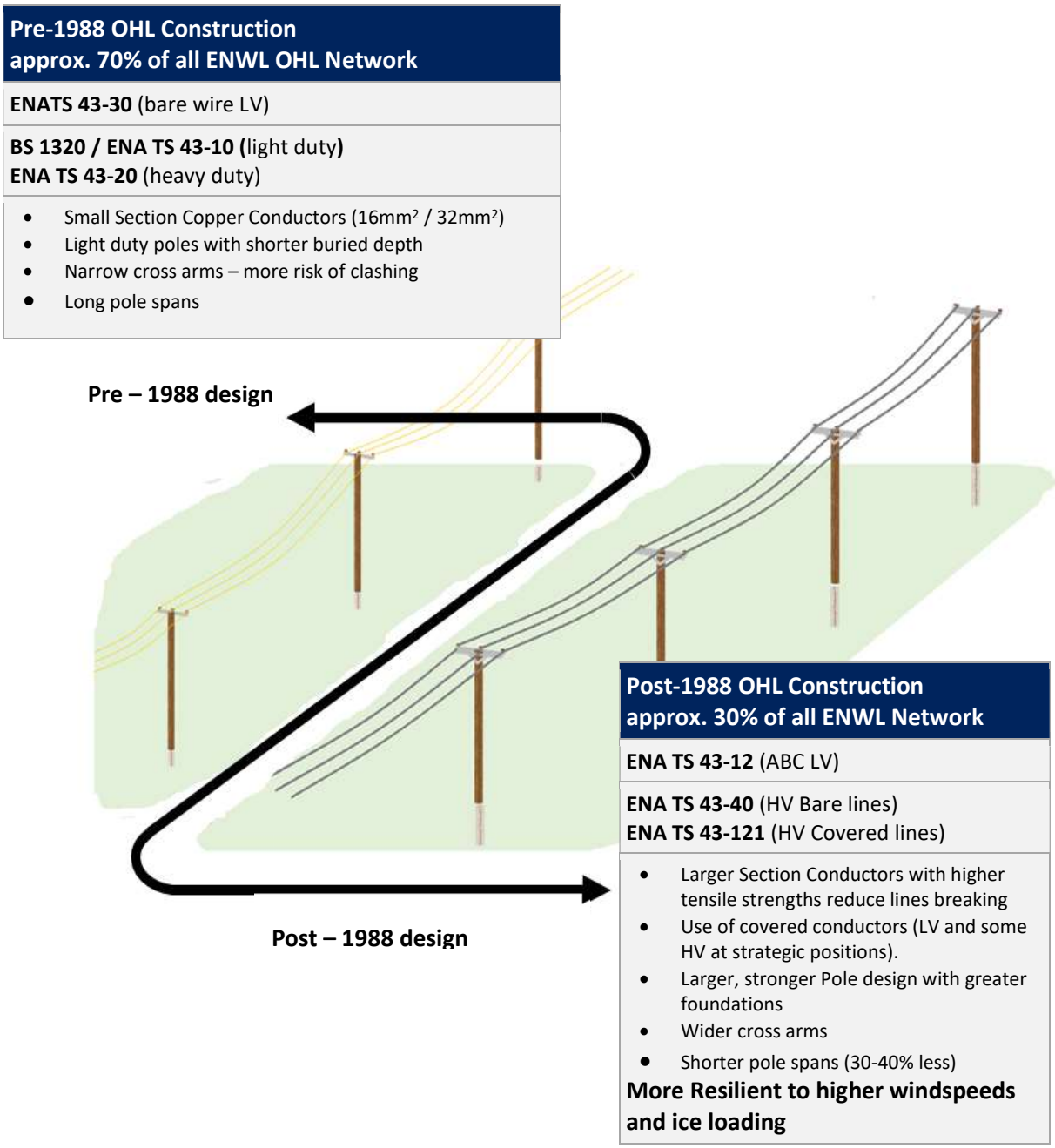

Figure 7-2 Summary of Overhead line design by age

Appendix F provides additional details of the specific technical standards applicable to woodpole overhead line construction.

Most of the overhead network across all DNOs was installed in the late 1950s to 1970s during a wide scale programme of rural electrification with general upgrades and fewer new lines installed later. Therefore, most of the lines on our network are constructed to historical (pre-1988) standards.

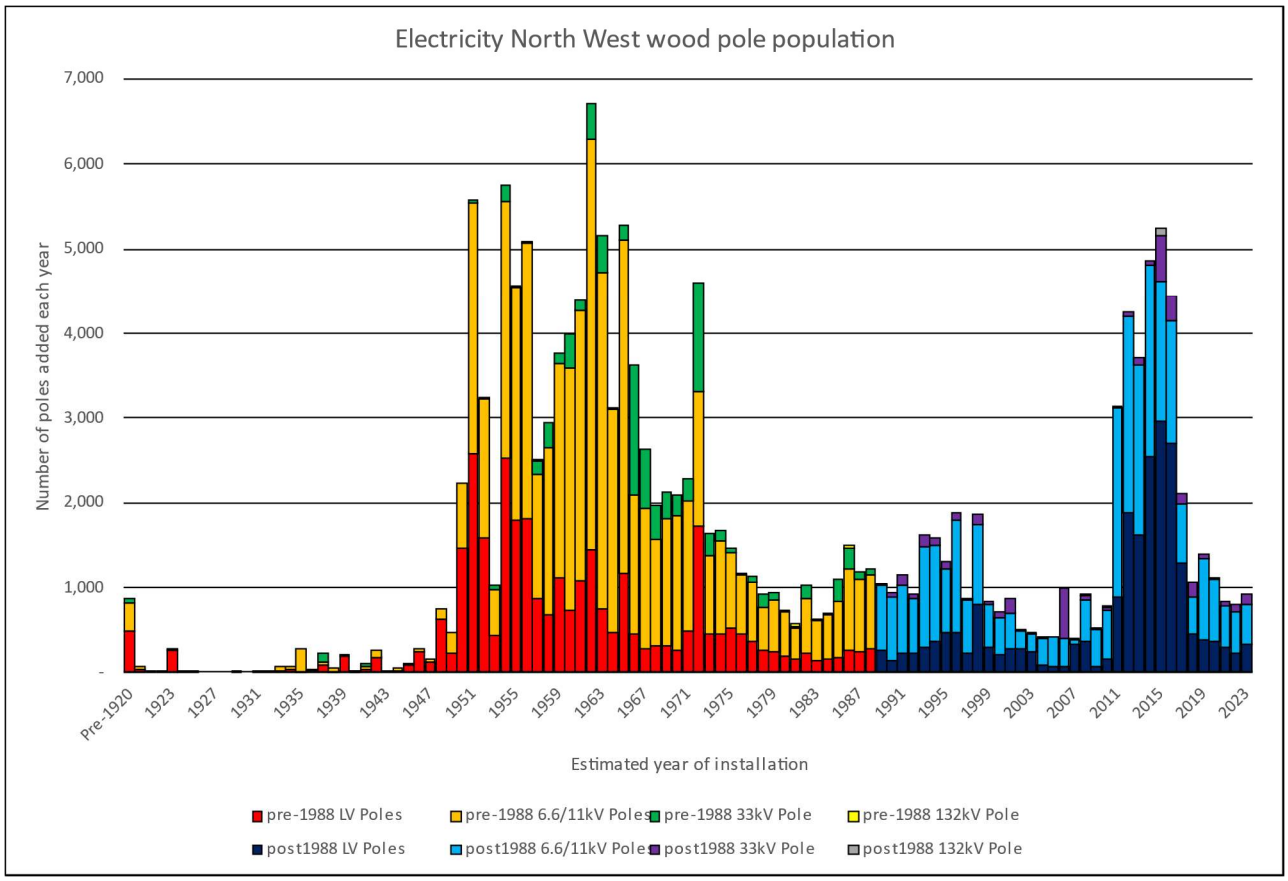

Figure 7-3 Year of installation of Electricity North West's pole population[13]

Analysis of the pole failures during Storm Arwen showed that a high proportion of the HV lines that failed were of light duty construction (BS1320 / ENA TS 43-10). Although the lines were at least 35 years old, the Health Index rating on these lines was less than HI4 for 80% of the failed poles, suggesting that pole specification rather than poor condition was the principal reason for failure.

As can be seen from Figure 7-2 the characteristics of historical light duty designs are longer spans, shallower pole planting depths, smaller conductors and narrower cross arms. The overall design is less resilient to high windspeeds and icing conditions such as those seen during Storm Arwen.

7.3 Upgrade options

All overhead lines are inspected and condition assessed on a regular basis and refurbished to the current Electricity North West standards when required. However, for historic light duty lines, the legacy of the design presents limitations to how much upgrading can be achieved.

To make older light duty overhead line designs (BS1320 or ENATS 43-10) more resilient, the light duty woodpoles are replaced with medium duty poles with deeper foundations, and the narrower crossarms replaced with wider versions. The improved pole grade reduces the risk of pole damage and wider crossarms reduces the risk of conductor clashing.

However, poles are normally replaced in-situ because relocation of poles for shorter spans, which improve resilience by reducing the potential wind loading on each pole and which are needed in order to upgrade to larger and heavier conductors, with resultant higher tension forces, is a more complex

[13] Please note the 'pre-1920' category is used as a default for poles installed pre-nationalisation in 1948 for which we have no detailed record of the original installation date.

task. The original poles were often positioned at field edges, and in some cases the area has built around sites of poles and the shorter spans would mean new poles in centres of fields or other inconvenient positions causing landowner resistance/delays and difficulty in gaining wayleaves.

As a consequence, conductors are normally also replaced on a like-for-like basis which limits the resilience improvement gained from refurbishment activities.

Therefore, upgrading of older lines built to historical standards is often a compromise. Improving the light duty lines with medium poles and wider crossarms with shorter spans will deliver a more resilient network. Further resilience can be achieved by rebuilding light duty lines to modern design standards either as a targeted approach, for example based on high altitude/wind speed, or rebuilding all light duty lines to modern design standards. However, rebuilding is expensive and so needs to be prioritised based on the areas at highest risk to ensure affordability as well as the biggest benefits to consumers.

7.4 Targeting

The overall resilience of an electricity network can be defined as the ability of that network to maintain supplies to customers in the face of extreme external events. Resilience of a network to a given event can therefore be considered to be made up of three elements:

- Susceptibility – This the probability that a network sustains damage (asset failure) as a result of that event;
- Vulnerability – The impact of the asset failure on customer supply in terms of the number of customers affected; and
- Recoverability – The ability of the network operator to restore supplies following damage in terms of the time taken.

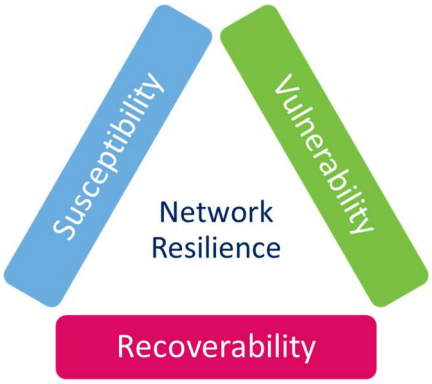

Figure 7-4 Network Resilience Elements

During Storm Arwen, some customers experienced an extended outage as a result of a combination of these three factors, for example:

- High windspeeds resulted in damage to overhead lines and supplies being interrupted;
- Customers fed though a radial element of the network meant that the asset damage resulted in customers being off supply until lines could be repaired or rebuilt, or emergency generation provided, as they could not be restored through switching;
- The number of concurrent faults overwhelmed the field resources available to conduct repairs. In some cases there was a delay before work started to restore supplies as field teams dealt with other (higher priority) faults; and
- Damage to other infrastructure (such as blocked roads) also impeded access to the assets, further slowing restoration.

Improving the resilience of the electricity network therefore requires that all three elements are considered and the interaction between these may change the most effective solution in each situation. For example, in some cases, rebuilding a line may be the most effective option, but if the issue is that there is a particularly exposed section which is likely to be difficult to access then undergrounding that section may be more appropriate. Similarly, if improving resilience would require a substantial length of line to be rebuilt, then additional interconnection to reduce the impact of damage may be the most effective solution.

The susceptibility of an overhead line to high winds can be evaluated as the comparison between the maximum windspeed each pole has been designed to withstand, and the maximum windspeed likely to occur at the pole location considering weather models, local topography and surface 'roughness' (such as the presence of buildings and hedges).

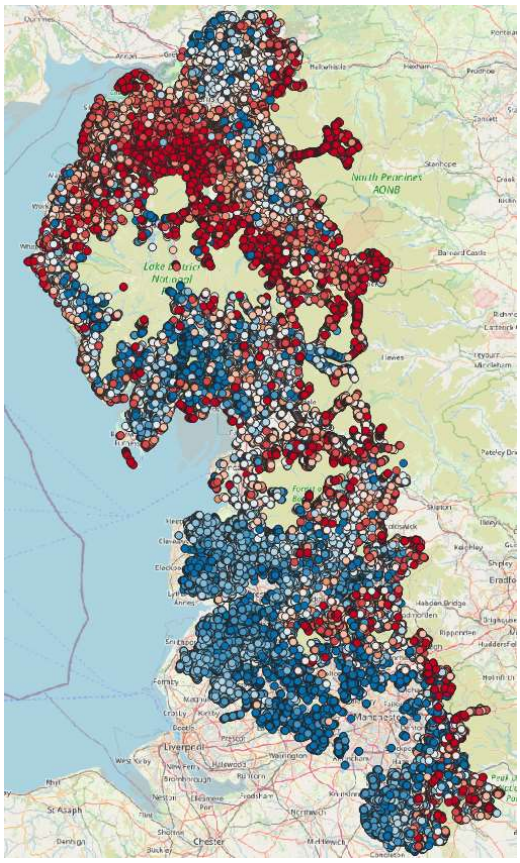

Figure 7-5 – 1 in 10 year maximum windspeed at 8m height

Blue dots represent lower windspeeds and red dots represent higher windspeeds.

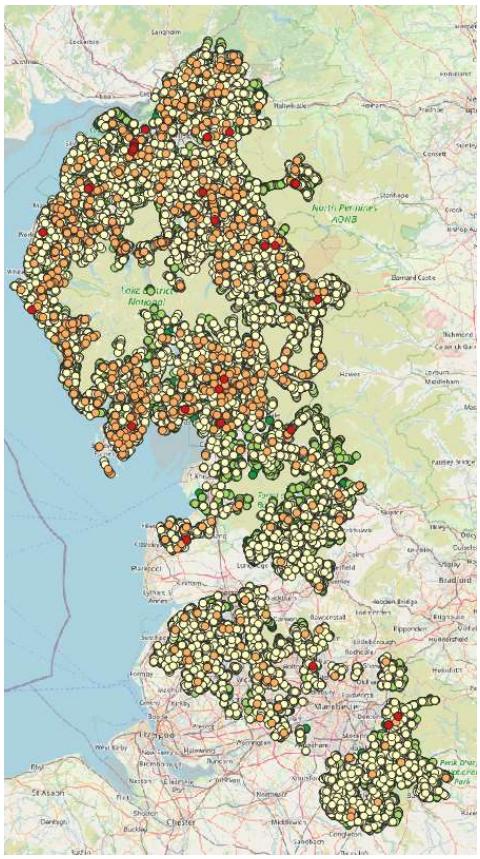

Figure 7-6 – Design windspeed of each intermediate pole

Green dots indicate higher design windspeeds (i.e. more resilient poles) and red dots represent lower design windspeed (i.e. less resilient poles).

We have a developed a proof-of-concept model to determine the susceptibility of each woodpole to wind damage based on the ratio between the design windspeed of the pole (calculated from the asset data using the technique within ENA Technical Specification 43-40) and an estimate of the peak windspeed at the pole location derived from the New European Wind Atlas (NEWA). The initial results (Figure 7-5 and Figure 7-6) show significant variation across the region. However, specialist support is

required to productionise this model to obtain more accurate extreme windspeeds from weather models, and to assess the exposure of each location to winds from different directions. This would also be combined with an assessment of the risk from vegetation damage to determine the susceptibility of a given line to high winds.

Whilst the initial focus would be on damage due to wind and icing events, as this is currently the least understood, this same framework can equally be applied to other hazards such as flooding and high temperatures.

The vulnerability aspect can be calculated based on the network topology to determine which customers could be restored by remote switching, and which customers would be off supply until a repair can be enacted (or emergency generation applied). The vulnerability assessment would also consider the type of customers fed by the area of network and any community services fed as experience from previous events has shown that loss of supplies to community services severely impacts community resilience during an extended outage. In addition, the vulnerability assessment may also assess the impact of common mode failures where potential backfeed circuits are susceptible to damage from wind from the same direction as the primary feed.

The recoverability aspect aims to determine the likely repair time, potentially based on a number of factors such as:

- The accessibility of the area in terms of the distance from a depot, the chance that access routes would be impassable during a storm, and likely difficulties in accessing the asset due to the distance away from a road, difficult gradients or the need to cross obstacles such as water courses which may be in spate;
- The likely volume of damage from an event. For example, if a larger number of assets are susceptible to damage from winds from a given direction, then the recovery time for these faults is likely to be longer.

On this basis, we propose to develop a resilience model which will allow the network resilience to be assessed and potential options traded off to allow a programme of investment to be developed which may include a combination of asset solutions, network solutions and potentially operational solutions to target investment where it is likely to have the greatest impact on network resilience.

There are a number of existing projects looking at aspects of resilience, however these look at specific aspects of resilience rather than an overall framework. These include:

- CReDo: This is a project run by the Science and Technology Facilities Council (SFTC) in collaboration with UK Power Networks (UKPN) which is looking at cross-network effects such as the effect of power outages on water, telecoms and health systems, and has primarily considered flooding risks. As such, this analysis fits into the vulnerability element of the proposed methodology.
- WELLNESS: This is a Strategic Innovation Fund (SIF) project being led by National Grid Electricity Transmission and supported by Electricity North West which focuses on the potential use of distributed generation, flexibility services and microgrids in a resilience context as well as looking at the specific susceptibility of tower structures and a cost-benefit framework for resilience investment. This project is therefore also complementary in assessing the feasibility of innovative means to reduce vulnerability and quantify the impact of extended outages.

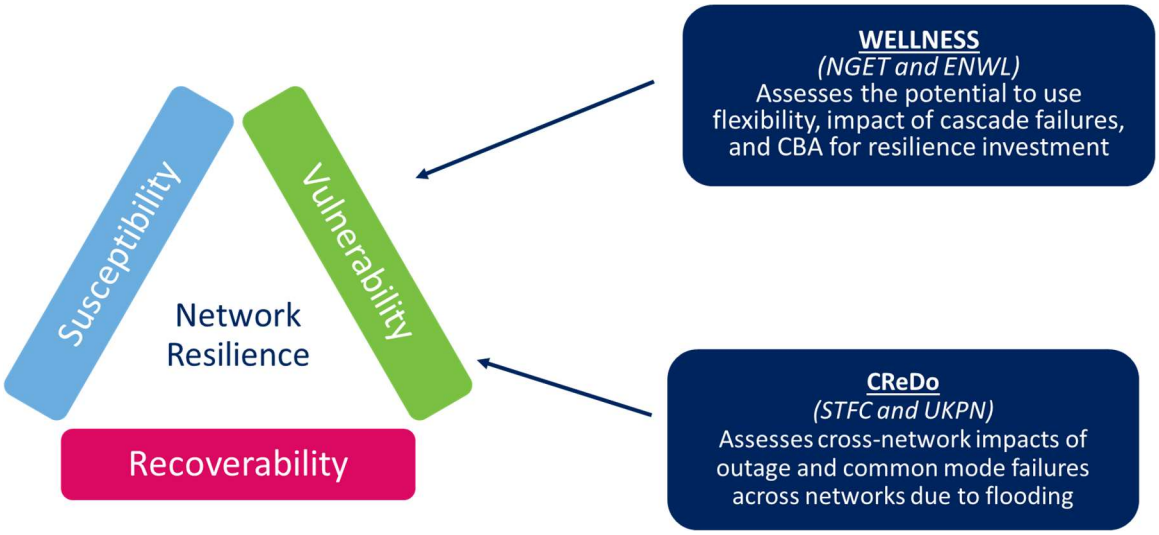

Figure 7-7 Relationship to existing projects

Our proposed programme includes the funding to complete the resilience modelling and to start to address the highest priority areas that are identified from it through a mix of overhead line strengthening and undergrounding as appropriate.

7.5 HV Strengthening Programme

In terms of our initiative to strengthen HV overhead line networks, we reported in our 2022-23 RIGs return a total length of 7,770km. High level analysis of recent storm impacts identifies 32 feeders with six or more storm-related faults since 2018-19. These feeders account for 1,383km or 18% of our total HV overhead line length, supplying a total of 33,036 customers.

Table 7-2 below shows indicative baseline costings of rebuilding or undergrounding HV overhead lines based on the Ofgem modelled unit costs used in the RIIO-ED2 cost assessment process. As a number of these sites will be in remote locations, we expect that the cost of delivery of many of these projects will be above the historic average unit cost used at final determination. To recognise these additional challenges we have added an uplift of 30% to all unit costs to reflect anticipated engineering difficulties across all projects.

Activity	Voltage	Unit	Ofgem modelled unit costs (£k/#) 2020-21 prices	
			Ofgem modelled	With 30% uplift
6.6/11kV OHL (Conventional Conductor)	HV	km	25.38	33.00
6.6/11kV Poles	HV	#	2.37	3.09
6.6/11kV UG Cable	HV	km	124.85	162.30
6.6/11kV Overhead rebuild	HV	km	64.94	84.42

Table 7-2 Indicative baseline HV overhead line rebuilding costs

At these voltages undergrounding is approximately twice the cost of rebuild, depending on assumptions relating to average span length of the new construction, additional cable route length and costs for moving any overhead-mounted plant.

Rebuilding the entirety of these circuits would cost £90m and undergrounding upwards of £200m. Focusing this way would also overlook large numbers of small lengths on other circuits that are particularly exposed to storm impacts.

Our proposed programme of £13m would enable the rebuilding of approximately 150km or undergrounding of approximately 80km of overhead line. This equates to rebuilding 11% or undergrounding 6% of the length of vulnerable feeders identified. This estimate accounts for additional dismantlement and wayleave costs, together with the potential need for longer cable routes and relocation of current pole-mounted plant equipment by including a 30% uplift on the baseline costs above.

This highlights the need for precise targeting of the priority areas where this investment can provide the greatest resilience benefit, guided by the proposed predictive modelling approach. By targeting investment to specific sections of the network with higher resilience risk, we forecast that we can materially reduce the storm impacts risk to a greater extent than could be achieved by upgrading a smaller number of full lines.

We estimate that we can materially reduce the storm impacts risk for up to 20,000 customers, primarily but not exclusively on the 32 feeders identified as high historic storm risk through this programme.

7.6 Summary

The overall proposal is therefore to develop a network resilience model and use the output from this model to target the proposed £13m investment where the greatest resilience benefit can be achieved.

The accompanying Engineering Justification Paper (EJP) - ENWL-EJP-SA1 “Network Resilience Improvements” - gives further details of the background to the scheme, options considered and details of the proposed solution.

8 Proposal summary – Distribution Network Interconnection

In this chapter we discuss the work we have undertaken with neighbouring DNOs to improve interconnection between networks and improve resilience for customers in both areas.

Our proposed expenditure is as follows:

		Cost £m (2020-21 money)					
No.	Proposal	FY24	FY25	FY26	FY27	FY28	ED2
3	Pennine and Borders Interconnection	0.0	0.0	0.0	0.8	0.8	**1.6**

Table 8-1 Indicative costs of proposal 3

Some of the communities hardest hit by Storm Arwen were in the Pennine and Borders area which is characterised by a spine of high ground up the centre of England and into Southern Scotland with valleys radiating to the east and west. The communities in these areas are particularly vulnerable to extended outages, both due to the difficulty in accessing these areas after extreme weather and the nature of the network which is characterised by long, radial, overhead feeders.

This means that they are both more likely to be affected by power outages due to severe weather due to the length of network they are dependent on and, when an issue does occur, the restoration can be long as they can only be restored when the network is repaired. In addition, access to both the lines and communities can be problematic due to fallen trees, flooding and snow. The nature of the geography makes network solutions expensive on a per customer basis.

However, as the electricity network developed, it generally extended out from the larger towns to the east and west into these remote areas meaning that whilst the extremities of the network are a long way from the feeding primary substation, they can approach relatively close to the extremities of an adjoining network.

Whilst a different topography, and not affected by Storm Arwen to the same extent due to the wind direction, a similar situation occurs on the West Lancashire plain, an exposed and sparsely populated agricultural area mostly served by Electricity North West, but which borders those dense urban areas along the coast from Southport down to Liverpool served by Scottish Power Energy Networks, as well as on the Cheshire plain which also has some sparse agricultural areas fed out from Manchester and Liverpool.

We have engaged with our neighbouring DNOs (Northern Powergrid, Scottish Power Energy Networks and National Grid Electricity Distribution) to explore the opportunities of inter-DNO connections as an efficient way to provide resilience to these remote communities. A multi-stage assessment process has been carried out to identify and assess opportunities and arrived at a set of proposals for such interconnections:

- Explore the boundaries between network areas to identify locations where networks approach each other and the network on one or other side is characterised by extended radial overhead network. An initial exercise identified 49 such locations across six neighbouring license areas;
- Assess the benefit to interconnection in terms of the number of customers potentially supported compared to the likely costs of interconnection in terms of cable lay distance and technical complexities such as transforming between voltage levels (e.g. 20kV and 11kV), protection issues and the need to install inter-system metering. Discard options deemed unlikely to offer sufficient benefit;

- Assess the capability of the supporting network to provide sufficient capacity to support the load from the other DNO in a storm scenario. This discarded option is not deemed feasible without significant reinforcement.

On the basis of this assessment, we have identified eleven potential interconnectors, nine of which benefit Electricity North West customers, and two of which benefit an adjoining DNO. The costs for the two which do not directly benefit Electricity North West customers would be borne by the DNO which benefits, so are not included within this submission.

Figure 8-1 Potential Interconnect locations

Specific details of each potential location are given in Appendix G.

9 Proposal summary – LV automation enhancements

In this chapter we discuss our proposal to add further automation to our LV network which will enable us to restore transient LV faults occurring in storm conditions automatically.

Our proposed expenditure is as follows:

		Cost £m (2020-21 money)					
No.	Proposal	FY24	FY25	FY26	FY27	FY28	ED2
4	LV automation enhancements	0.0	0.0	0.8	1.6	3.1	**5.5**

Table 9-1 Indicative costs of proposal 4

In rural areas, the provision of an LV supply from an open wire (uninsulated) circuit is commonplace. The supply is typically fed from a Pole Mounted Transformer (PMT) fed off an HV supply and protected on the LV side by fuses mounted on the pole below the transformer.

The general arrangement for a three-phase LV circuit is shown in Figure 9-1 below (single phase arrangements are also possible);

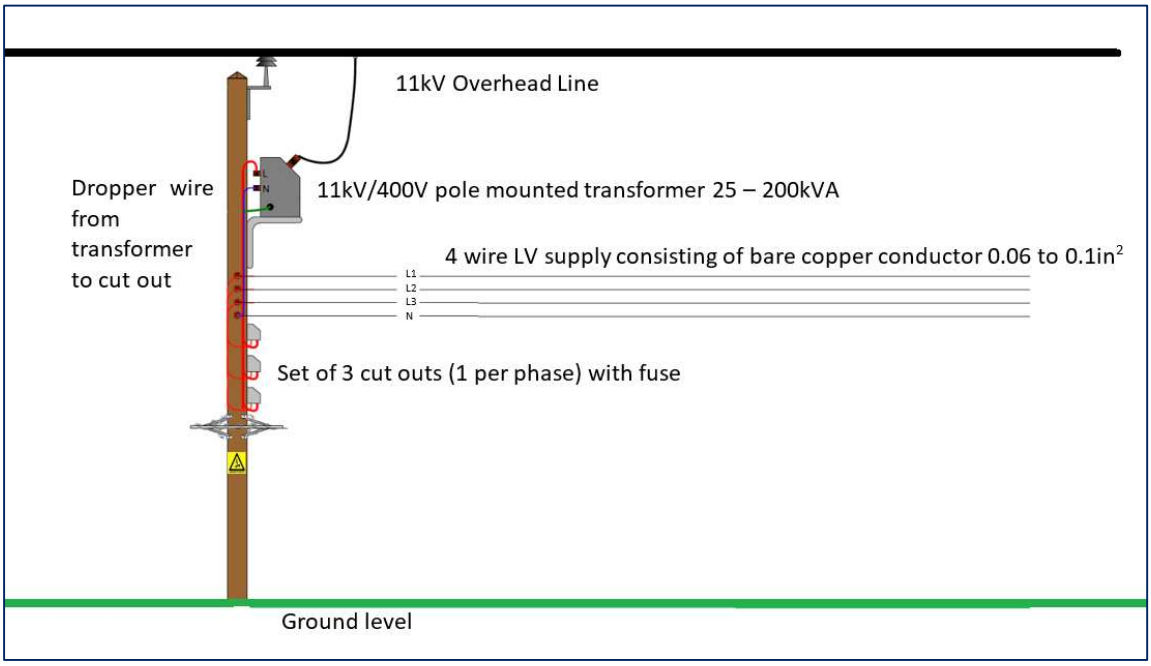

Figure 9-1 Typical PMT installation

We included in our RIIO-ED2 submission an initiative to replace fuses with auto-reclosers on LV circuits with long lengths from the fuses due to safety considerations, thereby removing the potentially dangerous occurrences where the fault level is too low to permit sufficient current to flow to operate the fuse protection. This was covered by EJP LS EJP 5 LV Auto reclosers at PMTs which has been included in the submission materials.

As highlighted in section 1.2, we experienced more LV faults than HV in Storm Arwen. Many of these were masked by an HV fault affecting a wider area so only became visible when the HV was restored, triggering a follow-on site visit at a time when resources were highly limited. In approximately half of the LV faults, the only action needed was the replacement of the fuses as the fault cause was transient

meaning no repair was required (e.g. a tree branch blowing into a line and causing a short circuit but not damaging the equipment). These additional extended wait times towards the event of a storm event can be reduced or eliminated through the fitting of the PERCH LV auto reclosing equipment originally proposed for safety reasons. The auto reclosers can restore the LV supply integrity in areas where no damage has occurred such that the LV becomes operational as soon as the HV is restored.

In our immediate follow-up actions to Storm Arwen, we committed to fit 750 such PERCH devices and we confirmed to Ofgem in March 2023 that these had been completed. In this Storm Arwen resilience programme we propose to extend the roll out of these devices through the installation of a further 750 units, focusing on open wire LV circuits with more than ten customers to ensure maximum impact. This LV initiative complements those at HV to reduce the numbers of transient nested LV faults which can disproportionally drive the longest storm outages.

This initiative will enable LV transient protection to be installed for over 7,500 customers.

10 Proposal summary – 33kV resilience to Coniston

In this chapter we set out our proposal to improve the resilience of our 33kV network at Coniston.

Our proposed expenditure is as follows:

		Cost £m (2020-21 money)					
No.	**Proposal**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**ED2**
5	Coniston – HV interconnector	0.0	0.0	0.2	1.3	1.6	**3.1**

Table 10-1 Indicative costs of proposal 5

Coniston is a small town in the Lake District, Cumbria fed by a single 33kV overhead line from Ulverston as illustrated in Figure 10-1 below;

Figure 10-1 Location and 132kV and 33kV network configuration for Coniston

There are 1,386 customer properties of which 93 are on our Priority Services Register (PSR) and 121 are highly vulnerable. This includes four food shops, 22 community hub buildings (schools, place of worship, community centre) and a pharmacy.

It is currently fed via a single 33kV woodpole overhead line (the infeed) to a small primary substation. This overhead line runs for approximately 18km from its connection to our wider 33kV network across

wooded landscapes and hillsides, mostly within the Lake District National Park. If there is a fault with this line, there is no other 33kV supply (backfeed) which could be used to supply the town and access to carry out repairs is difficult. Often in these circumstances we can use the HV network to restore many customers in the event of fault but, due to its location, there is minimal interconnectivity at the HV level as well. During Storm Arwen, tree faults required five spans and two poles of this 33kV line to be replaced which led to the whole community being off supply for three days.

Due to its location, it has also been difficult to identify cost-effective reinforcement solutions in the past. As a consequence, Coniston was the only LI5 primary in our 2022-23 Annex E RIGs return and has historically operated under a self-derogation from P2/7. Flexibility solutions have previously been sought but with no success. Our proposal is to install a new HV interconnector from Ambleside to provide backfeed capability in the event of loss of the incoming 33kV supplies. Figure 10-2 below shows the revised network configuration that would result.

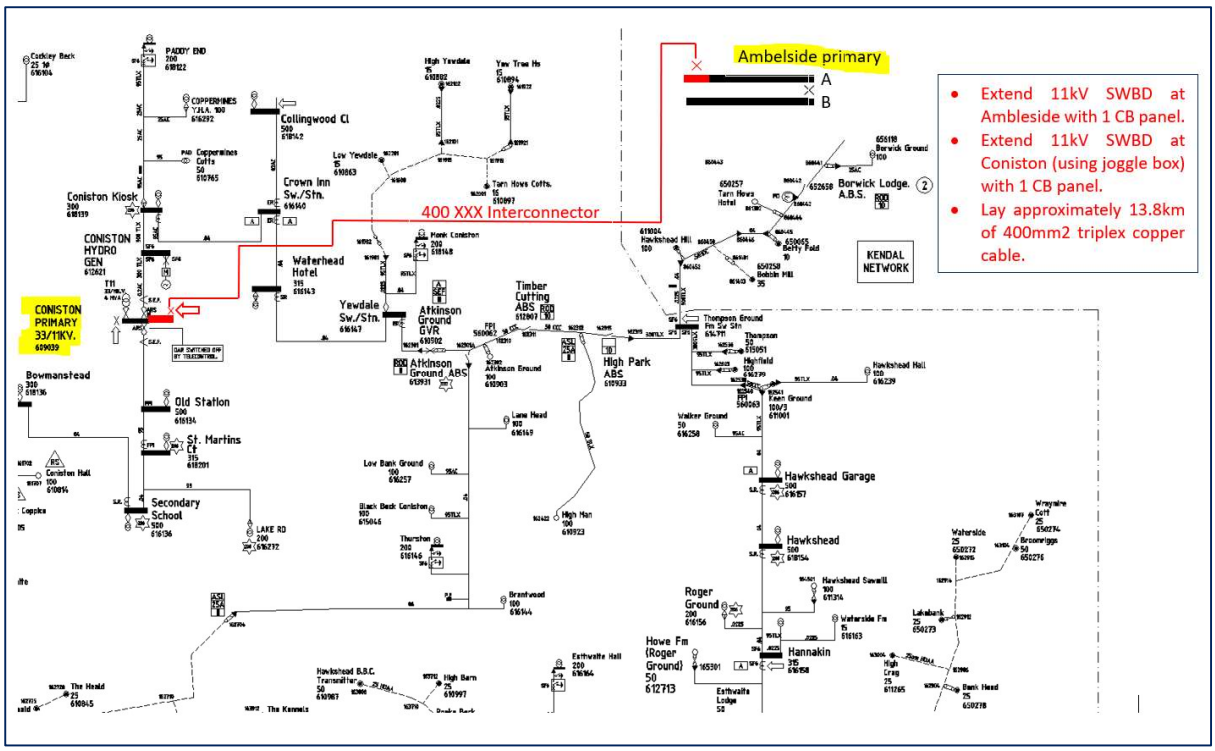

Figure 10-2 Proposed new network configuration for Coniston (extracted from EJP)

The incoming 33kV woodpole circuit and associated HV lines run across open access land and have previously been identified as a high priority for undergrounding by local stakeholders. In addition, the 33kV woodpoles comprising the line are relatively high HI and are approaching the need for replacement or refurbishment.

Figure 10-3 33kV and HV circuits running over Torver Common

We will review the different drivers of work in this area and also the results of the network strengthening modelling to identify whether any further work is required on the 33kV circuit.

The accompanying Engineering Justification Paper (EJP) ENWL-EJP-SA2 - "Ambleside – Coniston HV Interconnector" - gives further details of the background to the scheme, options considered and details of the proposed solution.

11 Proposal summary – improving resilience in the Alston area

In this chapter we set out our proposal to improve the resilience for our customers in the Alston area.

Our proposed expenditure is as follows:

		Cost £m (2020-21 money)					
Proposal	£m 20-21 prices	FY24	FY25	FY26	FY27	FY28	ED2
6	Alston – HV interconnector	0.0	0.0	0.2	0.6	3.1	**3.9**

Table 11-1 Indicative costs of proposal 6

Alston is a small town in the North Pennines with a single transformer primary fed by a 33kV overhead line connection from Penrith as illustrated in Figure 11-1 below.

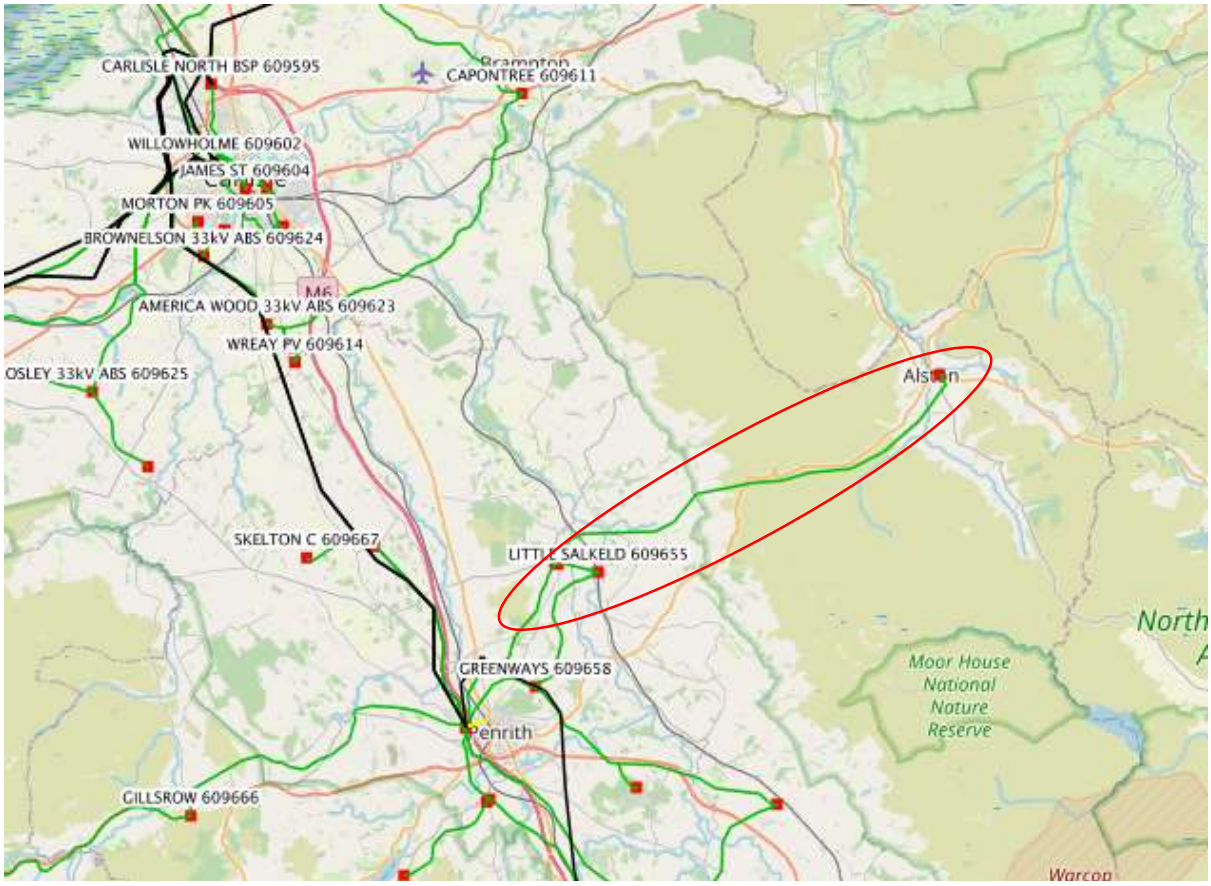

Figure 11-1 Location and configuration of 132 and 33kV network for Alston

There are 1,373 customer properties of which 153 are on the PSR and an additional 169 are highly vulnerable. The community includes six food shops, 14 community hub buildings, one pharmacy and a small hospital. Due to its location, Alston is frequently cut off in winter conditions such that customers are not able to access nearby facilities.

The 33kV infeed to the town goes over the Hartside pass (1,900 ft) which is the second highest A road in England (the highest is the route out of Alston to the east). Immediately to the south are the highest mountains in the Pennines range which routinely record the highest windspeeds in storm events.

Due to its location, access to undertake repairs is very difficult and the only HV interconnection with the wider Electricity North West network is via an HV overhead line which runs parallel to the 33kV overhead line. During Storm Arwen, ice loading brought down all three conductors at Hartside and a tree also fell on the line nearer to the town. As a result, Alston was off supply for four days due to the 33kV faults and some customers were off for longer due to 'nested' HV and LV faults which were only revealed once the 33kV network had been restored.

Figure 11-2 Customer feedback from Alston moor during Storm Arwen

In terms of loading, Alston primary was until recently LI4, but is currently reported as LI2 following the closure of a manufacturing site in the town. However, the primary transformer servicing Alston is rated at 3MVA, so a relatively small increase in load would increase the loading factor. As a result, it has previously featured in flexibility auctions but with no success.

Figure 11-3 Alston 33kV line with dropped conductors during storm conditions

The EJP for the Alston area considers undergrounding the 33kV infeed. This would also have NARMs and Undergrounding for Visual Amenity (UVA) benefits by virtue of the condition of the line and the

designation of the area. We have also explored potential interconnection with the neighbouring 20kV Northern Powergrid rural network but this is also an extended overhead line network fed from Hexham or Spadeadam, both of which are around 30km away. The proposed solution is an additional underground HV backfeed from the Little Salkeld primary substation which gives resilience in the case of a failure of the 33kV overhead line. The proposed revised network diagram is shown in Figure 11-4 below;

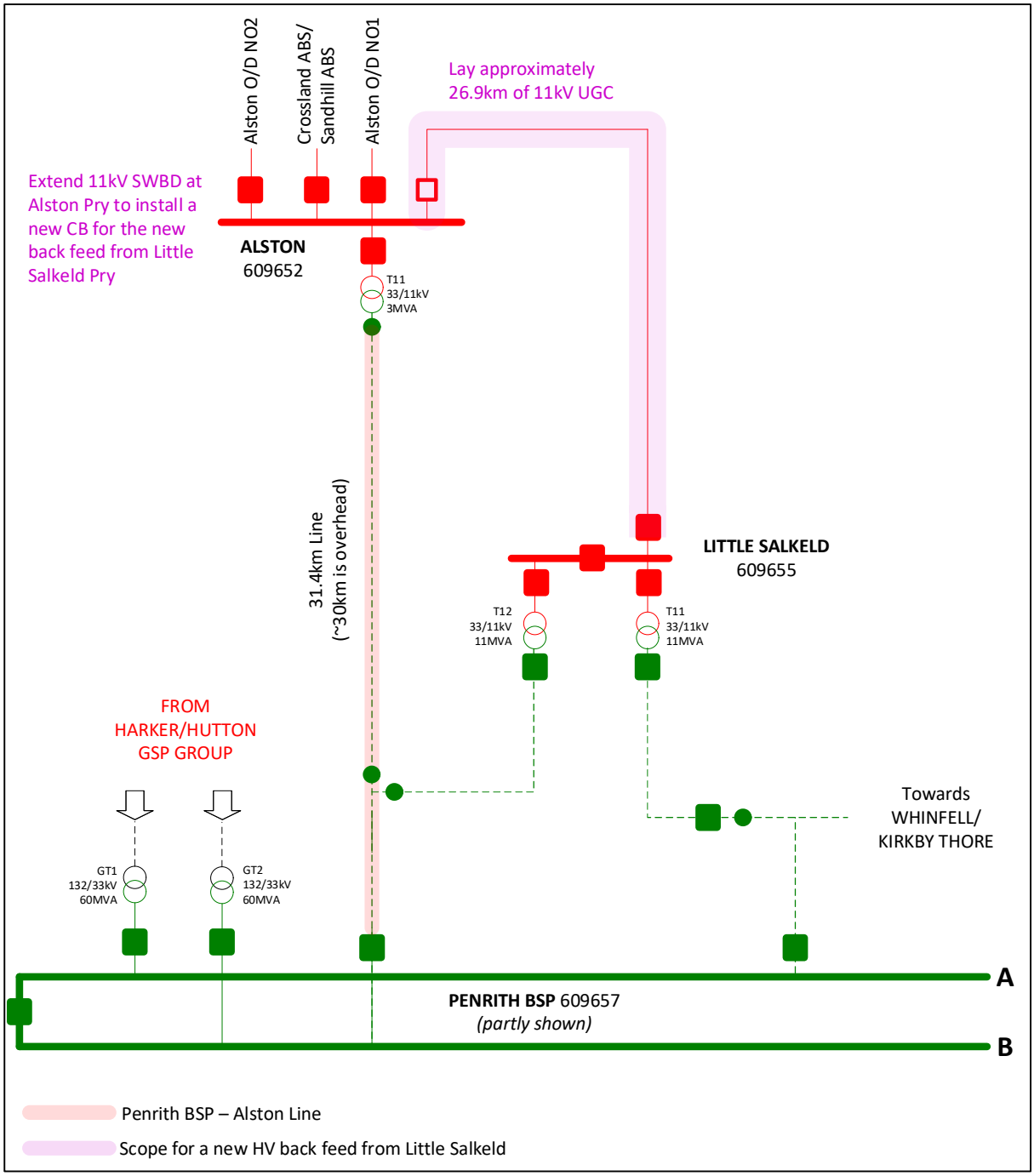

Figure 11-4 Proposed revised schematic for Alston (extracted from EJP)

The accompanying EJP - ENWL-EJP_SA3 - "Little Salkeld – Alston HV Interconnector" - gives further details of the background to the scheme, options considered and details of the proposed solution.

12 Area for review – ETR132 tree-cutting

Our seventh proposal is to engage in the national review of the ETR132 standard and review how we apply it within Electricity North West.

Once that review is complete we will be able to propose a programme of interventions and an estimate of the cost associated with the work. Consequently we have not provided an estimate of how much the cost of any changes in practice would be:

		Cost £m (2020-21 money)					
No.	**Proposal**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**ED2**
7	Review of ETR 132 standard	TBC	TBC	TBC	TBC	TBC	**TBC**

Table 12-1 Indicative costs of proposal 7

Vegetation management of trees at risk of falling is carried out through a risk-based approach using the guidance strategy document ETR132 (ENA Engineering Technical Report 132 - Improving resilience of overhead networks under abnormal weather conditions using a risk based methodology). Both Storm Arwen reviews identified the need to review the standard which is currently only applied in limited form with its targeting being driven by a very simple cost per customer calculation included within the standard itself.

The process of review is currently underway and being co-ordinated through the Energy Networks Association (ENA). We have input to this process and identified improvements we feel should be made. Additionally, we believe that greater consideration should be given to access difficulties when identifying poles for replacement. Application of ETR132 is also restricted by our relatively limited statutory powers with respect to obtaining landowner consent to felling or clearing trees around overhead lines. The need for greater statutory powers to enable a higher level of compliance has also been identified as part of the Arwen reviews.

The key current limitation with ETR132 in terms of resilient tree cutting is the requirement to give primacy to a cost per customer analysis as illustrated by the extract from the standard below;

6.2.5 Matrix 2 – detailed cost / benefit assessment

The detailed information gathered under 6.2.4 will be used to produce a new matrix, Matrix 2, where Protection Zones are ranked according to an accurate assessment of the cost effectiveness of improving the Resilience of each Protection Zone.

Figure 3 shows an example of Matrix 2, by taking the matrix in Figure 2 and applying an example set of actual costs determined from the on-site assessment.

Ranking	S/S code	Protection Zone	Tree affected spans	Cost of resilience measures	Customers	Cost per Customer
1 (1)	A1	A1 5	2	600.00	423	1.4
2 (2)	A1	A1 1	10	3000.00	669	4.5
3 (4)	A7	A7 2	6	1800.00	240	7.5
4 (5)	A5	A5 1	38	19000.00	1396	13.6
5 (6)	A1	A1 2	43	21500.00	1057	20.3
6 (3)	A2	A2 2	8	8000.00	348	23.0
7 (13)	A3	A3 1	91	27300.00	825	33.1
8 (14)	A4	A4 1	79	23700.00	531	44.6
9 (16)	A6	A6 1	78	23400.00	494	47.4
10 (12)	A1	A1 3	74	37000.00	681	54.3
11 (15)	A1	A1 4	54	54000.00	781	69.1
12 (10)	A7	A7 1	22	22000.00	228	96.5
13 (11)	A6	A6 2	36	36000.00	360	100.0
14 (8)	A3	A3 2	31	62000.00	612	101.3
15 (15)	A1	A1 4	9	9000.00	59	152.5
16 (7)	A2	A2 1	74	148000.00	516	286.8
17 (17)	A8	A8 1	13	26000.00	22	1181.8

Figure 3. Matrix 2: Example of detailed cost benefit assessment

Figure 12-1 Cost benefit analysis taken from ETR132 Issue 2

Following previous direction, networks are aiming to make 0.8% of their networks compliant with ETR132 each year. The application of the cost benefit approach set out in the document means that it is generally applied at 33kV level with limited or no current application at HV. The chart below shows the progress DNOs have made towards ETR132 compliance based on the data files associated with the RIIO-ED2 cost assessment process;

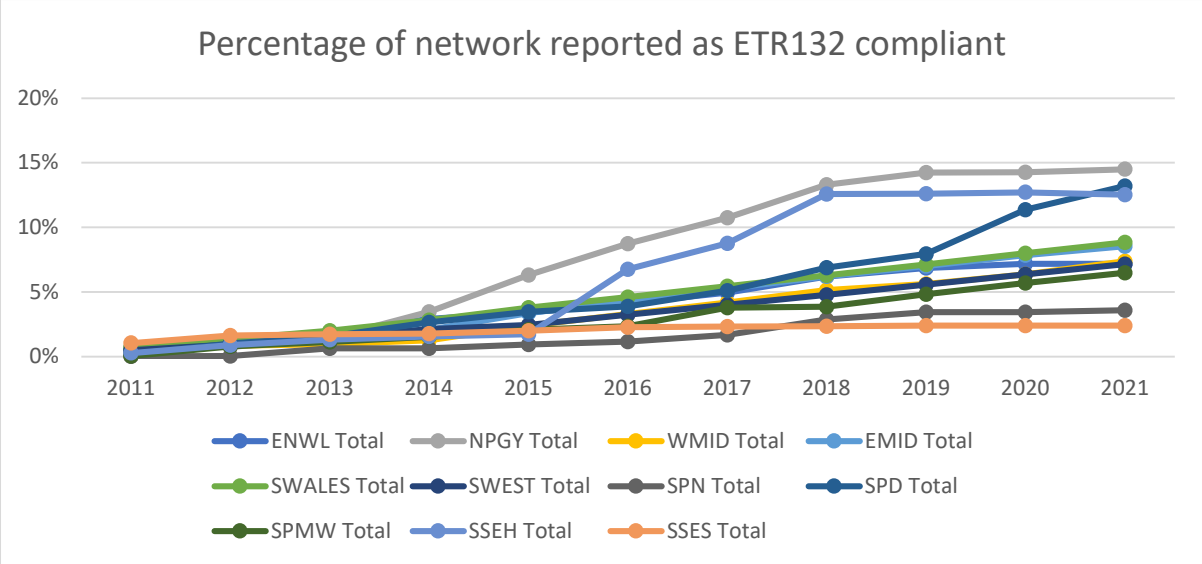

Figure 12-2 Percentage of overhead line network declared compliant with ETR132

Given the experience of tree-related faults in Storm Arwen, our programme will include consideration of any changes to the standard that result from the current review process and assessment as to whether additional scope is required beyond that which was funded as part of the vegetation management provisions within the RIIO-ED2 settlement.

This would potentially be included in a subsequent application under a second Storm Arwen re-opener, if granted.

Figure 12-3 HV overhead line damage caused by trees in Storm Arwen

Appendix A Ofgem Minimum requirements

The following table shows how we meet Ofgem's minimum requirements for a RIIO-ED2 re-opener.

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '2.1	High quality information is required. This should be: • Accurate • Unambiguous • Complete • Concise	Must	Y	This application has been assured so it is • Accurate • Unambiguous • Complete • Concise
General '2.2	Written confirmation from a senior person that: • It is accurate, robust, the proposal is financeable and is good value for customers • There are quality assurance processes in place to ensure the licensee has provided high quality information that enables Ofgem to make decisions in the best interests of consumers • The application has been subject to internal governance arrangements and has been signed off at an appropriately senior level	Must	Y	Our CEO cover letter confirms all of this condition, further information can be found; • CEO cover letter • Appendix B • Appendix B
General '2.3	2.3 A point of contact must be provided for each re-opener application (name/position/email/phone)	Must	Y	1.6 Contact Covering e-mail
General '2.4	Subject to paragraphs 2.5 and 2.6, the licensee must, within five working days of submitting a Re-opener application to Ofgem, publish its complete application in a prominent place on its website, in such a manner that relevant stakeholders can easily locate the application.	Must	Y	Published on our website at Public information (enwl.co.uk))
General '2.5	Redactions can be made for • Confidentiality • Commercial sensitivity • Security	May	Y	A summary of redactions made can be found in the redaction statement published alongside this application
General '3.1	Any re-opener must clearly provide answers to the following questions: • Why the adjustment is justified • What the adjustment should be	Must	Y	1.1 Our submission

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '3.2	The re-opener licence conditions prescribe the minimum that an application must contain. The guidance provides further detail on what should be included in a re-opener document.	Must	Y	No action necessary
General '3.3	If the licensee is unable to provide any of the requirements in this list, they must provide a justification for not providing the required information. Ofgem will consider whether there is sufficient information to progress the re-opener application in the absence of the required information on a case by case basis.	Must	Y	Our Engineering Justification Papers have been sent alongside this application. There is no EJP for the area for review ETR132, due to the uncertainty in this area
General '3.4	Every application must contain a table mapping out which sections of the document relate to individual requirements as set out in the re-opener licence condition and chapter 3 of the re-opener guidance document.	Must	Y	Appendix A
General '3.5	This chapter should be read in conjunction with any relevant appendices to this document and licence conditions.	Must	Y	No additional action necessary
General '3.8	All re-opener applications must include a needs case whether or not this is a specified requirement in the re-opener licence condition or guidance.	Must	Y	3.5 Needs Statement.
General '3.9	Subject to the re-opener licence conditions and guidance documents, the needs case must contain: (detail in 3.10 and 3.11)	Must	Y	-n/a
General '3.10	Alignment with overall business strategy and commitments: The application must contain a statement on how the proposal aligns with the future business strategy, how it relates the ED2 licence or other statutory obligations, and/or business plans for future price controls.	Must	Y	Table 2-1 - Needs Statement Table 1-1 .

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '3.11	Demonstration of needs case/problem statement There must be a clear statement as to the need for the proposed expenditure or the problem being addressed (with the risk being quantified) in the context of its significance for: • Consumers (these must be identified) • Network assets • Wider society	Must	Y	This condition can be found in 3.5 Needs statement further information can be found; • 3.5 Needs statement • 4.4 Costings • 4.3 Customer Impacts
General '3.12	The application must provide the rationale for the level of expenditure and why this is efficient	Must	Y	4.4 Costings This is also covered in our proposal summaries

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '3.13	Consideration of options and methodology for selection of the preferred option: The application must include a clear list of the options considered and the selection process for the preferred option. This must include the following (subject to 3.5: read in conjunction with relevant appendices to this document and licence conditions): • Description of the options considered, their key features, including the options not adopted • A 'do minimum' option as a counterfactual demonstrating the effects of little or no investment/programme expenditure • An option to delay capital expenditure, recognising the option value of the delay • A market-based option (where there is a valid market-based option e.g. commercial contracts instead of reinforcement) • A clear statement of the criteria used to assess the options, including assessment of each option against the criteria • An description of the process used to select the options, internal or the existing industry process • An appropriate sensitivity analysis, using relevant statistical or other techniques • A clear summary of any CBA/Engineering Justification (carried out in accordance with 3.22 and 3.23 • A justification for the proposed timing of additional expenditure	Must	Y	Covered in each accompanying EJP - section 4 Do nothing - section 4.1 in EJPs Do minimum - Section 4.2 in EJPs Delay capital expenditure – We have not included delayed capital expenditure as this would reduce the benefits for customers Market Based – 4.4 Costings also included in 10 Proposal Summary and 11 Proposal Summary Statement of criteria – Appendix E Description of processes of selected options - Section 5 in EJPs Sensitivity Analysis – Appendix E CBA - Section 5 Justification of timing - Section 6 & 7 in EJPs

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '3.14	The preferred option The application must include a clear description of the preferred option, sufficient to allow the Authority to make a decision if it is suitable. This must include the following (subject to 3.5: read in conjunction with relevant appendices to this document and licence conditions): • A clear description of the key features of the preferred option including how that option will address the issues set out in the needs case/problem statement • A statement of the benefits of the preferred option to customers, quantitative and qualitative • If the preferred option is predicated on a particular scenario, a description of the scenario • A clear statement of the key benefits of the preferred option, including any drawbacks • A register of the assets or programmes of work that will be impacted by the implementation of the preferred option • Evidence of the technical feasibility of the preferred option, using technical annexes as appropriate	Must	Y	• --3.5 Needs statement • -Appendix E • N/A • Covered in each proposal summary in the main document • Covered in EJPs optioneering sections. • Covered in EJP Deliverability and risk
General '3.15	The application must contain a statement on the project delivery and monitoring plan for the preferred option, including: • A project delivery programme including provisional dates and key milestones • A consideration of whether the licensee has access to sufficient resources to ensure timely delivery • A description of mitigation measures that can be taken to address potential deviation from the project delivery plan • A description of reporting mechanisms to monitor delivery and measure outcomes (this may be introducing a new PCD)	Must	Y	• - 6 Conclusions • Covered in EJPs sections deliverability and risk • Covered in EJPs sections deliverability and risk • Covered in 5. Regulatory outputs
General '3.16	The application must include an explanation of how stakeholder engagement contributed to the identification and design of the preferred option	Must	Y	3.3 Stakeholder Engagement and support

Guidance condition	Summary	Obligation	Arwen	Location in submission
General '3.17	Stakeholder engagement may not be necessary where there is not a material impact on stakeholders, or where the application is driven by statutory obligations	Must	Y	N/A
General '3.18	Stakeholder engagement will not be necessary where it would pose a risk to national security, specifically for applications related to cyber resilience and physical security Re-openers	Must	Y	N/A
General '3.19	When the adjustment sought relates to the level of allowances, re-opener applications must include sufficient cost information to: • Evidence to justify why the expenditure is additional to ex ante allowances, or allowances provided through other mechanisms • Evidence to justify why the level of costs is efficient (to be determined by the Authority)	Must	Y	• Covered in 5 Regulatory outputs • Covered in proposal summaries

General '3.20	3.20 the cost evidence must be provided in accordance with the following requirements (subject to 3.5: read in conjunction with relevant appendices to this document and licence conditions): • Use the specific re-opener templates developed for that re-opener • On the ED licence cost basis (2020-23 prices) • On a gross basis including direct and indirect costs, except where the mechanism is listed under the indirects scalar where only direct costs should be included • In Excel format with all data tables clearly labelled and set out logically, including instructions on workbook functionality where appropriate • In a sufficient level of detail to demonstrate how overall values are derived and in a way that can be easily replicated e.g. using transparent formulae • In a way that is easily comparable to other benchmarks or other data provided by Ofgem • With all relevant assumptions and data sources clearly provided and justified • With key cost drivers explicitly identified and justified • With uncertainties in forecast cost levels an any mitigations clearly identified. These should form the basis of any uncertainty analysis using appropriate techniques, and if so a register of these uncertainties must be included • Outturn data for similar projects • A risk register for the specific project for any allowances requested for project risk • Identification of cost efficiency measures and their impact accounted for • Demonstrate additionality (i.e. demonstrating the additional expenditure required in addition to that already provided through ex ante allowances, or that will be provided through other mechanisms)	Must	Y	Covered in BPDT, CBAs and EJPs • We have used the specific re-opener templates developed for that re-opener • Our costs are in 20/21 prices • The correct costs can be found in the BPDT • Our BPDT and CBAs are in excel format • We have used sufficient level of data • We have used the CBA templates from ED2, and a BPDT table to make it easy to benchmark • We have put all assumptions on benefits in Appendix E • Key cost drivers have been identified in 4.4 Costings and in the EJP • We have included all uncertainties • We have included all outturn data • EJP – Deliverability and Risk • Cost efficiency is covered in 4.4 Costings • Additional expenditure

Guidance condition	Summary	Obligation	Arwen	Location in submission
				covered in 5.1 Allowances
General '3.21	Further guidance on meeting requirements can be found in the HMG Infrastructure and Projects Authority Cost Estimating Guidance. The Authority expects these principles to be followed when generating cost estimates. Where companies do not consider this to be practical or cost effective, they should provide justification for why the alternative approach they have chosen is more appropriate.	Must	Y	No action necessary
General '3.22	CBA and EJPs are important evidence to be included in applications. When they are provided, they must: • Be consistent with published guidance and recognised best practice, e.g. The Green book and Spackman discounting approach • Demonstrate evidence of structured options development, including consideration of whole system options and non-network options where applicable, against a baseline scenario which involves the minimum level of intervention required to remain compliant with all applicable regulation. • Demonstrate the value of projects across different scenarios, where relevant, ad include an explicit consideration of (quasi) option values of deferring the investment • Be clearly linked to the re-opener application where applicable, with sensitivity to changes in input parameters assessed, for example future energy scenarios • Act as a robust decision support tool, and be open to scrutiny and challenge • Be transparent about which risks, costs and benefits have neither been considered nor monetised as part of the analysis • Be transparent about the assumptions, inputs and rationale for the decisions calculations and results arrived at.	Must	Y	Covered in CBAs • Is built into CBA/EJPs • Covered in 4. Optioneering for each EJP • Covered in 4. Optioneering for each EJP • Covered in 3. Background information for each EJP • Covered in EJP and CBA and BPDT • Covered in 6. Deliverability and risk for each EJP • Covered in 4.4 Costings

Guidance condition	Summary	Obligation	Arwen	Location in submission
SpC 3.2.69	The licensee must, when making an application under the Storm Arwen Re-opener, send to the Authority a written application that: (a) sets out the changes to the way in which the licensee operates its Distribution Business and the associated costs, including an explanation of how the circumstances in paragraph 3.2.67 are met; (b) sets out the modifications to the value of SARt in Appendix 1 being sought; (c) explains the basis for calculating any modifications requested to allowances and the profiling of those allowances; and (d) provides such detailed supporting evidence as is reasonable in the circumstances.			a) Needs Case table 1-1 b) 5.1 Allowances c) 4.4 Costings p.22-23 d) Covered in proposal summaries and EJPs
SpC 3.2.70	An application under this Part must: (a) relate to changes set out in paragraph 3.2.67 agreed on or after 1 December 2021; (b) be confined to costs incurred or expected to be incurred on or after 1 April 2023; and (c) take account of other allowed expenditure that could be avoided or reduced as a result of the circumstances set out in paragraph 3.2.67.			a) This submission relates to changes agreed b) All costs are incurred on or after 1 April 2023 c) Taken account of other allowed expenditure that could be avoided or reduced as a result of the circumstances set out in paragraph 3.2.67. further explanation about avoided costs can be found in Appendix E
SpC 3.2.73	Any modifications made as a result of an application under paragraph 3.2.68 must be made under section 11A (modifications of conditions of licences) of the Act.			Any modifications have been made under section 11A of the Act

Appendix B Submission assurance process

This submission has been managed under our well-established DAG (Data Assurance Guidance) processes which govern all of our regulatory reporting. Given its materiality and high profile, together with its one-off nature, it has been given the highest classification in our risk matrix.

As a result, we have followed a detailed process of internal review using the roles of Second Person Reviewer, Internal Expert Review and Senior Manager sign-off. Early versions were externally peer reviewed and the final version approved for issue by our Asset Management Director.

The content and development process were managed by a specific Steering Committee which reported in to our Regulation Steering Group, chaired by our Strategy and Growth Director.

Internal regulatory experts assessed the submission against Ofgem's Re-opener guidance and provided additional scrutiny against the associated Minimum Requirements.

Our Board approved the re-opener application in principle and delegated sign-off to our CEO who has provided the cover letter to this application.

As detailed in the narrative, we consulted a number of our stakeholder panels and individual stakeholders on aspects of the submission. In addition, our Independent Oversight Group (IOG) reviewed early versions of the introductory narrative and provided helpful advice and suggestions.

Appendix C What our customers told us

This appendix summarises the insight found from a desktop study of numerous pieces of research and reports produced after Storm Arwen. This information was collated to help identify current evidence as well as identify potential areas for discussion with stakeholders.

Storm Arwen feedback – What did people tell us?

Most of the information was collected through customer and stakeholder contact where they were asked their opinion of Electricity North West's response to the storm. Any specific questions around asset resilience were asked during the RIIO-ED2 business plan preparation.

Initially 500 customers were surveyed; 53 customers took part in focus groups and eight interviews were conducted with local resilience forum members. Nearly all of those surveyed were affected by Storm Arwen; over a third were without power for more than five days and half for three to four days in total.

Half of respondents found Electricity North West's response to be acceptable, though those who lost power for more than five days were less likely to find the response acceptable. This constrained overall satisfaction levels.

For those finding the storm response unacceptable, lack of correct information drove anxiety and frustration and prevented the making of alternative plans to help themselves in some cases. As well as being critical of communication, they questioned the level of forward planning for scenarios like Storm Arwen.

Stakeholder suggestions for improvements were mainly related to accuracy and speed of information provided.

Climate change was seen as a major reason for needing to invest in greater network resilience as it was viewed as making severe weather events more likely. Work to address climate change was seen as heavily linked to investment in resilience. Greater resilience of the network was seen as a necessary shorter-term solution and investing in addressing climate change was seen as a longer-term solution. However, both were urgent needs for proactive investment.

Whilst worst served customers were seen as important beneficiaries of investment, some panel members also raised questions about the extent to which customers who choose to live in an area which is poorly served willingly accept a reduced standard of service when they decide to live there. This prompted consideration that there may be an equality factor here if customers have no choice but to live in poorly served areas.

RIIO-ED2 submission customer insight on Resilience

Willingness to pay research and prioritisation of the initiatives in the business plan submission ranked Storm Resilience third out of 24 initiatives tested, with future action being to proactively strengthen or move underground powerlines that are at risk from storms, so that most future storms would cause less than 60 power cuts over winter.

In the acceptability testing, our storm resilience proposition received consistently strong support among customers (86% of domestic customers and 85% of business customers).

88% of domestic customers and 91% of business customers supported building a resilient network.

The new approaches we proposed to introduce included improving the resilience of the network in areas most at risk of damage from storms (e.g. rural areas) and reducing the number of customers affected by large storms every winter from 70,000 to 25,000.

Some observations made by Electricity North West were that networks can make the infrastructure even more resilient, but this will come with additional costs especially in remote rural areas (e.g., moving overhead lines underground or building in redundancy). Ofgem already has a 'worst served customer' scheme in place which helps address customers who suffer frequent supply interruptions; perhaps this could be extended to protect small and rural communities from extended duration supply disruptions?

A stakeholder panel of 40 people thought that customers in general will be understanding of problems coming from difficult-to-predict events, but predictable events should be planned for. This particularly related to weather events; bad weather was to be expected and therefore planned for, but members are also accepting of the fact that some extreme weather events are difficult to plan for.

A long term solution of undergrounding of cables in targeted areas was often suggested as a good solution but the groups were not sure how feasible this is. Customers wanted to find the best value approach to achieve storm resilience.

A review to explore the most cost-effective means of providing resilience to rural locations would be helpful. How much resilience should the networks provide and how much should be provided at an individual level or through small groups of householders and businesses by, say, the provision of local generators and connection points, and how should this be funded?

RIIO-ED2 submission on storm resilience

We included proposals to improve storm resilience through network strengthening in our draft business plan, but they were removed from our final business plan because it was challenging to identify at that time a confirmed scope of work supported by robust targeting analysis due to the issues discussed in section 3.4. We did identify that incremental improvements in storm resilience would be achieved from a range of other investment proposals in our RIIO-ED2 plan such as tree management, flood protection and LineSIGHT. These will work together with the initiatives proposed in our re-opener application as set out in section 2.1 of the main narrative.

For openness and transparency the outcomes from our customer research were retained in chapter 3 of "Annex 1: Customer research findings" of our RIIO-ED2 submission[14].

[14] https://www.enwl.co.uk/globalassets/about-us/regulatory-information/riio2/december-final-submission/annexes-final/annex-01-customer-research-findings-wtp-and-triangulation.pdf

Appendix D Storm Arwen Alternative Action Arrangements letter

electricity north west
Bringing energy to your door

Electricity North West
Hartington Road, Preston,
Lancashire, PR1 8AF

Email: enquiries@enwl.co.uk
Web: www.enwl.co.uk

[redacted]
Ofgem
10 South Colonnade
London
E14 4PU
[redacted]

31 March 2023

Dear Tom,

Alternative action arrangements with Electricity North West Limited (ENWL) in relation to the Gas and Electricity Markets Authority's (the Authority) report on the events surrounding Storm Arwen and the Authority's preliminary consideration of ENWL's response to Storm Arwen.

As a follow-up to the letter from Akshay Kaul on 8 June 2022, I am writing to provide an update on Electricity North West's delivery of the agreed terms of the alternative action arrangements.

I can confirm that, in advance of 31 March 2023, ENWL has successfully completed delivering all the agreed alternative action steps of:

- Provided £500,000 (£290,000 shareholder funded) to a new community fund supporting the resilience of rural communities.
- Delivered 750 Low Voltage monitoring devices at substations in South Cumbria and other rural areas affected by Storm Arwen.
- Delivered enhancements to our new Network Management System (NMS) and to our website infrastructure, putting these measures in place for winter 2022/23.

This included:

- Outage Management System Auto Snap to enable network issues identified by the public to be better integrated into our NMS;
- Enhancements to automated restoration tools;
- Enhanced system message management during Storm conditions;
- Increased remote operability of air brake switches;
- Enhanced system reporting;
- System enhancements to support improved business processes for providing more accurate restoration times to customers.

INVESTORS IN PEOPLE | Living Wage | Carbon Literate Organisation | ServiceMark The Institute of Customer Service | TrainingMark The Institute of Customer Service

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Further to these agreed actions, we have taken additional steps to enhance the resilience of our network and improve the experience of our customers in future storm events.

This has included:

- Carrying out extensive cleansing of our data in the Network Management System for vulnerable customers which involved a complete reload of all associated networks and data to ensure 100% alignment;
- Training an additional 300 staff in call handling;
- Extending our winter preparedness communications for the 2022 winter to also include communications with customers on Rota Load Disconnections and enhanced our IVR (Interactive Voice Recognition) to provide greater support to customers.

We trust this confirmation concludes the alternative action arrangements.

Yours sincerely,

Paul Bircham
2023.03.31
08:29:37
+01'00'

Paul Bircham
Safety, Compliance & Markets Director

For and on behalf of Electricity North West Limited

Appendix E Approach to Cost Benefit Analysis

The CBA methodology specified for use in our RIIO-ED2 submission is relatively narrow in its assessment of benefits, focusing on direct impacts to us as the network operator plus consideration of carbon costs. Whilst this does provide a robust baseline for project analysis/assessment it has the potential to miss the wider benefits to consumers which aren't included in traditional assessments of the benefits of network investment. Because of its status for ED business planning, we have used the CBA for ED as our starting point and CBAs for our proposals have been included within this submission. Where we haven't provided a CBA, we have stated a clear justification as to why we have not undertaken the exercise for that proposal.

To supplement traditional CBAs, we have utilised Social Return on Investment (SROI) to assessment the benefits and impacts on a broader basis focussing on customer benefits of investment. The development of a standardised SROI model including a more holistic approach to the assessment second and third-order beneficial impacts of planned investments has been undertaken by the ENA with work done by SIA partners. To give the fullest consideration of benefits in the CBA assessment we have used both the traditional CBA and SROI in combination considering items such as:

- Modelling IIS (Interruptions Incentive Scheme) impacts (without adjustment for exceptionality exemption thresholds) and Guaranteed Standards Payments on the assumption that these areas are at risk of another incident similar in scale to Storm Arwen on a ten-year interval without any intervention. We have also tested sensitivity based on alternative frequencies to the ten-year internal storm. These calculations use methodologies provided by Ofgem for RIIO-ED2 and have been calculated for a five-day interruption at category 2 – severe weather level.
- Currently, severe storm impacts are subject to an exemptions regime under the IIS scheme which protects the DNO from the full financial impacts. The CBA models ignore these exemptions such that the full impacts can be assessed at their non-exempted value.
- We have used a version of SROI by the Energy Networks Association (ENA) to provide a social value to customers for these projects. We included the outputs from the SROI workbook within the CBAs attached to this submission. The SROI workbooks are available upon request and in the workbook we have taken these social impacts as well as GSOP payments and combined those with savings to emergency services for call-outs and outpatient visits to hospitals along with the Value of Lost Load based on the latest figures from ONS for mean domestic consumption per household of 3.66kWh per day for domestic customers. Because VoLL was developed by Electricity North West, this has been used in the CBA itself.
- We have applied 'whole community' multipliers for the projects which are aimed at specific communities, based on an understanding of the composition of those communities. To do this, we used an economist provided by Cumbria Local Enterprise Partnership to specifically look at the two communities of Coniston and Alston. The report and methodology can be found in Appendix I.

<u>Social Return on Investment</u>

To calculate the social values for use in the CBA, the Social Value Framework Model as developed by the ENA was used. The framework model uses pre-loaded values to give a value for Social Return on Investment, we have utilised the pre-loaded values to enter into the CBA.

Coniston and Alston - HV interconnector

The first pre-loaded value we used was the Value of Lost Load which was developed by Electricity North West in 2018. VoLL is an important measure of the value or cost to a customer of a power cut and its associated impacts. As this measure is the value to customers for the loss of electricity per MWh, using the figure from the ONS of 3.66kWh per day we modelled the value of lost load for three scenarios of power cuts. One similar to Storm Arwen of 5 days every 10 years, one of a bigger storm for 7 days every 20 years and one smaller storm for 3 days every 5 years. This allowed for a testing of the sensitivity of the assumptions to storm frequency and the impact that this has on the benefits of investment under the differing scenarios tested.

Another pre-loaded values that we used was the avoided inpatient hospital attendance and avoided requirement of an ambulance. We undertake significant work when storms occur to support our highly vulnerable customers as well as all customers on our extra care register (PSR) including but not limited to proactive telephony contact as well as face to face interaction through door knocking. Where we can we offer alternatives to support customers in the event of a power cut such as food provision, alternative accommodation and in some circumstances remote generation. This proxy was used as in small, limited circumstances a storm event could have an impact on customers of requiring medical support. We have calculated the benefit of avoiding this by using the number of highly vulnerable people in Coniston and Alston and the assumption that 1% may need an ambulance and therefore require inpatient attendance at a hospital if they lost power for more than 5 days.

Similarly, the final pre-loaded values that were used were avoided outpatient hospital attendance and avoided cost of GP attendance. Again, this was calculated by the number of highly vulnerable people in Coniston and Alston and the assumption that 2% may need an outpatients attendance at a hospital then a follow up visit to a GP if they lost power for more than 5 days.

Further we have considered the impact of our works and as such options 3 and 4 at Alston had a 50% reduction applied to them for benefits as the solution still included a risk of being affected by storms.

Network Strengthening

Network strengthening is a combination of proposals including; the predictive modelling and the HV strengthening and undergrounding. The results from the predictive modelling will determine where any strengthening happens.

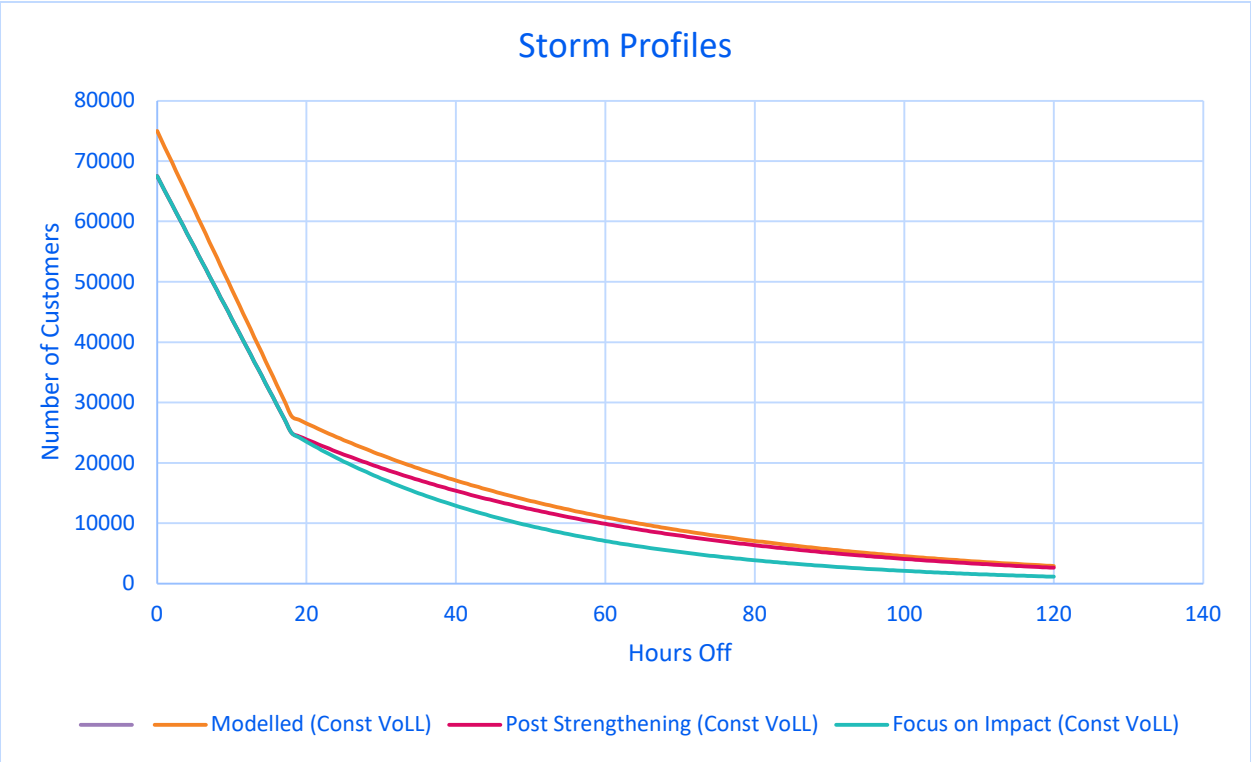
For the benefits assessment of predictive modelling and HV strengthening programme, a different method of calculating benefits had to be used as we weren't able to accurately assess which customers would benefit and where they would be given the programme is reliant on the predictive modelling results.

To fully understand the benefits of this programme we took the assumption of how many customers would initially benefit and through modelling a similar storm to Storm Arwen we predicted;

- one scenario where we manage to reduce the customers off by 10% due to more resilient lines (i.e. undergrounding, stronger poles, interconnects so fewer customers are at repair time risk on radials and can be restored by automation and switching),
- and a second scenario where the exponential decay is quicker as a greater proportion of the faults we do have are in easier to fix places, and we have fewer to deal with.

A further metric was added in the post 18-hour decay rate which is the rate in which faults are fixed, in the modelled Storm Arwen scenario this is set at 0.022 when focussing on the full impact of a

storm the decay rate is set at 0.044, this is because there would be more resource to restore other faults or provide generators. This can be shown in the following graph.



The post strengthening line does not include the decay rate just the initial customers who would benefit from pole strengthening or undergrounding.

Appendix F Overhead line Technical Standards and Specifications

LV Main Overhead lines

Old design (bare conductor) were constructed to ENA TS 43-30. Modern designs (using Aerial Bundled Conductor (ABC)) are constructed to ENA TS 43-12.

Existing bare-wire lines are refurbished as follows:

- Preferably, bare-wire lines shall be replaced by ABC lines designed and constructed to ENA TS 43-40.
- Where it is not practicable to replace a bare-wire line with an ABC line or underground cable, then the existing bare-wire line shall be refurbished to Electricity North West policy using ENA TS 43-30.

HV Overhead lines

Old designs (bare conductor) were constructed to BS1320 / ENA TS 43-10 (light duty construction) or ENA TS 43-20 (heavy duty construction). Modern designs are constructed to ENA TS 43-121 or ENA TS 43-40.

Existing lines are refurbished as follows:

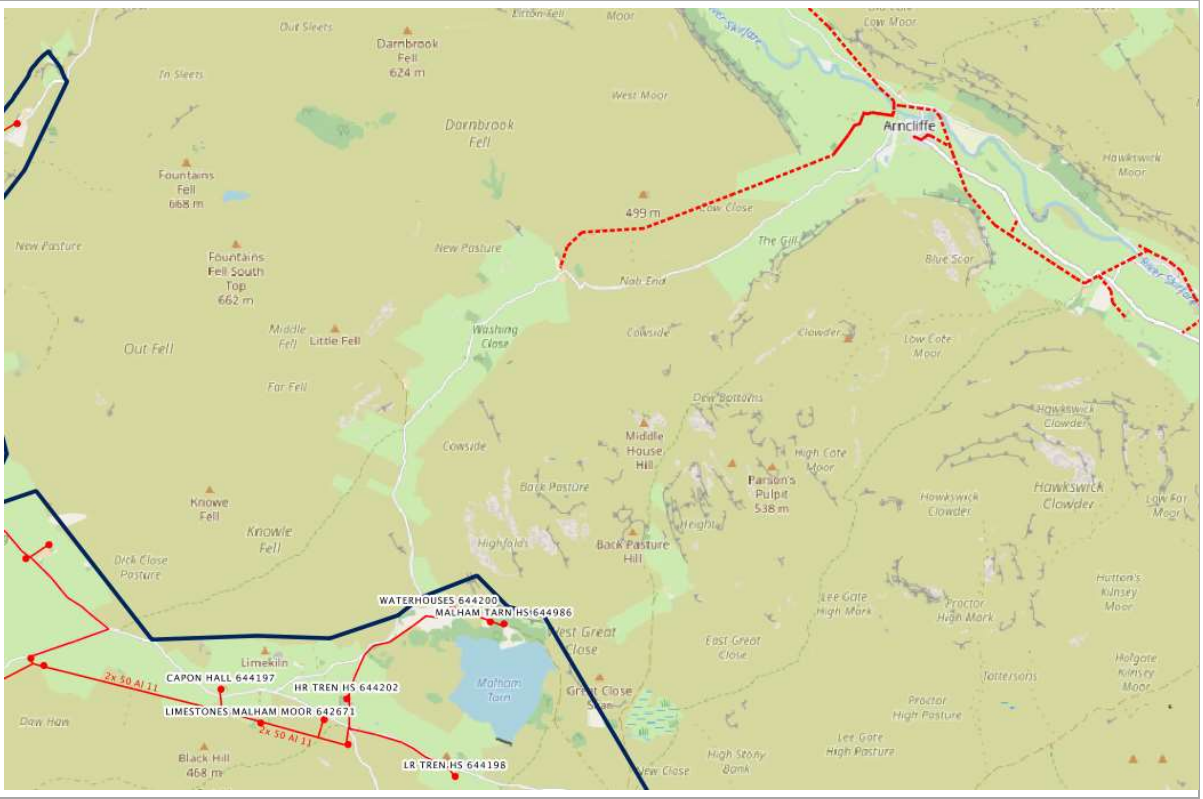
- ENA TS 43-121 for Compact Covered Conductor overhead lines.
- ENA TS 43-40 for bare-wire overhead lines previously built to ENA TS 43-40 or historical heavy-duty construction overhead lines, e.g. ENA TS 43-20.
- Electricity North West's own policy for light duty construction overhead lines, e.g. historical designs to ENA TS 43-10 or BS1320 to upgrade steelwork, pole ratings and conductors as appropriate.

Appendix G Potential new HV interconnectors

In the timeframe of this re-opener application , these schemes have not been subject to detailed design assessment, so technical or legal difficulties may arise during the design process which increase the costs such that they are no longer justified by the benefit. As such, we propose that these interconnectors are managed within the overall Use-It-Or-Lose-It (UIOLI) allowance.

Halton Lea Gate			
Other DNO	Northern Powergrid (North) (NPg)		
Benefitting DNO	Electricity North West & Northern PowerGrid (North) (ENWL)		
Radial Length (inc spurs)	5.6km	**Number of ENWL Customers**	81
Accessibility	The site is 20 miles from the ENWL Carlisle Depot along the A689 (a non-trunk A road) rising to a height of around 215m on the north edge of the North Pennines.		
Interconnect Rationale			
Supports a relatively long radial circuit in the Pennines in a relatively remote area.			
Proposed Solution			
Underground cable between ENWL MIDGEHOLME substation and NPg HALTON LEA GATE substation following the route of the A689 (around 1.1km). A new 20kV/11kV transformer to be installed at HALTON LEA GATE, and automation and metering added to the switchgear.			
Proposed Funding Arrangement			
The underground cable would be funded and installed by Electricity North West, and the substation works at HALTON LEA GATE would be funded and completed by NPg.			
Estimated Overall Cost	**£346k**		
Estimated ENWL Cost	**£173k**		

Malham Tarn			
Other DNO	Northern PowerGrid (Yorkshire)		
Benefitting DNO	Electricity North West & Northern PowerGrid (Yorkshire)		



Radial Length (inc spurs)	18.2km	**Number of ENWL Customers**	114
Accessibility	37 miles from ENWL Kendal depot, only accessible via steep minor roads up to a height of 450m from Settle		

Interconnect Rationale

Supports a very long radial in the Yorkshire Dales which is a significant distance from the nearest depot, and likely to be difficult to access in the aftermath of a storm.

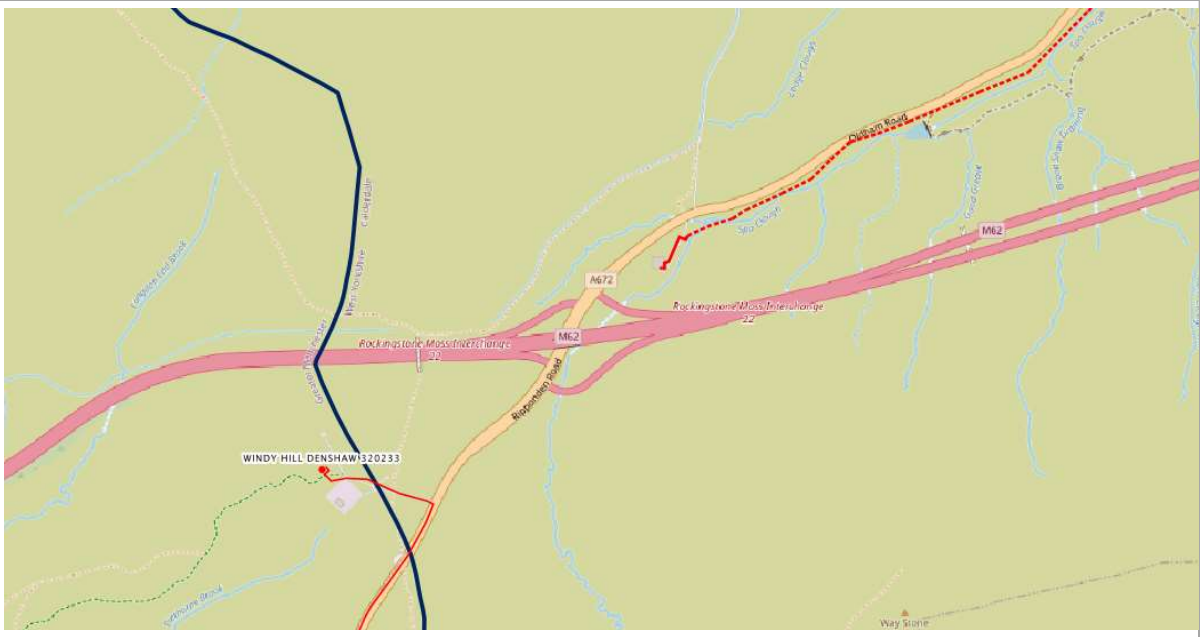
Proposed Solution

Underground cable from ENWL WATERHOUSES substation to NPg DARNBROOK FARM substation with metered and telecontrolled switchgear at one end. The Electricity North West network would need to be reinforced by restringing around 6km of overhead line from single phase to 3 phase

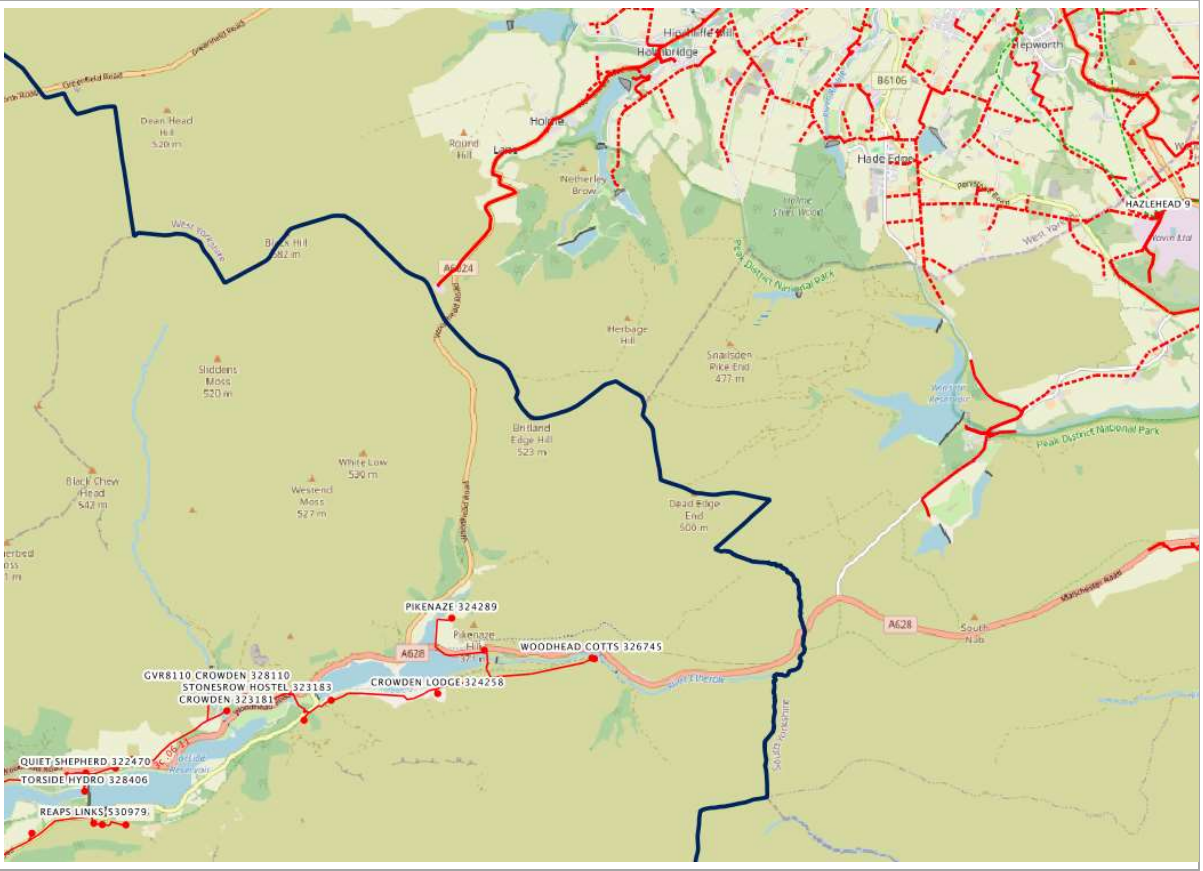
Proposed Funding Arrangement

Interconnect cost split 50:50 between DNOs, but the reinforcement cost will be borne by Electricity North West.

Estimated Overall Cost	**£711k**
Estimated ENWL Cost	**£453k**

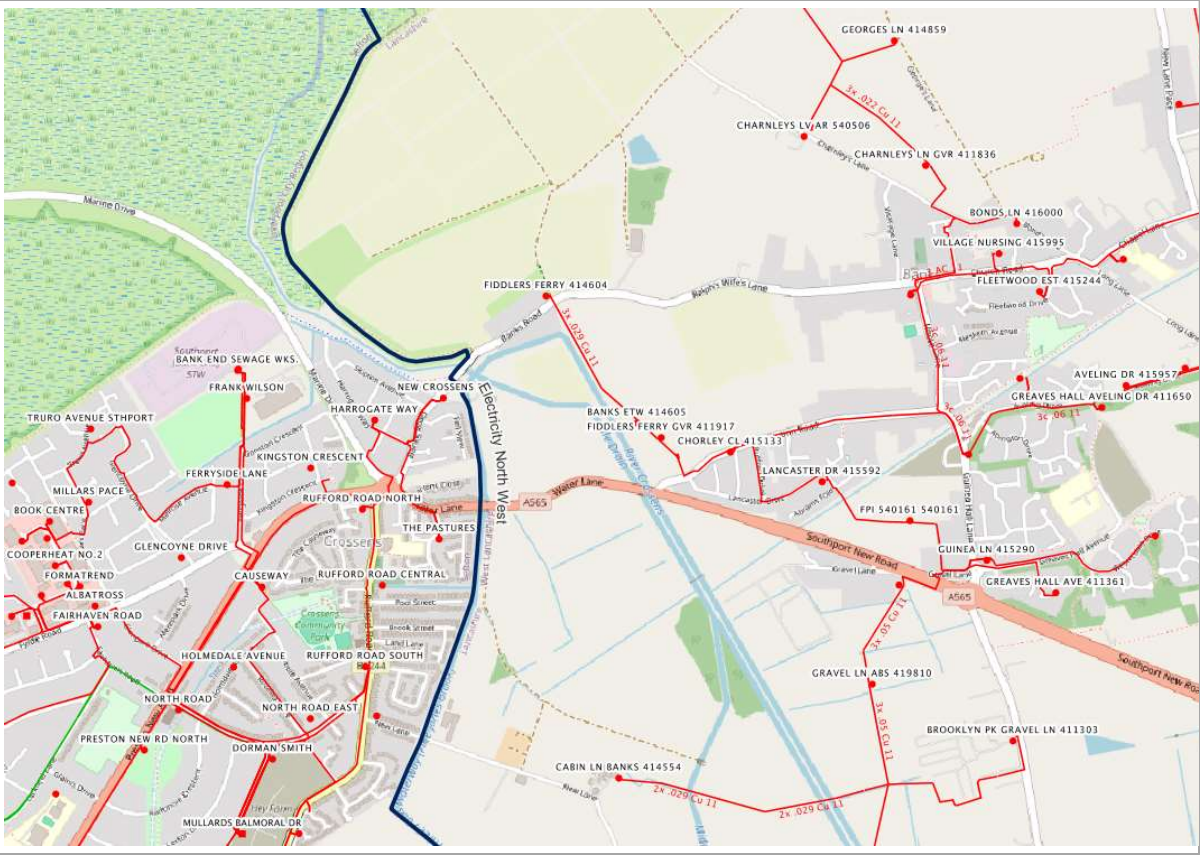
M62			
Other DNO	Northern PowerGrid (Yorkshire)		
Benefitting DNO	Northern PowerGrid (Yorkshire)		
			
Radial Length (inc spurs)	5km (underground)	**Number of ENWL Customers**	37
Accessibility	N/A		
Interconnect Rationale			
N/A			
Proposed Solution			
Underground cable between spare switches at ENWL WINDY HILL DENSHAW substation and NPg ROCKING STONE MOSS substation and additional telecontrol at NPg substation.			
Proposed Funding Arrangement			
Funded by NPg			
Estimated Overall Cost		**N/A**	
Estimated ENWL Cost		**N/A**	

Woodhead Pass			
Other DNO	Northern PowerGrid (Yorkshire)		
Benefitting DNO	Electricity North West		



Radial Length (inc spurs)	17.5km	**Number of ENWL Customers**	165
Accessibility	20 miles from ENWL Oldham depot along the A628 Woodhead Pass road up Longdendale		
Interconnect Rationale			
Supports a very long radial circuit with significant numbers of customers in the Pennines.			
Proposed Solution			
Underground cable from ENWL PIKENAZE substation to NPg HOLME MOSS along the route of the A6024 (4km)			
Proposed Funding Arrangement			
Funded by ENWL			
Estimated Overall Cost		**£655k**	
Estimated ENWL Cost		**£655k**	

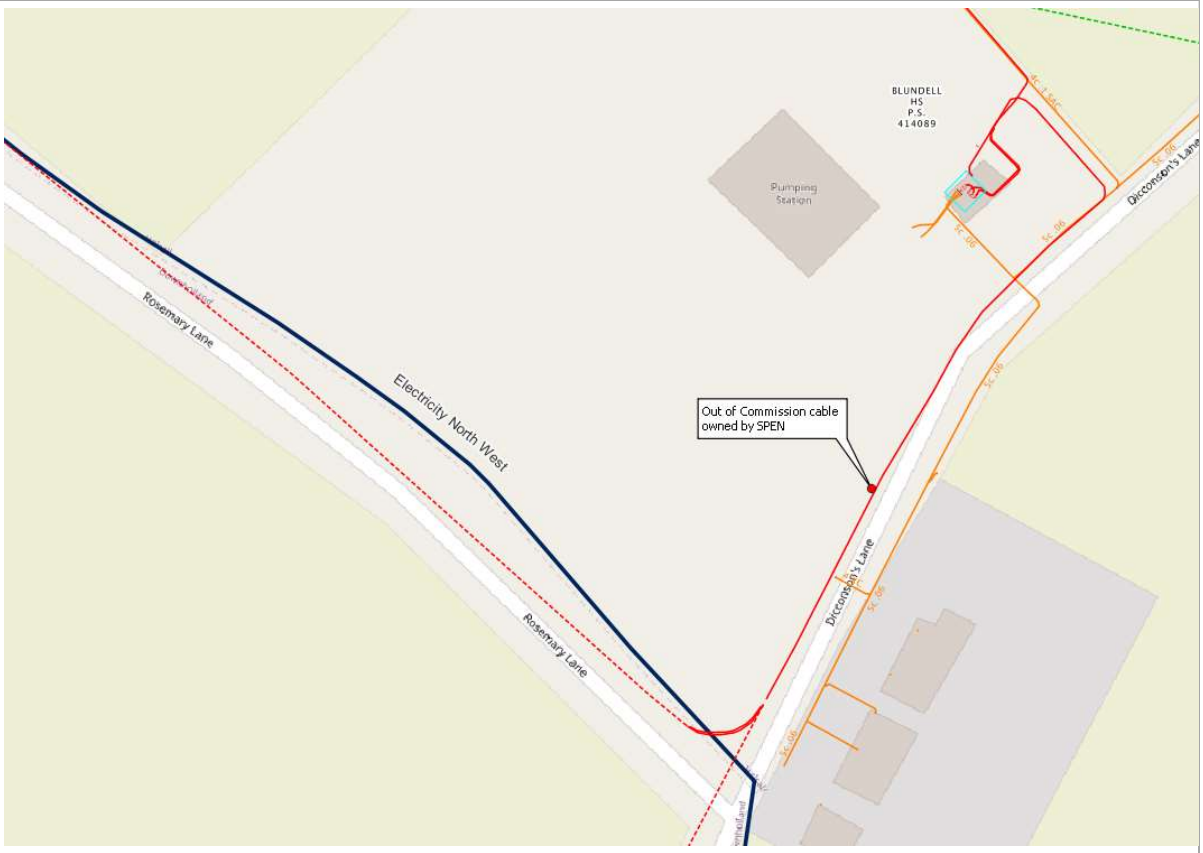
Fiddler's Ferry			
Other DNO	Scottish Power Energy Networks (MANWEB)		
Benefitting DNO	Electricity North West		



Radial Length (inc spurs)	860m	**Number of ENWL Customers**	46[15]
Accessibility	15 miles from ENWL Preston depot		
Proposed Solution			
Underground cable (450m) between ENWL FIDDLERS FERRY substation to SPEN CROSSENS PS substation and additional telemetered switch within SPEN substation			
Proposed Funding Arrangement			
Interconnector funded by ENWL, but SPEN will replace the existing board as an asset replacement programme to enable the board extension			
Estimated Overall Cost	**£139k**		
Estimated ENWL Cost	**£47k**		

[15] This interconnect also helps to support the town of Banks with around 2100 customers which is fed by a predominantly overhead network across the West Lancashire plain and is therefore susceptible to wind damage

Blundell House Pumping Station			
Other DNO	Scottish Power Energy Networks (MANWEB)		
Benefitting DNO	Electricity North West & Scottish Power Energy Networks (MANWEB)		

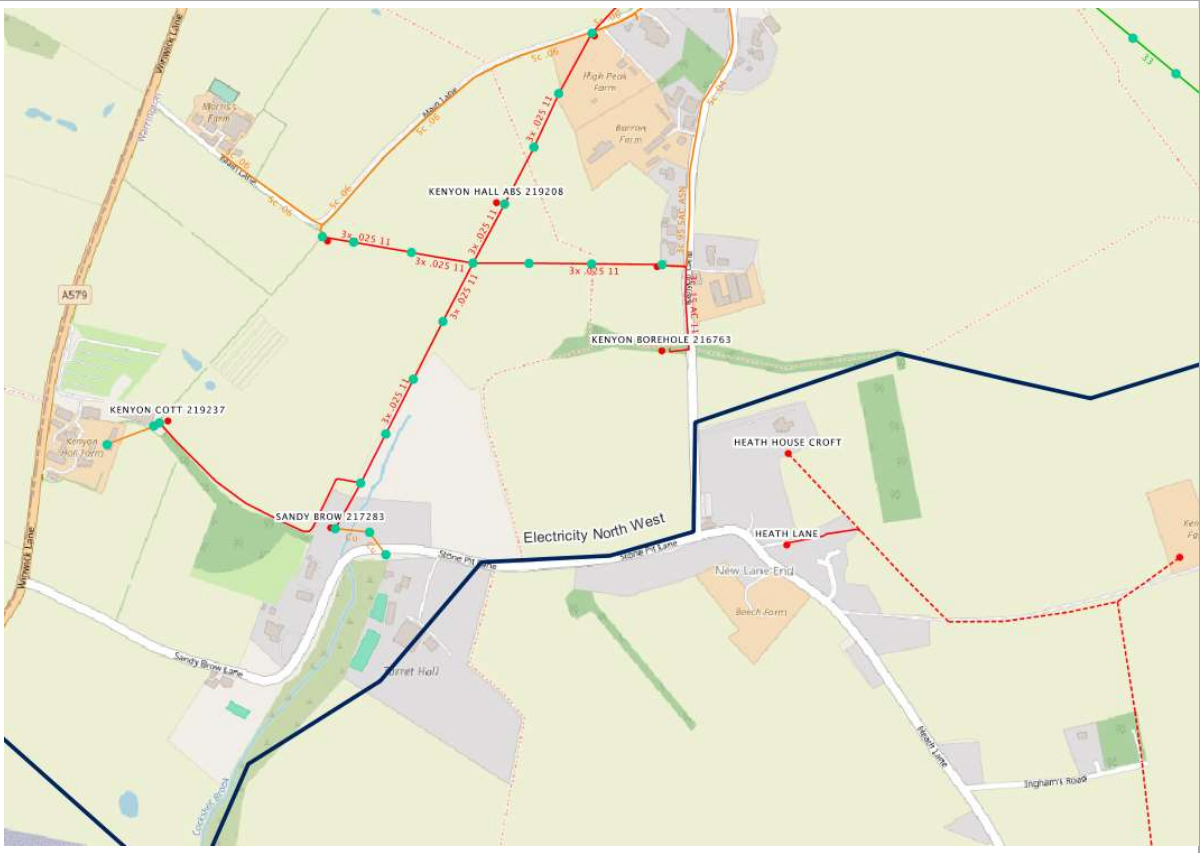


Radial Length (inc spurs)	1.35km	**Number of ENWL Customers**	23
Accessibility	22 miles from ENWL Preston depot		

Proposed Solution
Overlay existing out of commission SPEN cable into ENWL BLUNDELL HS PS, connect to existing ENWL switch and add telemetry. It appears that part of the current SPEN network was originally fed from this substation when part of Lancashire Electric Power, but the networks were split at nationalisation into the North Western Electricity Board (NWEB) and Merseyside and North Wales Electricity Board (MANWEB) networks.
Proposed Funding Arrangement
Overall cost split 50:50 between DNOs

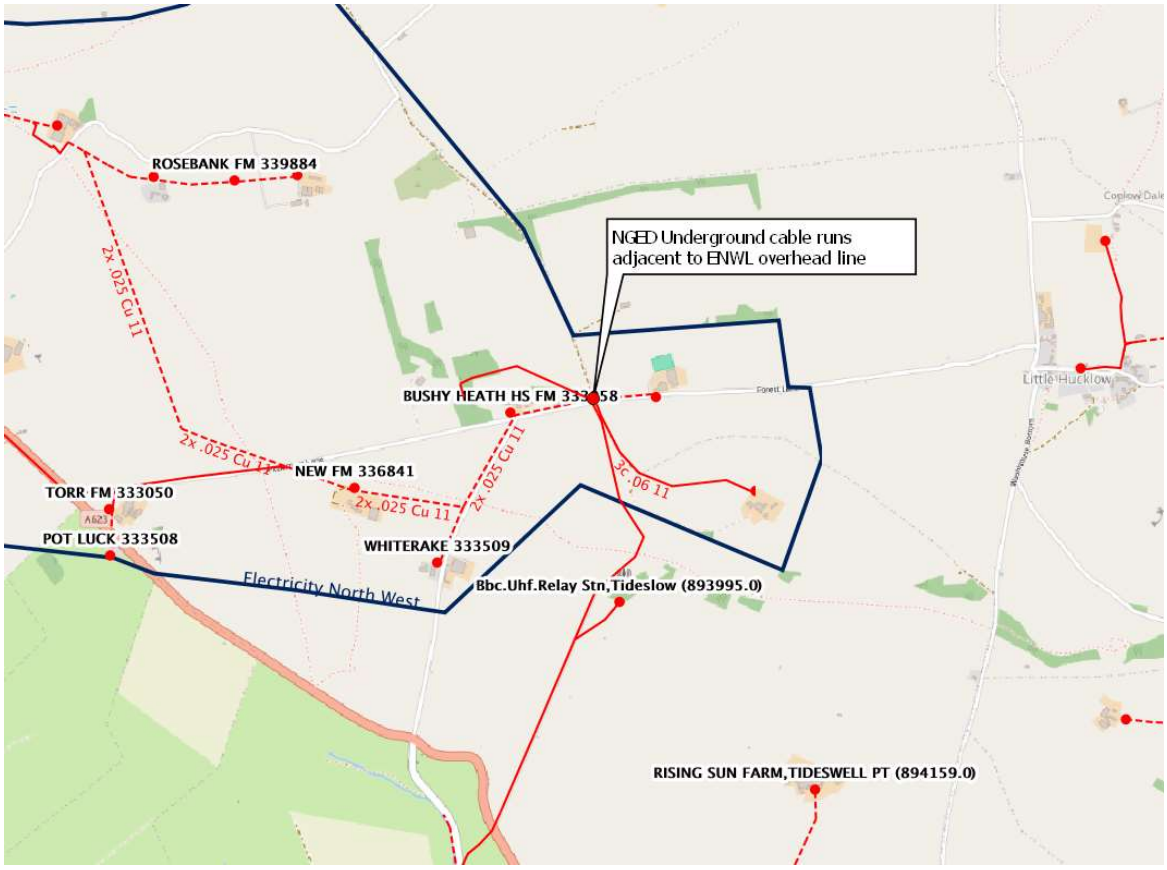
Estimated Overall Cost	**£38k**
Estimated ENWL Cost	**£19k**

Heath House, Kenyon			
Other DNO	Scottish Power Energy Networks (MANWEB)		
Benefitting DNO	Electricity North West & Scottish Power Energy Networks (MANWEB)		



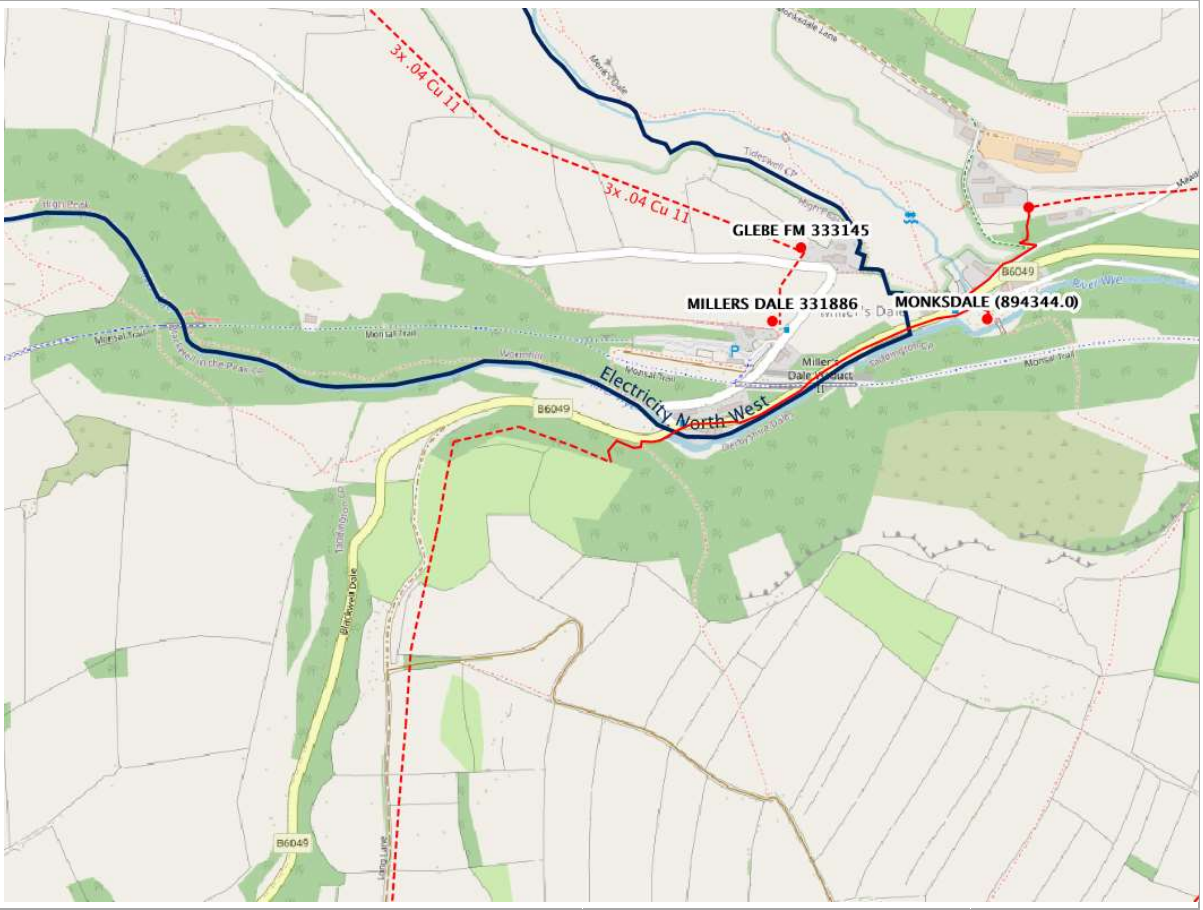
Radial Length (inc spurs)	3.5km	**Number of ENWL Customers**	262
Accessibility	10 miles from ENWL Walkden depot		
Proposed Solution			
Install new telecontrolled RMU at ENWL KENYON BOREHOLE (216763), then overhead line through to SPEN HEATH HOUSE CROFT (200m)			
Proposed Funding Arrangement			
Switchgear funded by ENWL and overhead line funded by SPEN			
Estimated Overall Cost		**£67k**	
Estimated ENWL Cost		**£45k**	

Tideslow			
Other DNO	National Grid Electricity Distribution (EMID)		
Benefitting DNO	Electricity North West		



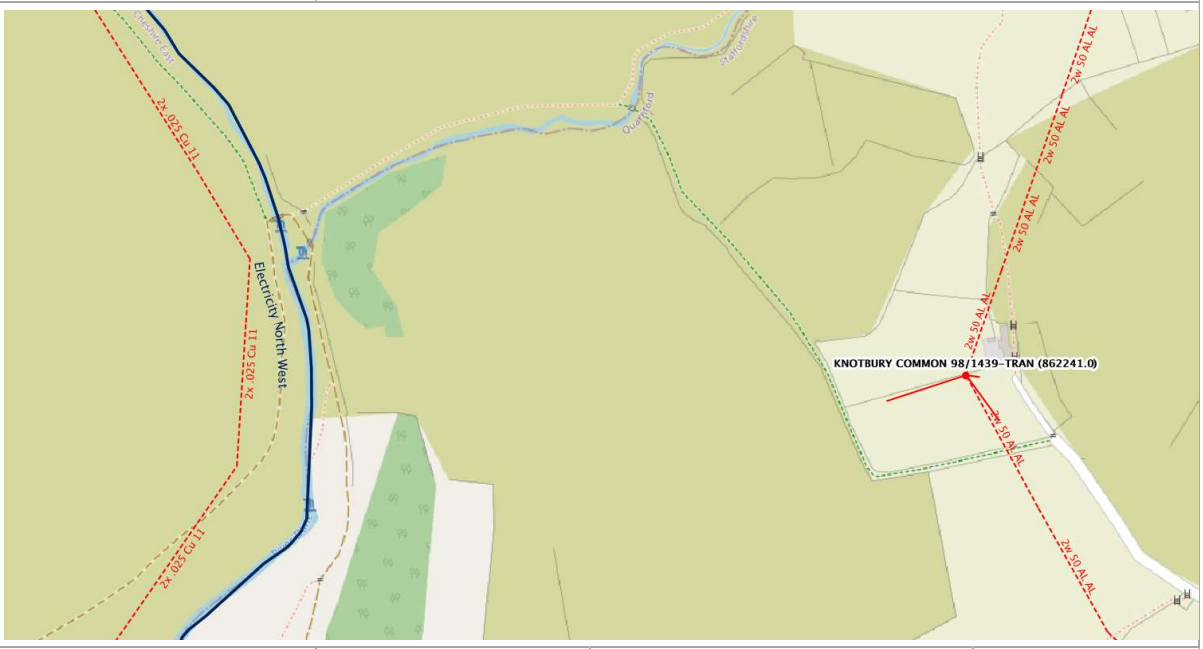
Radial Length (inc spurs)	7.5km	**Number of ENWL Customers**	46
Accessibility	21 miles from ENWL Stockport depot		
Proposed Solution			
Tee of NGED underground cable at the base of the pole and install new telecontrolled GVR.			
Proposed Funding Arrangement			
Funded by ENWL			
Estimated Overall Cost		**£25k**	
Estimated ENWL Cost		**£25k**	

Millers Dale	
Other DNO	National Grid Electricity Distribution (EMID)
Benefitting DNO	Electricity North West



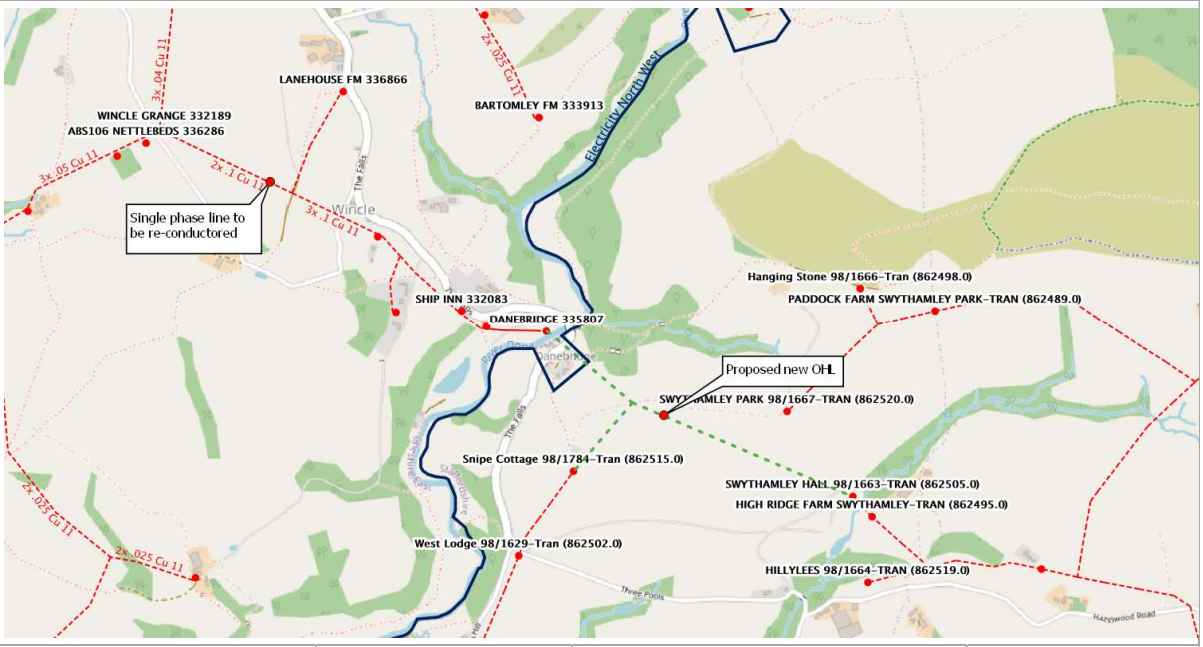
Radial Length (inc spurs)	3.3km	**Number of ENWL Customers**	91
Accessibility	24 miles from ENWL Stockport depot		
Proposed Solution			
Overhead line to extension south-west of MILLERS DALE (331886) substation to connect to a new telecontrolled GVR on a NGED pole just south of the B6049.			
Proposed Funding Arrangement			
Funded by ENWL			
Estimated Overall Cost		**£49k**	
Estimated ENWL Cost		**£49k**	

Knotbury Common			
Other DNO	National Grid Electricity Distribution (EMID)		
Benefitting DNO	Electricity North West and National Grid Electricity Distribution (EMID)		



Radial Length (inc spurs)	11.7km	**Number of ENWL Customers**	53
Accessibility	23 miles from ENWL Stockport depot		
Proposed Solution			
Overhead line to extension West from NGED KNOTBURY COMMON PMT to connect to new telecontrolled GVR on ENWL overhead line			
Proposed Funding Arrangement			
Overall cost split 50:50 between DNOs			
Estimated Overall Cost		**£65k**	
Estimated ENWL Cost		**£32k**	

Danebridge			
Other DNO	National Grid Electricity Distribution (WMID)		
Benefitting DNO	Electricity North West and National Grid Electricity Distribution (WMID)		



Radial Length (inc spurs)	2km	**Number of ENWL Customers**	43
Accessibility	23 miles from ENWL Stockport depot		

Proposed Solution
Reinforcement of overhead line to DANEBRIDGE (335807) to upgrade from single to three phase. New telecontrolled GVR at DANEBRIDGE (335807) connecting to a new NGED overhead line connecting to SWYTHAMLEY HALL (98/1663) and SNIPE COTTAGE (98/1784) with Air Break Switch (ABS)
Proposed Funding Arrangement
Switchgear and overhead line reinforcement funded by ENWL. Additional overhead line to be funded by NGED

Estimated Overall Cost	**£162k**
Estimated ENWL Cost	**£75k**

Appendix H Glossary

Term	Description
LV	Low Voltage - 230V or 415V
HV	High Voltage - 6.6kV or 11kV
EHV	Extra High Voltage - 33kV
132kV	132kV
ABC	Aerial Bundled Conductors - a type of overhead line
BEIS	Department for Business, Energy & Industrial Strategy (DESNZ took responsibility for energy portfolio in 2023)
BS	British Standards
BSP	Bulk Supply Point
CBA	Cost Benefit Analysis
CCARWG	ENA Climate Change Adaptation Reporting Working Group - made up of representatives of UK gas and electricity network companies
CCRWG	ENA Climate Change Resilience Working Group - made up of representatives of UK gas and electricity network companies
CFIs	Current Fault Indicators
CLEP	Cumbria Local Enterprise Partnership
Cumbria CVS	Cumbria Council for Voluntary Service
Defra	Department for Environment Food & Rural Affairs
DESNZ	Department for Energy Security & Net Zero
DNO	Distribution Network Operator
EFIs	Earth Fault Indicators
EGAP	Economic Growth Advisory Panel - Electricity North West stakeholder panel
EJP	Engineering Justification Paper
ENA	Energy Networks Association
ENA TS	ENA Technical Specification
ETR132	ENA Engineering Technical Report 132 - Improving resilience of overhead networks under abnormal weather conditions using a risk based methodology
GS	Guaranteed Standards
GSOP	Guaranteed Standards of Performance
GSP	Grid Supply Point
HI	Health Index - a measure of the probability of failure of an asset

Term	Description
IIS	Interruptions Incentive Scheme - a scheme to incentivise DNOs to reduce the frequency and duration of interruptions
IOG	Independent Oversight Group - Electricity North West stakeholder panel
IP	Internet Protocol telephony
LEP	Local Enterprise Partnership
LI	Load Index - a measure of the capacity used on a circuit or substation
LineSIGHT	Innovative project to install monitoring devices on HV overhead lines to ensure legal compliance, but also providing added resilience during storms detecting damaged overhead lines more quickly
LRF	Local Resilience Forum
NARMs	Network Asset Risk Metric - a measure of the risk of failure and consequence of failure of assets
NGED	National Grid Electricity Distribution
NEOP	National Energy Outage Platform - a national power cut map for all DNOs
NEWA	New European Wind Atlas
NEWSAC	Agreement through which electricity network companies across the British Isles support each other during storms or other high impact events.
NMS	Network Management System
NPg	Northern Powergrid
OHL	Overhead Lines
ONS	Office of National Statistics
P2/7	ENA - Engineering Recommendation P2 Issue 7 2019 -Security of Supply; a guide to system planning
PERCH	Project to install LV Automated Reclosers and Communications equipment on the LV overhead line network
PMT	Pole Mounted Transformer
PSR	Priority Services Register - a free UK wide service which provides extra advice and support when there's an interruption to electricity, gas or water supply.
RIGs	Regulatory Instructions and Guidance - this is used to refer to the annual regulatory reports that DNOs submit to Ofgem.
RIIO	Energy network price review framework based on Revenue = Incentives + Innovation + Outputs
RIIO-ED1	The first electricity distribution price review under the RIIO framework, running from 2015 to 2023
RIIO-ED2	The second electricity distribution price review under the RIIO framework, running from 2023 to 2028
RIIO-ED3	The third electricity distribution price review under the RIIO framework, running from 2028 to 2033

Term	Description
RPE	Real Price Effects – inflationary impacts above those captured in economy-wide indices such as CPI
SAIG	Storm Arwen Implementation Group
STFC	Science and Technology Facilities Council
SIAP	Stakeholder Insight Advisory Panel - Electricity North West stakeholder panel
SIF	Strategic Innovation Fund - a funding mechanism for innovation projects
SPEN	Scottish Power Energy Networks
SROI	Social Return on Investment
SWBD	Switchboard
UIOLI	Use it or lose it - a form of regulatory funding.
UKCP09	UK Climate Projections published by the Met Office in 2009
UKCP18	UK Climate Projections published by the Met Office in 2018
UVA	Undergrounding for Visual Amenity - a programme to replace overhead lines with underground cable in National Parks and Areas of Outstanding Natural Beauty
VoLL	Value of Lost Load
WSC	Worst Served Customers - investment to improve performance for customers with multiple interruptions

Appendix I Measuring the local economic value of avoiding Storm Arwen type disruption

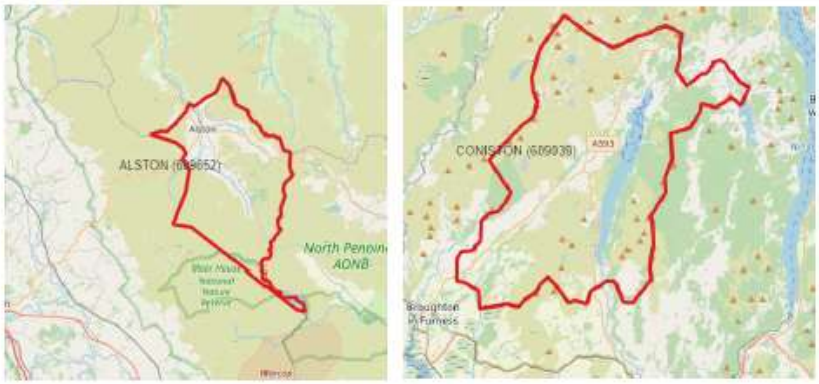
Briefing Note for ENWL on measuring the local economic value of avoiding Storm Arwen type disruption

Nicol Economics, 5th January 2024

Introduction

1. Electricity North West Limited (ENWL) are responsible for the electricity distribution network across much of the North West of England including all of Cumbria. They are responsible for ensuring a robust supply of electricity to all premises in Cumbria both domestic and non-domestic. This is by the provision and maintenance of a network of overhead power lines, underground electricity cables and other infrastructure that connects customers to the electricity generated.
2. ENWL face challenges in ensuring the supply of power when natural events such as storms and flooding occur. These events are, as is well documented, becoming more frequent and serious as a result of climate change. Remoter rural locations are more vulnerable as the networks serving many of these areas are inherently less robust (with at time single main power lines into a community.
3. The recent events precipitated by Storm Arwen in November 2021 led to two parts of Cumbria, Alston and Coniston, being without power for several days and they were some of the worst affected parts of the ENW network in terms of length of the power cuts that occurred.

Figure 1: Location of areas affected with vulnerable power supply in Alston and Coniston



Source: ENW. Note: scales for the two maps differ

4. The affected area in and around **Alston** comprises the town, surrounding settlements such as Raise, Nenthead and Garragill and isolated houses and businesses. In total around 1,400 properties are supplied via the ENW network. Alston is one of the highest and most isolated towns in England located in the far north east of Cumbria inside the North Pennines AONB.

5. The affected area in and around **Coniston** comprises the town itself and the large village of Hawkhead as well as smaller settlements such as Torver and High Nibthwaite as well as isolated houses and businesses. Coniston is located in the south west of Cumbria inside the Lake District National Park and is less isolated than Alston. As with Alston, around 1,400 properties are supplied via the ENW network in the Coniston area.

Assessing impact of power outages

6. ENWL are considering investing in upgrading the electricity network serving the two areas to make it more robust (eg by replacing overhead with underground cables). The capital cost of the investment need to meet certain investment criteria metrics set by Ofgem. However as the number or properties served is relatively small the investment cases struggle with the standard metrics (which measure benefits in relation to compensation payments for a five day period and repair work avoided).
7. The current Ofgem compensation for a Category 1 storm is £80 if power has been cut-off for 24 hours, with an extra £40 for every 6 hours after that. The maximum amount that can be claimed is, currently, £2,000 (which would be for power being cut off for 13 days in total). According to data supplied by ENW for a 5 day outage the compensation paid for the two areas would be around £0.75 million in each case or around £560 per property.
8. This note explores alternative and additional measures that could be used by ENWL as part of the case making for investment in better power supply resilience in these locations. In so doing it is important that we avoid double counting with the compensation payments.

General approach

9. The approach adopted is to consider what extra economic (or social) costs would be incurred by the local economy as a result of a **5 day power outage**[1] and consequent disruption and lost output. The impact of a power cut is arguably greater now than it would have been in the past for businesses due to the importance of access to the internet for communications and many business processes as well as the impact on supporting machinery used in businesses (eg electronic tills).
10. The approach involves six steps:
    - Step 1: map the affected areas onto local data sets to create an estimate of local employment and other measures of economy activity
    - Step 2: use these to create an estimate of annual economic value generated in the immediate local economy.
    - Step 3: ensure this is in current prices.

[1] This is the time period ENWL use for such investment cases to assess costs avoided s

- Step 4: adjust for those sectors of the economy where a power cut is less likely to impact on economic activity.
- Step 5: assess effect of five days lost activity.
- Step 6: remove compensation paid to non-domestic properties to avoid double counting.

11. These steps are explained in turn below.

Step 1: Map the ENWL affected areas onto local data sets

12. Most economic data sets are available at small areas for wards, lower super output areas (LSOA), output areas (for limited population data) or in some cases parishes. In the case of Alston, the area of properties defined by ENW is a very good fit onto the ward or LSOA area[2] covering Alton (see Figure A1 Appendix A). This area has 2,002 usual residents and 958 households according to the 2021 Census.

13. However, in the case of Coniston It is not possible to map precisely the ENWL area and other data sets and so we have had to use best fit areas. The area covers Coniston as well as Hawkshead (see Figure A2 in the Appendix A). We have reviewed the data and the ENWL area is best proxied by:
    - The whole of the LSOA covering Coniston town and part of the LSOA covering Hawkshead[3] . In the case of the latter this LSOA covers parts of Newby Bridge, Near and Far Sawry and Bouth which are outside the ENWL Coniston area. Using 2021 Census population data for smaller geographical areas it appears that around 36% of the population of this LSOA lives in Hawkshead, giving an estimate of 935 households and 2,052 usual residents recorded in the 2021 Census
    - A best fit set of parishes[4] giving an estimate of 880 households and 1,891 usual residents in 2021.

14. Unfortunately most economic data sets are at best available down to LSOA level only and here they are rounded and aggregated. We have accessed a combination of data on:
    - Employment based data on where business are located (from the Business Register and Employment Survey : open access via Nomis)
    - Population data based on where people live rather than where jobs are located.

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[2] E01019305 : Eden 001A
[3] Respectively: E01019350 : South Lakeland 008C (covering Coniston); and E01019356 : South Lakeland 007A (covering Hawkshead)
[4] Coniston along with Blawith and Subberthwaite, Hawkshead, Satterthwaite and Torver

Step 2: Create an estimate of overall annual economic value generated in the immediate local economy and Step 3: Ensure this is in current prices

15. We have used several methods to try and assess local economic value, this relies on apportioning the GVA data for Cumbria by sector for 2021[5] to the local areas essentially based on respective shares of employment by sector or my resident workforce. This work produces a range of annual economic value produced by the local economy in 2021 prices of:
    - Alston: £25 to £50 million (with an average of the three methods of £41 million)
    - Coniston: £49 to £62 million (with an average of the three methods of £54 million).
16. The GVA data measures output in 2021 in 2021 prices, we have adjusted these to 2024 prices using the GDP deflator published by HM Treasury in November 2023[6], this forecast inflation of 15.1% from 2021 to 2024 (calendar years). The updated estimates of local economic value generated in 2024 prices are:
    - Alston: £29 to £57 million (with an average of the three methods of £48 million)
    - Coniston: £56 to £72 million (with an average of the three methods of £62 million).
17. The figures are set out in Table A2 in Appendix A. The steps taken to make these estimates is set out in Appendix B. There is a range used in this note because there are inherent uncertainties in these methods arising from:
    - First, the process of creating a best fit area (an issue mainly for Coniston);
    - Second, the process of apportioning overall GVA at a Cumbria level by sector or overall to local areas using employment as a proxy as: measures of employment at local levels are subject to data irregularities; and the implicit assumption that the average GVA per job is the same as the Cumbria level within each sector may not be true.

Step 4: Adjust for those sectors of the economy where a power cut is less likely to impact on economic activity and Step 5: Assess consequence of five days lost activity

18. The figures generated under Step 3 measure the overall economic value and as Table A2 in Appendix A shows the average value of these can be calculated for a five day period which is in effect 1.4% of a full year. For the average of the three methods this £650,000 of economic output (GVA) for the Alston area and £850,000 for the Coniston area in (current) 2024 prices for a five day period.

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[5] Total GVA generated across Cumbria was estimated as £12,085 million in 2021, sourced from: Regional gross value added (balanced) by industry: all International Territorial Level (ITL) regions, ONS, April 2023

[6] https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-november-2023-autumn-statement

19. This assessment is not based on assuming a particular time of year and so is a "typical" or average 5 day period. In areas with an important visitor economy (Coniston) the relative impact is likely to be higher in summer period and lower in the winter (depending on when the outage occurs) as visitor occupancy rates very across the year (see Figure 3A in Appendix A).

20. However, it is likely that not all economic output will be lost a result of a 5 day power outage in all sectors and of course businesses will do their best to avoid a loss of production or sales.

21. For many a power cut will result in complete closure over the period with also the possible loss of other sales/economic activity outside the 5 day period (if for instance sales over the internet are lost). In other words it is conceivable that the effect is greater than a 1.4% loss of economic output, however in some cases businesses may be able to make up some of the sales and activity after the period of the power outage.

22. There are also some forms of economic activity which are less building or place dependent (such as construction where firms go to construction sites to deliver work) and so we have reduced the assumed economic loss by sector as shown in Table 1 below.

Table 1: Assumed impact of power outage by sector [7]

Sector	Likely impact % of full potential impact	
1 : Agriculture, forestry & fishing (A)	MED	50%
2 : Mining, quarrying & utilities (B,D and E)	HIGH	100%
3 : Manufacturing (C)	HIGH	100%
4 : Construction (F)	LOW	25%
5 : Motor trades (Part G)	HIGH	100%
6 : Wholesale (Part G)	HIGH	100%
7 : Retail (Part G)	HIGH	100%
8 : Transport & storage (inc postal) (H)	MED	50%
9 : Accommodation & food services (I)	HIGH	100%
10 : Information & communication (J)	HIGH	100%
11 : Financial & insurance (K)	HIGH	100%
12 : Property (L)	HIGH	100%
13 : Professional, scientific & technical (M)	HIGH	100%
14 : Business administration & support services (N)	HIGH	100%
15 : Public administration & defence (O)	HIGH	100%
16 : Education (P)	HIGH	100%

[7] The logic of the reduced impact on the construction sector is the high proportion of workers who travel to deliver work, for transport it is because the activity is mainly mobile and for other services many of these are mobile and also ones where there can be some catching up (eg hairdressing and beauticians). We have made an adjustment of agriculture to reflect the general higher levels of resilience and for beef and sheep meat production that this would be relatively unaffected by a power outage (this is not true for dairying however, but there is no robust data on types of farms in the two areas, they are likely to be primarily meat production with some dairying)

Table 1: Assumed impact of power outage by sector [7]		
Sector	Likely impact % of full potential impact	
17 : Health (Q)	HIGH	100%
18 : Arts, entertainment, recreation & other services (R,S,T and U)	MED	50%
Source: Nicol Economics		

23. The impact of these adjustments depends on the degree of value in local economic impact by sector, overall the effect is to reduce the assessed 5 day economic impact by 14% in the Alston and 10% in the Coniston area. We have applied these adjustment factors for the two areas to all three methods.

Step 6: Remove compensation paid to non-domestic properties to avoid double counting.

24. There is a potential element of double counting in that ENWL makes payments to compensate customers for loss of power. As we understand it the same value of payments are made domestic or non-domestic customers. These would be therefore £50,000 and £77,000 respectively for Alston and Coniston areas.

25. Table 2 sets out the final results from this exercise.

Table 2: Final estimates of value of loss of 5 days output as a result of a power outage, £000s						
Area		Best initial estimate before adjustments		Less adjustment for sectors less affected	Value of payments to non-domestic properties	Final assessed figure
		2021 prices	2024 prices	2024 prices		
Alston area	Lower	£349	£401	£347	-£50	£296
	Higher	£678	£781	£670	-£50	£619
	Av. All 3	**£567**	**£653**	**£563**	**-£50**	**£513**
Coniston area	Lower	£671	£773	£715	-£77	£638
	Higher	£855	£984	£887	-£77	£810
	Av. All 3	**£738**	**£850**	**£766**	**-£77**	**£689**
Source: estimates by Nicol Economics						

Conclusions and caveats

26. These estimates consider the impact from an **economic output** perspective (as measured by Gross Value Added). The estimates are inevitably broad brush and so have been presented as a range as noted above in practice the actual local community and economic impacts will depend on the time of year of the power outage. The estimates consider lost economic output **in the local communities affected**, they do not consider the expect to which some of this economic activity may be displaced to other areas in Cumbria (or elsewhere) eg from cancelled holidays or retail spend that goes elsewhere.

27. The range is greatest for the Alton area as there is a greater difference between the method based on people resident there as opposed to economic activity that take place there.

28. They also do not consider the potential adverse social impacts (on health, vulnerability, education etc) in the local areas not because these are not important but because there is a very limited data on which to assess these. It should be noted that some of these social costs are picked up explicitly in the estimates (eg lost economic value in the health and education sectors implicit in the estimates). Also the majority of compensation payments are to domestic properties and so arguably are aimed at covering these social less/impacts.
29. The estimates could be improved if ENWL were able to provide more detailed information on the nature of premises served (type of business. it also could be possible to match up premises with the non-domestic rates valuation data base to establish more precisely the nature of business located in the areas (type of premise and rateable value and floor area). However, this would be a time consuming exercise.

Nicol Economics, January 2024

Appendix A: Data

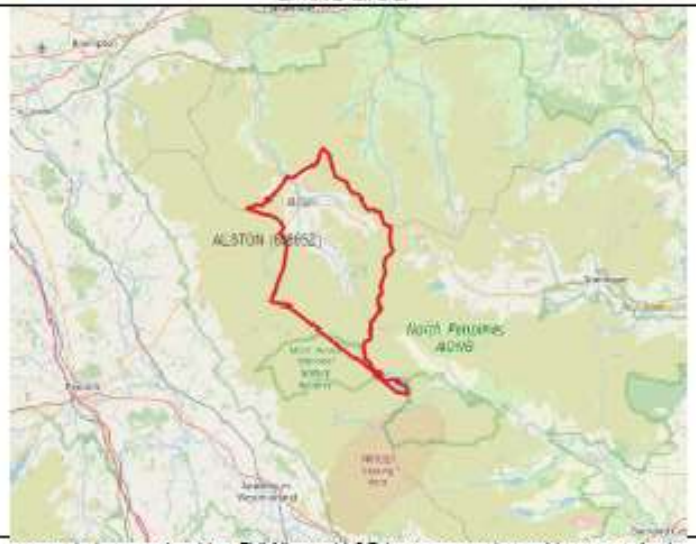
Table A1: Properties covered

Area	All properties	Priority Services Register (PSR)	Other highly vulnerable	All vulnerable	% of domestic properties	All not vulnerable	% domestic	All domestic	All non-domestic	Payouts
Alston	1,373	153	169	322	25%	1,051	93.5%	1,284	89	£776,000
Coniston	1,386	93	121	214	17%	1,172	90.0%	1,247	139	£769,000

Source: data supplied by ENWL

Figure A1: Areas covered Alston

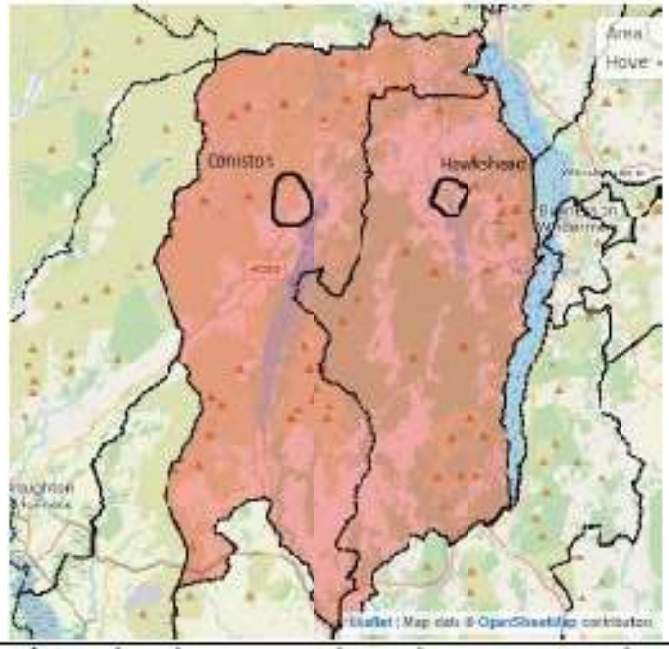
ENWL area



Local ward and LSOA boundary

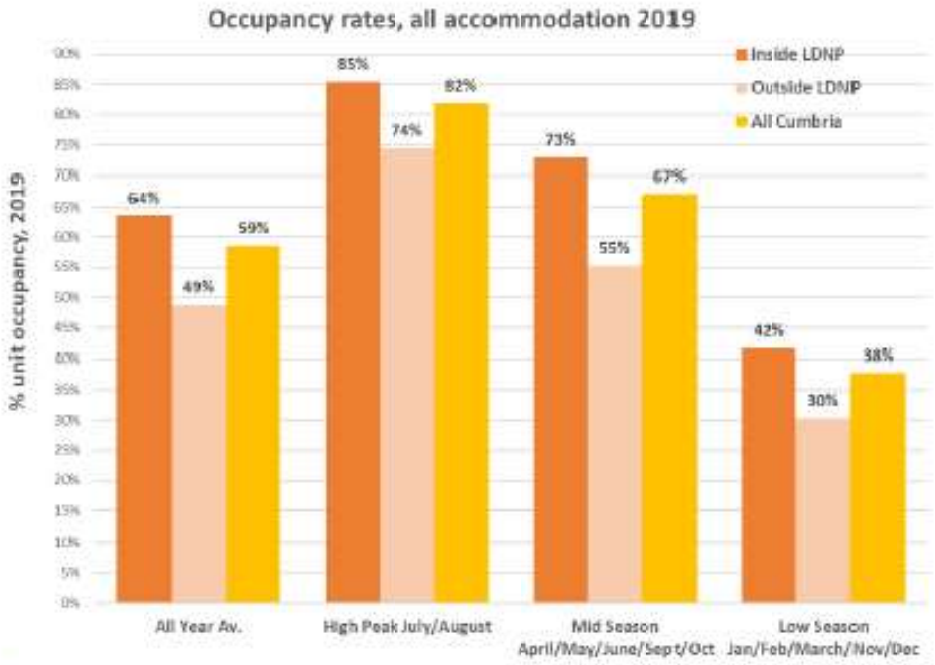
Source: data supplied by ENWL and LSOA accessed via Nomis website

Figure A2: Areas covered Coniston

ENWL area	Local LSOA boundaries
	

Source: data supplied by ENWL and LSOA accessed via Nomis website. Note/left LSOA in red is the one covering Coniston the one to the right covers Hawkshead but also other areas

Figure A3: Occupancy rates in Cumbria by location and time of year



Source: data from Cumbria Tourism analysed by Nicol Economics and used in draft Visitor Management Plan (2019 taken as typical per Covid year)

Table A2: Estimates of Local economic output generated on the local area (not social cost or value)

	Overall								Per premise		
	£ms	£ms	£ms	£ms		£ms	£ms		All	Non-domestic	Not vulnerable
Local annual economic output	Method A	Method B	Method C	Average of methods		Lower	Higher		£000s	£000s	£000s
Alston area	£25.5	£49.5	£49.2	**£41.4**		£25.5	£49.5		£30.2	£463.9	£39.4
Coniston area	£62.4	£50.3	£49.0	**£53.9**		£49.0	£62.4		£38.9	£388.9	£46.0
Daily economy output, £000s											
Alston area	£70	£136	£135	**£113**		£70	£136		£0.08	£1.27	£0.11
Coniston area	£171	£138	£134	**£148**		£134	£171		£0.11	£1.07	£0.13
5 days economic output, £000s									£000s	£000s	£000s
Alston area	£349	£678	£674	**£567**		£349	£678		£0.41	£6.36	£0.54
Coniston area	£855	£689	£671	**£738**		£671	£855		£0.53	£5.33	£0.63
2024 Q1 prices											
Local annual economic output £ms	£ms	£ms	£ms	£ms		£ms	£ms		All	Non-domestic	Not vulnerable
Alston area	£29.3	£57.0	£56.6	**£47.6**		£29.3	£57.0		£34.7	£533.9	£45.3
Coniston area	£71.8	£57.9	£56.4	**£62.0**		£56.4	£71.8		£44.8	£447.5	£52.9
Daily economy output, £000s											
Alston area	£80	£156	£155	**£131**		£80	£156		£0.10	£1.46	£0.12
Coniston area	£197	£159	£155	**£170**		£155	£197		£0.12	£1.23	£0.15
5 days economic output, £000s											
Alston area	£401	£781	£776	**£653**		£401	£781		£0.48	£7.31	£0.62
Coniston area	£984	£793	£773	**£850**		£773	£984		£0.61	£6.13	£0.73

Table A3: Estimates of local GVA based on BRES employment data at LSOA level applied to 2021 Cumbria GVA (Method A)

Sector	Alston		Coniston		Hawkshead	
	Based on BRES jobs share		Based on BRES jobs share		Based on BRES jobs share	
	Employees	All Employment	Employees	All Employment	Employees	All Employment
1 : Agriculture, forestry & fishing (A)	£0.0	£4.3	£0.0	£1.7	£2.2	£1.5
2 : Mining, quarrying & utilities (B,D and E)	£0.9	£0.9	£0.1	£0.1	£0.0	£0.0
3 : Manufacturing (C)	£9.1	£9.1	£3.1	£3.4	£3.1	£3.1
4 : Construction (F)	£1.2	£1.4	£2.2	£2.3	£2.0	£2.3
5 : Motor trades (Part G)	£0.2	£0.4	£2.2	£1.8	£0.4	£0.4
6 : Wholesale (Part G)	£0.0	£0.4	£0.0	£0.0	£0.0	£0.0
7 : Retail (Part G)	£1.9	£2.7	£1.9	£2.7	£2.8	£2.7
8 : Transport & storage (inc postal) (H)	£0.4	£0.4	£0.0	£0.0	£2.2	£2.0
9 : Accommodation & food services (I)	£2.9	£3.1	£16.5	£18.2	£19.6	£21.4
Including property (L)						
10 : Information & communication (J)	£1.7	£1.7	£0.5	£0.5	£0.0	£0.0
11 : Financial & insurance (K)	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
12 : Property (L)						
13 : Professional, scientific & technical (M)	£1.8	£1.6	£0.7	£0.7	£1.1	£1.1
14 : Business administration & support services (N)	£0.7	£0.8	£1.5	£1.5	£0.2	£0.2
15 : Public administration & defence (O)	£0.4	£0.4	£3.6	£3.6	£0.0	£0.0
16 : Education (P)	£1.3	£1.3	£3.7	£3.7	£0.6	£0.6
17 : Health (Q)	£1.9	£1.9	£1.5	£1.5	£3.8	£3.8
18 : Arts, entertainment, recreation & other services (R,S,T and U)	£0.2	£0.2	£2.8	£2.5	£6.4	£5.8
Total	£19.5	£25.5	£42.3	£46.3	£44.3	£44.8
% in ENW areas	100%	100%	100%	100%	36%	36%
Adjusted for % of activity in ENW area	£19.5	£25.5	£42.3	£46.3	£16.0	£16.1

Source: Nicol Economics estimates

Appendix B: Methodology to assess local economic impact

Three methods were used to develop an estimate of the local economic outputs (Gross Value Added) generated for the Alston and Coniston areas

1. Method A: uses estimates of **local employment** by sector multiplied by Cumbria levels of average GVA per job for that sector to arrive at an estimate of total GVA generated by business located in the areas.
2. Method B: uses the share of local **residents** who were reported as being economically active in the Cumbria total to apportion Cumbria's total GVA to the areas.
3. Method C: uses the share of local **residents** who were estimated as being of working age in the Cumbria total to apportion Cumbria's total GVA to the areas.

In all cases the GVA data was sourced from ONS estimates of "Regional gross value added (balanced) by industry: all International Territorial Level (ITL) regions" that was published in April 2023. The latest year for which this data is available is 2021 so that year was used. Table B1 shows this data for Cumbria. The employment data used is for 2022 (the most recent year) open access Business Register and Employment Survey (BRES) data accessed via Nomis

Method B and Method C

These methods are fairly straightforward. Using the best available data and best fit areas we calculate the share of Alston and Coniston in total economically active residents or working age population (16 to 64) and apportions total GVA in Cumbria based on this share. This method allocates total GVA based on where people live rather where they work. It therefore has limitations as there will be commuting in and outflows. The data used is in Table B2. This produces shares of Cumbria total of 0.41% (both measures)for Alston and 0.41% to 0.43% for the best fit Coniston area.

This method assumes that economic output per person resident in the two areas is the same as the Cumbrian average.

Method A: Explained in more detail

This is the more complicated method and arguably the one which would be the most robust if the data available was fully robust. It relies on the use of the sectoral BRES data as a proxy for economic activity and output applied to sectoral GVA data. This suffers from some limitations:

1. First, BRES data is not as reliable at local (LSOA) levels as it is at a county level and so is indicative only of the economic activity.
2. Second, the method assumes that, in effect, economic output per person employed by sector is the same in the two areas as the Cumbria average, a simplifying but necessary assumption.
3. Third, for Coniston that we can apportion employment data for the LSOA : South Lakeland 007A which includes only part in the ENW area based on the

Hawkshead share of population who is economically active (39%) as with Methods B and C.

Three further adjustments have been made to reflect data issues as follows:

- Adjustment 1: As can be seen from Table B1 a large share of GVA in Cumbria is allocated to the property sector (13%) but employment levels in this sector are low (2% of the total). This is due to the role of property in generating GVA via rentals (ie the accommodation self-catering sector amongst other sectors which are not located according to where employment is located). Employment data on its own is not a robust way of allocating this GVA to local areas. We have used the property and accommodation sectors combined to allocate GVA taking employment estimates combined for these two sector. This is still not an entirely ideal approach, but reduces the effects of data anomalies at a local level.
- Adjustment 2: in the case of accommodation and food services there is a very high figure of 600 people employed in this sector in the LSOA that covers Hawkhead (around or 2.1% of the Cumbria total). This reflect the presence of several large hotels in this LSOA however they are largely based in the Newby Bridge area which is <u>not</u> in the ENW Coniston area. Therefore, for this sector in this one area we have reduced the assume share in the Hawkshead part of this LSOA by a further 50% (to around 20%) to adjust for this. In the absence of this adjustment, the approach would artificially inflate the economic activity taking place in the ENW Coniston area.
- Adjustment 3: the final adjustment is for the agricultural sector. At a LSOA level BRES data only includes employees not working proprietors (ie farmers) who account for bulk of employment. So without further adjustment we would understated the employment and so GVA in this sector at a local level. We have replaced the BRES data with 2021 Census data for residents who work in agriculture (158 in the Alston LSOA, 56 in the Coniston LSOA and 63 in the LSO covering Hawkhead).

Table B1: Economic data at a Cumbria level,

Sector	GVA, £ms, 2021	Employ-ment*, 2022	GVA per job, £000s**
1 : Agriculture, forestry & fishing (A)	£381	14,000	£27.2
2 : Mining, quarrying & utilities (B,D and E)	£499	3,500	£142.6
3 : Manufacturing (C)	£2,668	39,000	£68.4
4 : Construction (F)	£748	16,000	£46.8
5 : Motor trades (Part G)	£216	6,000	£35.9
6 : Wholesale (Part G)	£288	8,000	£35.9
7 : Retail (Part G)	£827	23,000	£35.9
8 : Transport & storage (inc postal) (H)	£403	10,000	£40.3
9 : Accommodation & food services (I)	£576	29,000	£19.9
10 : Information & communication (J)	£147	3,000	£49.0
11 : Financial & insurance (K)	£239	2,500	£95.6
12 : Property (L)	£1,562	5,000	£312.4
13 : Professional, scientific & technical (M)	£491	15,000	£32.7
14 : Business administration & support services (N)	£339	10,000	£33.9
15 : Public administration & defence (O)	£646	9,000	£71.8
16 : Education (P)	£553	15,000	£36.9
17 : Health (Q)	£1,173	31,000	£37.8
18 : Arts, entertainment, recreation & other services (R,S,T and U)	£330	10,000	£33.0
Total, all sectors	**£12,085**	**249,000**	**£48.5**
Accommodation and Food (I) and Property (L) combined	£2,138	34,000	£62.9

Sources: ONS Regional GVA estimates and the open access Business Register and Employment Survey (BRES) data accessed via Nomis. Notes: * this is all employment which in employees plus working owners (it does exclude other forms of self-employment however who are not VAT registered); ** although the employment data is for 2022 the GVA per job is best expressed for 2021 as employment levels have changed little between these years, the GVA is per total job not adjusted for full or part time work for simplicity

Table B2: Resident based shares of Cumbria

Economic activity status	Area				Share of Cumbria			
	Cumbria	Alston LSOA : Eden 001A	Coniston LSOA : South Lakeland 000C	Covering Hawkshead	Alston LSOA : Eden 001A	Coniston LSOA : South Lakeland 000C	Covering Hawkshead LSOA : South Lakeland 007A	Best fit Coniston**
Total: All usual residents aged 16 years and over	420,034	1,762	1,358	1,262	0.42%	0.33%	0.30%	0.44%
Economically active (excluding full-time students)	239,669	1,002	751	705	0.42%	0.32%	0.29%	0.43%
Economically active (excluding full-time students):In employment	231,540	955	749	698	0.41%	0.32%	0.30%	0.44%
Economically active (excluding full-time students): unemployed	8,029	47	12	7	0.59%	0.15%	0.09%	0.13%
Economically active and a full-time student	6,175	5	19	10	0.08%	0.31%	0.16%	0.37%
Economically active and a full-time student: In employment	4,671	5	17	7	0.10%	0.35%	0.14%	0.41%
All economically active	245,744	1,007	730	715	**0.41%**	0.32%	0.29%	**0.43%**
Economically inactive	174,290	755	538	547	0.43%	0.34%	0.31%	0.46%
All aged 16 to 64	290,000	1,217	897	790	**0.41%**	0.30%	0.27%	**0.41%**
Share of best fit Hawkshead Output Areas in "Hawkhead LSOA"*				39%				

Source: 2021 Census accessed via Nomis. Note: *based on shares of all economically active in Output Areas E00097837 and E00097838 (best fit for Hawkhead); **