Scottish & Southern
Electricity Networks

RIIO ED2 Engineering Justification Paper (EJP)

Tree Cutting

Investment Reference No: 324_SSEPD_NLR_TREES

Contents

Table of Figures

Table of Tables

Investment Summary Table

Table 1 below provides a high level summary of the key information relevant to this Engineering Justification Paper (EJP) on Tree Cutting during RIIO-ED2.

Table 1: Investment Summary

Engineering Justification Paper (Non-Load)							
Name of Programme	Tree Cutting						
Primary Investment Driver	Non-Load: Network Reliability						
Investment reference	324_SSEPD_NLR_TREES						
Output Type	Tree Cutting						
Cost (£m)	189.7						
Delivery year	RIIO ED2						
Reporting Table	CV29: Tree Cutting						
Outputs included in RIIO ED1 Business Plan	No						
Spend Apportionment (£m)	**Licence Area**	**ED1**	**ED2**	**ED3+**			
	SEPD	-	**140.3**	-			
	SHEPD	-	**49.4**	-			
RIIO ED2 Spend (£m) – Tree Cutting							
CV29 Tree Cutting RIIO ED2 Spend Profile (£m)	**Licence Area**	**2024**	**2025**	**2026**	**2027**	**2028**	**Total**
	SEPD	28.2	30.9	26.9	26.9	27.3	**140.3**
	SHEPD	8.7	10.2	11.7	9.4	9.4	**49.4**

2 Executive Summary

This Engineering Justification Paper (EJP) describes the cost and volumes associated with the Tree Cutting required during RIIO ED2 across both the SEPD and SHEPD licence areas.

The **primary investment drivers** covered within this EJP include the following, but hinge around the safety of the overhead line network for the public and our employees and compliance with mandatory Health & Safety Executive (HSE) legislation:

- Compliance with the Electricity Safety, Quality and Continuity Regulations (ESQCR) via the ENA TS 43-8 tree cutting standard to ensure the safety of our overhead line network;
- Compliance to ETR-132 to improve the resilience of the overhead network under severe weather conditions;
- Minimising the risks assocaited with Ash Dieback, both safety and network reliability, a disease that is killing Ash Trees across the country.

In addition, an important **secondary driver** for investment in tree cutting is network reliability and the need to minimise tree and vegetation related network outages. Continued investment in tree cutting will help avoid increases in both Customer Interruptions (CI) and Customer Minutes lost (CML).

Without continued tree cutting investment during RIIO ED2 we expect an **increase in costly conductor faults,** which will significantly **impact both network reliability, affordability** for customers and most importantly the **safety of our network** for the public and our staff.

Alongside the investment set out in this document we are also undertaking various initiatives to offset the environmental impact of our activities, including that associated with Tree Cutting. These steps are described further in our ***Environmetal Action Plan (EAP) (Annex 13.1)*** and reflected in our Biodiversity and Natural Capital investments, which includes the planting of trees during RIIO ED2.

In total, funding equal to **£189.7m is required (£140.3m SEPD, £49.4m SHEPD)** to manage tree and vegetation growth alongside our overhead line network. This includes the cutting of approximetely 474,000 spans of overhead line across all voltage level over the 5-year period of ED2. It also includes all cost associated with LiDAR surveys of the distribution network and a detailed inspection to identify the location of the diseased Ash across our network.

As above, **a LiDAR survey** of the overhead line network will be undertaken over both SEPD and SHEPD to quickly and accurately determine exactly where trees impact our overhead line network and to allow us to create an efficient tree cutting delivery programme.

This EJP also describes the approach chosen to manage the growing threat posed by **diseased Ash trees**. Ash dieback is expected to kill a large percentage of the United Kingdom's (UK) Ash tree in the coming decade, many of which sit alongside our overhead line network. **A £[redacted] two year survey** is proposed to identify exactly where Ash affects our network and to inform an Uncertainity Mechanism (UM) that has been designed to account for the incremental costs associated with the management of diseased Ash.

Open wire conductor on the LV network represents an important safety risk for our people and network customers. To address this risk we have proposed a programme of **Insuline and ABC deployment** to insulate and protect our existing LV open wire circuits and complement the ongoing tree cutting programme of these circuits. The primary driver for this investment is to ensure our LV overhead line network is compliant with safety driven legislation (ESQCR and ENA TS 43-8) as quickly and cost effectively as possible.

Table 2 below shows the results of the Cost Benefit Analysis (CBA) that has been undertaken to determine the most cost effective intervention option for SEPD's LV open wire spans.

Table 2: Tree Cutting CBA Results – LV ABC and Insuline Deployment

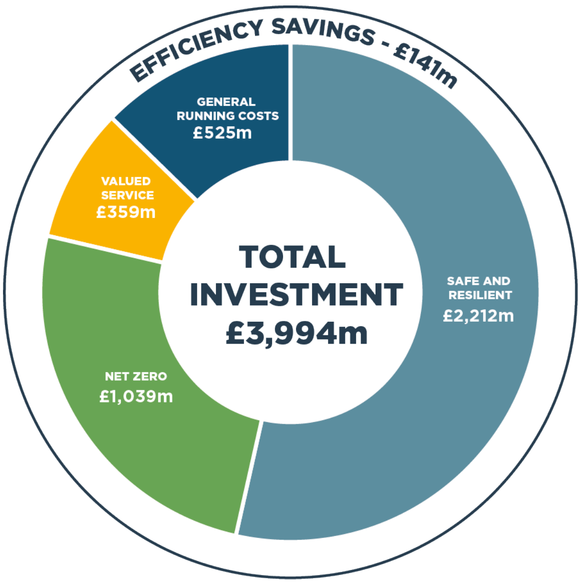
Intervention Option	Description	SEPD NPV (£k)
Tree Cutting on LV Open Wire	Cut the vegetation alongside the existing LV open wire spans to meet ESQCR requirements.	-49,569
LV ABC Programme	Replace existing LV open wire spans with ABC and tree guards to improve safety, reduce tree realted faults and reduce tree cutting cycle.	-44,510
LV ABC and Insuline Programme	**Retrofit 500km of the existing LV open wire spans with Insuline, replace 500km of conductor with ABC and tree guards where Insuline isn't practicable.**	**-34,831**

The ENA TS 43-8 tree cutting volumes described within this EJP are based upon a cycle of tree cutting which considers the growth rate of vegetation across both the SEPD and SHEPD licenced areas and the mandatory safety requirements associated with the Electricity Safety, Quality and Continuity Regulations (ESQCR).

In SHEPD, a tree cutting cycle of 1 in 4 years is adequate to ensure compliance with the mandatory safety legislation set out within ESQCR. This cycle protects both our people and the public from the dangers associated with vegetation growing into our tower and poles lines.

In SEPD, a shorter 1 in 3-year tree cutting cycle is required to maintain the safety and compliance of our overhead line network at the HV level and above. The justification for this shorter cycle is described within this EJP and is informed by an independent report produced by ADAS which highlights the challenges posed by a significantly higher tree growth rate in the SEPD geographical area. The key learning from the ADAS report is provided within Appendix 2.

The total CV29 (Tree Cutting) spend of £189.7m over the five years of RIIO ED2 sits within the Safe and Resilient totex spend as illustrated in the figure below. Please also see our ***Maintain a resilient network (Chapter 7)*** which provides more detail on our overarching strategy in this area of the RIIO ED2 business plan.



3 Introduction

This Engineering Justification Paper (EJP) describes the investment required to manage the tree and vegetation growth expected alongside our overhead line network over the duration of RIIO ED2.

This EJP firstly provides useful background information on tree cutting across both our licence areas including historic volumes and past performance **(section 4).** Following this, the EJP describes how we determine the affection level of vegetation across our network and the reasons why continuous investment is required to manage this vegetation within the limits mandated by Health & Safety Executive (HSE) legislation such as the Electricity Safety Quality Continuity Regulations (ESQCR**) (section 5).**

This includes a description of our inspection techniques and the innovations we plan to deploy during RIIO ED2 to establish a detailed view of the trees that grow alongside our network, followed by the investment options available to us to manage the risk associated with vegetation growth alongside our OHL network as efficiently and safely as possible whilst minimising disruption to our many network customers and stakeholders **(section 6)**

More specifically, the paper also provides further detail on how the safety risks associated with uninsulated open wire conductor at the low voltage (LV) level will be mitigated through a tailored programme of **Insuline and ABC deployment** on our existing LV open wire circuits.

Our **long-term strategy** required to safety and efficiently deal with **Ash Dieback** is also covered within this report (**section 5)**. Ash Dieback is a disease that is aggressively and rapidly killing Ash trees across the United Kingdom. Many of these trees sit within falling distance of the overhead line network. As the disease progresses, the risk that these trees fall into our overhead line network increases. This report describes the detailed survey that is planned to identify exactly where Ash grows across our distribution network and the level of disease of these trees.

The results of this survey will help us to create an efficient tree cutting programme and inform the **Uncertainty Mechanism (UM)** (***Annex 17.1)*** that will be used to account for the additional costs incurred when addressing diseased Ash during our normal tree cutting programmes.

In addition, the document describes how we plan to continue to support the Forestry industry when felling of their crops is required alongside our overhead line network **(section 5 and 6).** We plan to work closely with the Forestry Commission and other forestry organisations to ensure their crops are harvested safety and efficiently. The costs associated with this activity and the innovations we plan to deploy to carry out this work are described within this EJP.

A detailed analysis **(section 7)** is provided which summarises the full cost and volumes associated with all the activities described above as set out in the CV29 cost and volumes table in the RIIO ED2 Business Plan Data Tables (BPDTs).

The is complemented with our stakeholder engagement section **(section 8)** which describes how our key stakeholders have informed our tree cutting strategy, followed by a conclusion **(section 9)** which collates the key information from the EJP.

Finally, four appendices are included which provide additional useful information such as a list of the key policies and standards relevant to tree cutting, the learnings from an independent ADAS report on the growth of trees and vegetation within our licence areas, and further information on our LiDAR surveys and how we quality assure the data arising from these.

4 Tree Cutting Background Information

Tree Cutting is a critical activity undertaken to maintain the safety and integrity of the overhead line (OHL) network and remain compliant with statutory requirements such as the Electricity Safety, Quality and Continuity Regulations (ESQCR's). Tree and vegetation growth represent a real risk to the reliability and safety of the electricity distribution network and must be managed effectively within both of our distribution licence areas as shown in Figure 1.

Figure 1: SSEN licence areas - SHEPD (North) and SEPD (South)

Unmanaged tree and vegetation growth can cause serious physical damage to the OHL network. Tree branches can grow into the conductor, fittings, insulators and cause damage which results in faults and outages for network customers. In extreme cases, during storms trees can fall onto the OHL network resulting in significant damage and a serious safety risk to the public and our employees as demonstrated by Figure 2 & 3 below.

Figure 2: Example of tree related damage to an overhead pole line

Figure 3: Storm related damage to a 132kV Tower Line

There is over 58,000km of overhead line network across both SHEPD and SEPD. This represents a huge challenge to ensure the length of the network remains compliant with minimum standards. However, as an activity that is critical to the safety and reliability of the network we are committed to undertaking the work require to manage vegetation and tree growth.

Table 3 shows the length of the overhead line network within both the SHEPD and SEPD licence areas from 2016 to 2020. This demonstrates the scale of the challenge, especially given the high affection rate of trees within falling distance of the OHL network.

Table 3: SSEN Overhead Line Network Length (km)

Licence Area	Voltage Levels	2016 - OHL Length (km)	2017 - OHL Length (km)	2018 - OHL Length (km)	2019- OHL Length (km)	2020- OHL Length (km)
SHEPD	LV	3,855	3,862	3,857	3,842	3,833
	HV	21,497	21,501	21,501	21,489	21,474
	EHV	5,364	5,378	5,378	5,377	5,374
SEPD	LV	9,226	9,213	9,206	9,192	9,183
	HV	12,641	12,611	12,603	12,579	12,632
	EHV	3,401	3,389	3,388	3,382	3,369
	132kV	1,905	1,903	1,903	1,903	1,903
SSEN	LV	13,081	13,075	13,063	13,034	13,026
	HV	34,174	34,149	34,141	34,103	34,077

	EHV	8,766	8,768	8,767	8,760	8,755
	132kV	1,905	1,903	1,903	1,903	1,903

To manage the trees and vegetation that affect our OHL network, we operate a cyclical tree cutting and inspection programme. The trees that are cut inevitably grow back over time and require future intervention to maintain the minimum clearance distances. As such, the OHL network is regularly inspected via LiDAR to maintain visibility of the OHL spans which are affected by tree growth.

In SHEPD a 4-year tree cutting cycle is required to account for the annual growth rate seen in the North of Scotland, whilst a 3-year tree cutting cycle is required in the SEPD licence. This is to account for the fast growth rate seen in the south of England. This increase growth rate is evidenced in the independent ADAS report that has been commissioned for RIIO ED2 (see Appendix 2), which states as a key finding:

"The SSE (Southern) region experiences the highest average USD at baseline. This will likely also continue to be the case into the next decade according to UKCP18 climate projections."

USD refers to utility space degradation, a measurement that assesses the impact of growth rates on the encroachment of overhead power lines by vegetation.

It should, however, be noted that as the climate changes and average temperatures increase, growth rates are also expected to increase meaning the tree cutting cycle frequency must be regularly reviewed. This is relayed in another key finding in the ADAS report:

"Overall the burden of managing the potential risk to the OHL network from trees in the SSE (Southern) region can be expected to become more complex, time consuming and costly as climate change continues to cause the region to experience warmer and drier conditions. The relatively high number of trees across the region, particularly of those species which are already being affected by known pests and pathogens, represents a larger responsibility for the DNO in terms of monitoring and cutting of trees when compared with the other DNOs in the UK."

There are approximately 30,708 km and 27,127 km of OHL within the SHEPD and SEPD networks respectively. Each region has its own unique local environments, challenges and inspection and maintenance requirements and thus management of such a large asset base spread across a large geographical area is extremely challenging. This is reflected in the RIIO ED2 unit cost which is an average of the costs incurred across these diverse environments.

Table 4 shows the volume of spans that have been inspected and cut within the first 5 years of RIIO-ED1. This is further highlighted in Figure 1 (SHEPD) and 2 (SEPD) below, to show the span inspections and cuts per voltage level for the years 2016 through to 2020.

Table 4: SSEN Overhead Line Network inspections and cuts

Area	Volumes	Unit	2016	2017	2018	2019	2020
SHEPD	LV Spans Cut	spans	7,732	8,930	9,921	11,178	9,140
	LV Spans Inspected	spans	23,222	20,356	18,830	20,581	16,973
	HV Spans Cut	spans	14,704	14,913	15,469	16,517	14,696
	HV Spans Inspected	spans	49,017	55,084	55,233	51,994	44,849
	EHV Spans Cut	spans	2,431	3,763	3,748	2,643	4,094
	EHV Spans Inspected	spans	5,624	11,432	5,876	7,339	10,620
SEPD	LV Spans Cut	spans	1,672	369	2,711	5,681	7,979
	LV Spans Inspected	spans	-	-	-	1,814	1,995
	HV Spans Cut	spans	22,974	24,102	11,215	12,883	27,919
	HV Spans Inspected	spans	32,921	24,055	6,388	13,066	37,165
	EHV Spans Cut	spans	2,164	4,154	2,453	3,143	4,109
	EHV Spans Inspected	spans	3,843	2,795	921	3,084	5,135
	132kV Spans Cut	spans	529	4,411	783	663	719
	132kV Spans Inspected	spans	1,783	2,938	296	651	1,162

Figure 1 – SHEPD Spans inspected and cut over ED1 reporting period (2016-2019) for all voltage levels

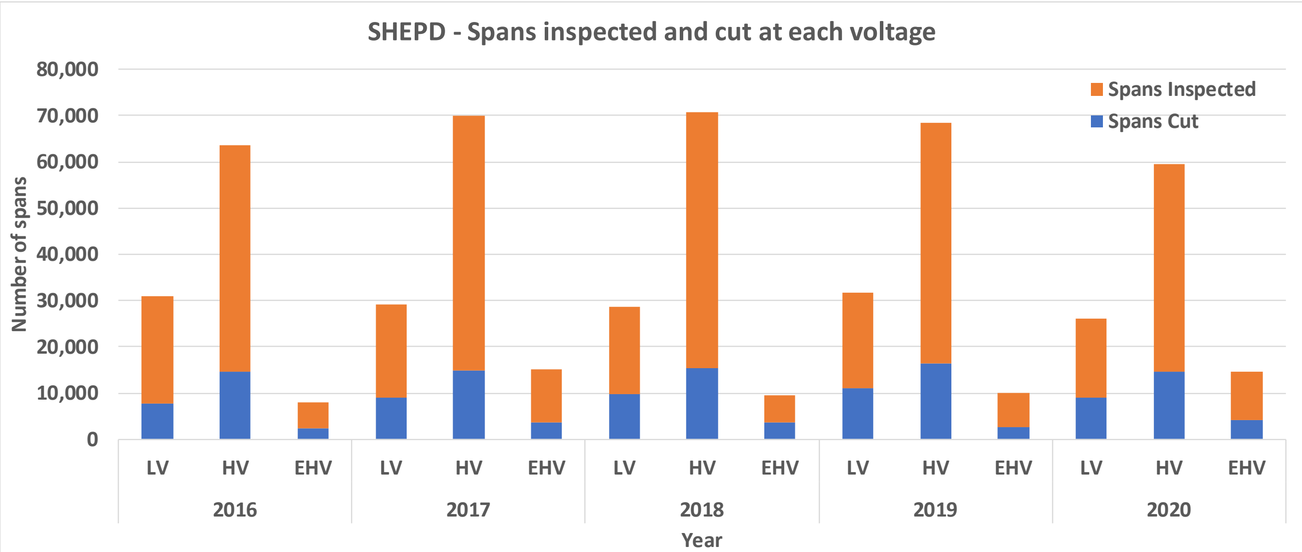
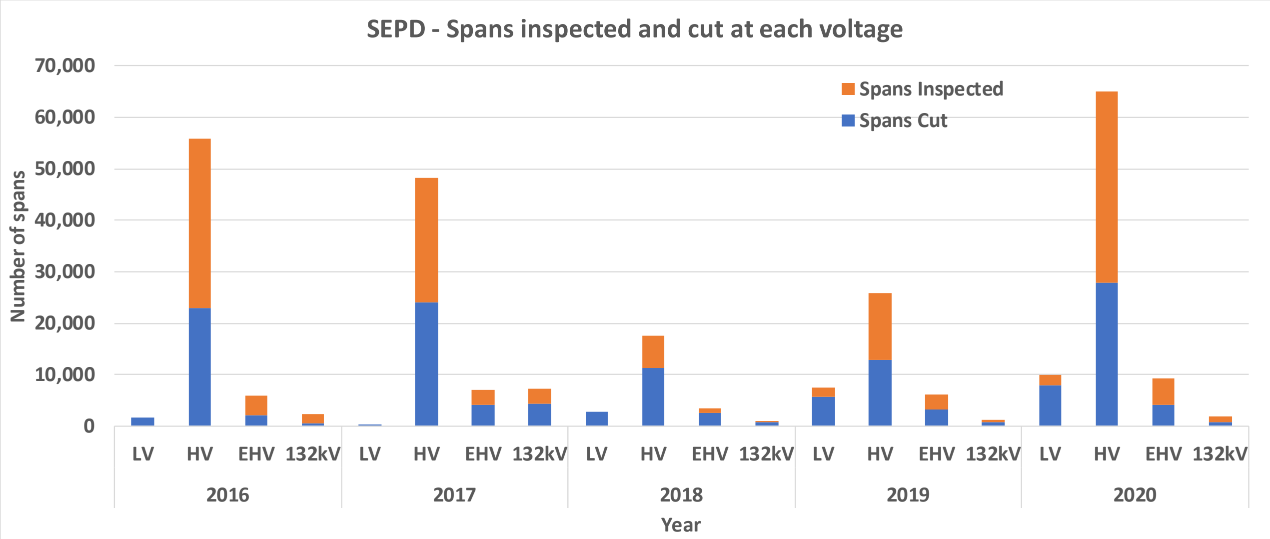


Figure 2 – SEPD Spans inspected and cut over ED1 reporting period (2016-2019) for all voltage levels



Traditionally, we have operated an annual inspection programme to identify the spans which are affected by trees. This inspection programme informs the tree cutting programme by identifying where vegetation growth is affecting our OHL network and which spans are at most risk due to this growth.

In the past, these inspections have been undertaken via manual foot patrol of the network. During these manual inspections the distance of tree canopies to spans is recorded to identify which spans require intervention.

However, during RIIO ED1 we have commissioned LiDAR flights across both licenced areas as a lower cost alternative to conventional manual inspection of the OHL network to ascertain where vegetation growth is affecting the overhead line network. When processed the data arising from the LiDAR flights can be used to quickly identify all OHL spans which are affected by spans and the distance of each tree to the conductor. This data is far more complete and accurate than the data that arises from the manual inspection of the network via foot patrols.

From the LiDAR flights that have been undertaken to date it was found that the number of affected spans in SEPD close to breaching the ENA TS 43-8 standard was much higher than previously thought, particularly across the LV and HV networks. To account for this there has been an increase in the number of spans cut in the most recent years of ED1 to reflect the additional data that has been gathered through the use of LiDAR.

Impact of Tree and Vegetation Growth on Faults

Safety and compliance with HSE legislation is the primary driver for investment in tree cutting. However, a secondary driver for investment in to minimise the impact of vegetation growth on network faults. With current tree cutting volumes, 4.5% (SHEPD) and 7.3% (SEPD) of all faults (ED1 to date) are caused by tree and vegetation growth. This includes falling dead or live trees (not felled) and branches falling onto live conductors.

Improving network resilience, particularly in extreme weather conditions, relies on following the ESQC Regulation 20A and the ETR-132 standard. These standards aim to make a proportion of the network resilient to severe storms each year; the cumulative total currently stands at 1.1% for SEPD and 12.6% for SHEPD. This equates to a total of 4.9% of our overall OHL network compared to a target of 20% of the overall network by 2035.

The graphs below display the historic fault trends, where trees have been listed as the cause, for both SHEPD (Figure 3) and SEPD (Figure 4) regions.

With current annual tree cutting volumes there has been a downward trend in the number of tree related faults between 2016 and 2021 for SHEPD but a slight upward trend in the same period for SEPD region. This indicates that additional tree cutting, and vegetation management methods are required in SEPD to prevent a continued rise in faults during RIIO ED2.

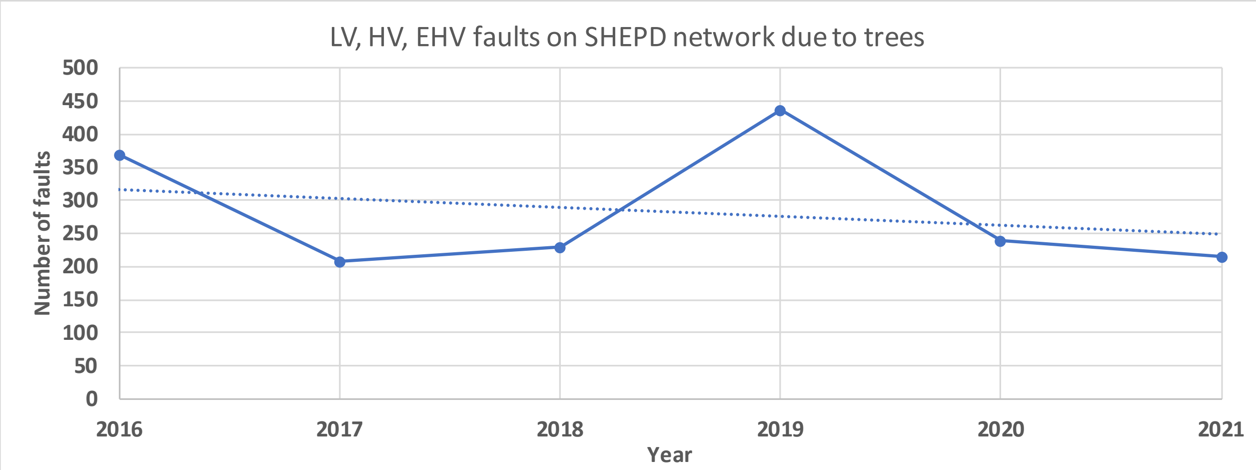


Figure 3 – SHEPD HV and EHV OHL faults due to trees

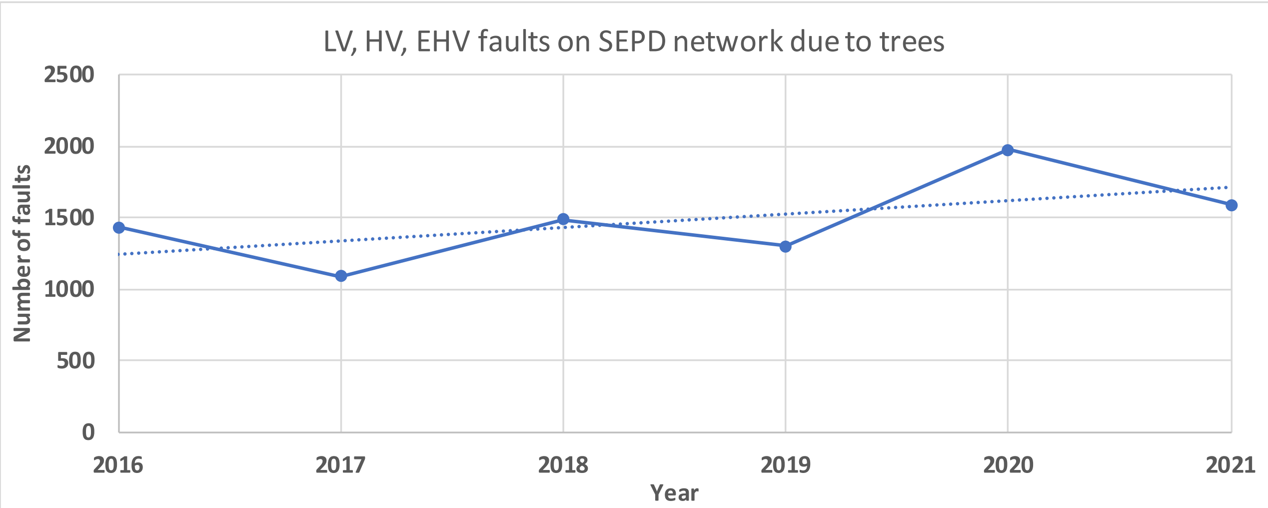


Figure 4 – SEPD HV and EHV OHL faults due to trees

5 Tree Cutting Investment Drivers

This section of the EJP describes the Primary Investment Drivers which underpin the need to continue the inspection of the OHL network and the cutting of vegetation during RIIO ED2.

5.1 Electricity Safety, Quality and Continuity Regulations (ESQCR)

ESQCR is enforced by the HSE and specifies the Health and Safety standards expected by industry. This legally binding legislation includes reporting requirements but also minimum safety standards for the electricity network. Within Tree Cutting, ESQCR ensures that the public and our employees are safe from the impact that vegetation growth can have on the safety of the OHL network. This includes minimum safety clearances and the management of climbable trees next to distribution network assets.

It is critical that our tree cutting programmes deliver compliance with the latest ESQCR legislation. To do this we follow the ENA TS 43-8 standard which specifies the minimum clearances to the OHL network and the way in which this will be managed by GB DNOs. This is reflected in the internal policy document PR-PS-340 which provides guidance on recommended clearance requirements that allow us to continue to meet the relevant compliance standards.

5.2 Compliance with ENA Technical Standard 43-8 (ENA TS 43-8)

ENA TS 43-8 sets out how DNOs should achieve compliance with the ESQCR legislation. The standard defines the minimum allowable clearances between overhead line conductors and vegetation growth and other obstructions. Table 5 below covers the minimum clearances for both bare (B) and effectively insulated (EI) conductor i.e. ABC at each voltage level.

Table 5: ENA TS 43-8 Minimum Clearances by voltage level

Item	Description of clearance	Nominal system voltage (kV) Minimum clearance (m)					
		≤ 33 (NOTE 1)		66	132	275	400
		B	EI				
3	Line conductors to that part of a tree under / adjacent to line and:						
	(i) Unable to support ladder/climber.	0.8	0.5	1.0	1.4	2.4	3.1
	(ii) Capable of supporting ladder/climber.	3.0	0.5	3.2	3.6	4.6	5.3
	(iii) Trees falling towards line with conductors hanging vertically only.	0.8	0.5	1.0	1.4	2.4	3.1
	(Note 5, Note 6 and Figure 2(a))						

NOTE 5: Clearances to effectively insulated conductors may be lower than the value stated but the conductor must be afforded mechanical protection.

Trees capable of supporting a ladder or climber have a more stringent minimum clearance than those not able to support a ladder for bare wire spans. As such it is important that we identify all climbable trees to ensure they meet the minimum requirements set out in ENA TS 43-8. There are associated notes to this table, with Note 5 very pertinent to effectively insulated conductor clearance requirements. This is noted directly below the table and states that the clearances may be lower than the stated value if there is mechanical protection on the conductor such as tree guards and shrouding.

With these clearances being the minimum acceptable, along with our desire to follow best practice, larger clearances may be necessary than those stated above to account for growth rates of vegetation within the tree cutting cycle and swaying of trees in the wind.

5.3 Compliance with ETR-132

ENA TS 43-8 clearances are only sufficient to prevent direct contact or arcing from branches being too close and to prevent public access to any un-insulated part of the network. They do not protect against the possibility of tree related faults from broken limbs or fallen trees as a result of wind or snow or ice loading where the trees and branches are above and adjacent to the network.

The ETR-132 standard provides guidance on how to improve network performance during abnormal weather conditions. The standard recommends a risk-based methodology to identify the network locations which would most benefit from additional investment to improve the resilience to a 1-in-20-year weather event. These interventions can be through additional tree cutting or via network diversions or undergrounding of overhead lines etc. A CBA is undertaken to determine the most cost-effective solution for each shortlisted circuit which is to be made compliant to the standard.

ETR-132 advocates a risk-based approach to determine where and when to carry out vegetation management or other measures for the purpose of improving network resilience, and this is seen in the policy document WI-NET-OHL-005 where the surveyance procedure and risk categorisation calculation is described.

A resilience risk score is allocated against each span using a quantitative scoring system assessing species present, proximity of trees to the overhead network, ground conditions, tree form and tree condition. The scoring system calculates the risk score as follows:

Risk Score = (S x P) + T + F + C
S = Species
P = Proximity
T = Terrain
F = Form
C = Condition

Figure 5 – SSEN risk score calculation

The score will be banded into one of five risk categories described in Table 6 below.

Table 6 – SSEN risk banding

Risk Category	Risk Description	Score
Very High	Imminent Risk to network	36 - 50
High	Probable Risk to network	21 - 35
Medium	Possible Risk to network	11 - 20
Low	Improbable Risk to network	1 - 10
No Risk	No Risk to network	0

The risk assessment will identify areas of the network where it is beneficial to either carry out vegetation management to a set of deterministic criteria or take alternative actions to reduce the risk of network damage during abnormal weather conditions.

This is supported by the commitment we have made to increase the number of overhead line spans that are ETR-132 compliant, that is 0.5% of the total overhead line network length each year. This volume will start from the second year of RIIO ED2 as we prioritise compliance with ENA TS 43-8 in the first year of ED2.

5.4 Ash Dieback

This section of the report describes the disease known as Ash Dieback and how we plan to manage this disease alongside our overhead line network during RIIO ED2.

5.4.1 Background

Ash dieback, a chronic disease of Ash trees that has spread across Europe, is affecting all areas of the UK and is now classed as an epidemic. It is expected that the disease will affect greater than 95% of the ash population and best-case modelling is that between 80 and 95% of the population will be lost.

Characterised by leaf loss and crown dieback in infected trees, this disease affects the trees ability to draw nutrients into its upper branches and grows inside the tree eventually blocking its water transport systems causing it to die, often rotting from the inside-out and eventually collapsing. Caused by a fungus called Hymenoscyphus fraxineus (formerly known as Chalara fraxinea) which arrived from Asia to Europe during the 1990s, it spread rapidly across Europe. Although the first official record in Britain was in 2012, later analysis shows that trees were dying from the fungus as far back as 2004.

In 2019, the University of Oxford estimated that Ash Dieback will cost the UK £15 billion, half of which is expected over the next 10 years. Figure 6 shows two examples of how this deadly fungus can impact Ash trees. The later stages of the disease can cause trees to fail disruptively and fall upon overhead lines.

Figure 6: Example of Ash dieback fungus

This disease has significant implications for our tree cutting programmes in both SHEPD and SEPD during RIIO ED2 as this epidemic transmits across the Ash tree population. So far, there have been trees affected by ash dieback managed under the 43-8 cutting programme, however, since it is not as widespread as predicted in the coming years the impact on cost has been minimal. This will change when the spread of the disease affects multiple trees per span or larger, more resilient trees.

During storms these diseased trees threaten both the safety and reliability of the overhead line network. If additional steps are not taken to manage this growing risk, there will be an unacceptable increase in the number of tree related faults. There will also be an increase in the cost associated with maintaining ENA TS 43-8 compliance as Ash trees become unsafe to operate upon in the later stages of their disease cycle.

Figure 7 below shows how the disease progresses over time. It is unsafe to operate on the trees in the later stages of the disease as the strength and structural integrity of the tree become compromised. Ash is naturally a brittle species when healthy. Decayed Ash poses an extreme risk to operatives. As a result, the trees become unclimbable and may split during felling. MEWP access will not always be available to all network locations, so it is important these trees are dealt with in the early stages of the disease cycle.

On average a tree will move between each Class in just one growing season, although in extreme cases trees have been seen to die within just 2 years. Growing numbers of Class 4 trees are already present throughout the UK. Given the rate at which the disease can progress we expect Ash Dieback to have significant implications on the ENA TS 43-8 tree cutting programme.

Figure 7: Ash Dieback progression over time

Class 1: 100%–76% of the crown remains

Class 2: 75%–51% of the crown remains

Class 3: 50%–26% of the crown remains

Class 4: 25%–0% of the crown remains

It is most efficient to deal with Ash trees where they are found alongside the regular tree cutting programme and it is much safer and prudent to proactively manage Ash trees rather than to reactively respond to the late-stage Ash dieback effect on the overhead line network.

Thus, tree disease management will be incorporated into the ENA TS 43-8 tree cutting programme as the most efficient way to deal with these trees. However, during the first two years of ED2 we will record the incremental cost associated with dealing with diseased Ash trees as part of an Uncertainty Mechanism (UM) and Ash survey that is described in more detail below.

As the appropriate intervention is dependent on the stage of disease, there are various solutions that may be implemented: from felling the tree to cutting the crown or producing a regular compliant cut. Where possible, we will attempt to minimise the number of Ash trees that are felled. However, it is likely that a large proportion of ash trees within falling distance of overhead line will need to be felled due to the nature of the disease, survival rates and the potential catastrophic impact it could have on the safety risks of the network. Solutions will be determined on a case-by-case basis and therefore the cost associated with the work required will be highly situational and vary from span to span, to minimise the adverse effects that diseased trees will have on the overhead line network.

Whilst Ash dieback activities will be delivered under the ENA TS 43-8 tree cutting programme, it will be funded under an Uncertainty Mechanism since surveys have thus far only covered a small proportion of both network regions and are therefore unable to accurately determine the cost increase that will be seen. A dedicated network survey will be used to inform this uncertainty mechanism and identify exactly where Ash affects our distribution network.

The surveys that are currently ongoing to determine the prevalence of ash trees on all network spans have identified, in SEPD, 5,348 spans to date which have ash trees within falling distance of the conductor from a sample of 21,481 spans. This currently gives a prevalence of 25% across all voltages. The results of the survey may be seen below in Table 7. In the SEPD region, this survey accounts for 5% of the overhead network, from a total of 405,965 spans in the region. In the SHEPD region, the survey accounts for 6% of the overhead network from a total of 474,522 spans in the region. In addition, the Ash population in the SHEPD region is a lot more disparate and has a scattered population, meaning the Ash affection rate extrapolated from conducted surveys may not be reflective of the true Ash affection levels seen across SHEPD.

Table 7: Ash trees within falling distance of overhead conductor

Licence Area	Voltage	Surveyed spans (#)	Ash on spans affecting the network (#)	Percentage of ash affecting the network (%)
SHEPD	LV	5,418	287	5.3%
	11 kV	16,349	481	2.9%
	33 kV	8,808	188	2.1%
SEPD	11 kV	21,481	4,844	24.9%
	22 kV		2	
	33 kV		385	
	132 kV		117	

5.4.2 Ash Dieback Uncertainty Mechanism (UM)

One of the biggest risks to the safety and integrity of our overhead line network is the onset of Ash Dieback, a disease which threatens up to 95% of the UK's population of Ash trees. This rapidly spreading disease attacks the structural integrity of Ash trees making the trees unsafe for our people to work on with traditional tree cutting methods. The progression of disease from initial infection to the death of the tree can be rapid ranging from 3-5 years and may impact a large percentage of the nation's Ash trees within the RIIO ED2 period.

Due to the reduced and unpredictable residual strength of a diseased Ash tree the recommended removal of Ash Trees often requires mechanical harvesting equipment with the operator in a protective cab rather than traditional chainsaw methods. However, the cost of mechanical removal can be as much as 5 times that of conventional manual methods and requires more stringent safety precautions and measures due to the unpredictable nature of the disease

However, currently the exact location of all the Ash trees alongside our overhead line network is unknown. Furthermore, the development of the Ash dieback disease amongst the population of trees is also unknown without a targeted inspection to gather this data. As a result, it is challenging to determine the scale of the investment required to manage the diseased Ash trees alongside our overhead line network during RIIO ED2.

The uncertainty in the volume of Ash that will require intervention and the stage of disease at which this intervention will take place leads to a significant error margin when predicting the funds that will be required, particularly when intervention on trees which are further into the disease cycle can costs significantly more than the cost to cut healthy and strong trees.

For this reason, we believe that an Uncertainty Mechanism (UM) is the best option to minimise the impact to the billpayer during RIIO ED2. An Uncertainty Mechanism will allow us to gather additional data to better understand the problem and the funding required to manage it effectively. The potential forecasted costs of around £100m may be vastly overvalued in the best-case scenario or vastly undervalued if the volume of Ash dieback is lower than expected

As the data is uncertain and the cost of removing Ash trees with Ash Dieback is also uncertain from £[redacted] per span to potentially over £[redacted] per span then we propose an Uncertainty Mechanism to request additional funding during RIIO ED2 once a full network survey has been undertaken and the challenge is better understood.

As a result, during the first two years of ED2 we intend to undertake a full survey of our overhead line network to record where Ash affects our network and to inform the investment required to manage this over the remainder of the price control period and beyond. We will also record the incremental costs incurred during the first two years of ED2 when managing diseased ash trees and use this data as part of a re-opener for additional funding.

5.4.3 Ash Dieback Network Survey

Within the CV29 baseline for RIIO ED2, we have included the costs associated with a full survey of our overhead line network. The purpose of this survey is to better understand the likely costs and timescales associated with the management of diseased Ash trees alongside our overhead line network.

Please note, the costs associated with this network survey have been captured within the ENA TS 43-8 "Spans Inspected" section of the CV29 tables within our RIIO ED2 BPDTs.

As previously described, the later stages of this disease impact the structural integrity of the Ash tree and makes it unsafe for the trees to be operated upon safely by operatives using normal trimming and felling practices. Ultimately, the longer a diseased tree is left before intervention, the more safety risk it poses to both our work force and members of the public and reduces the integrity of the network.

To account for this additional safety risk, additional safety measures are required which significantly increases the cost associated with the management of any Stage 3 or 4 diseased Ash trees.

To allow us to manage Ash Dieback both safely and cost efficiently it is therefore critical that we develop a detailed understanding of where Ash encroaches upon our overhead line network and the stage of the disease of each tree.

This information will allow us to more accurately determine the ED2 cost of intervention and the most efficient intervention strategy depending on exactly where Ash affects our network and to what extent the disease has progressed.

To illustrate the importance of the proposed survey, Table 8 below show the potential variance in the cost to manage Ash dieback depending upon the stage of disease when the affected trees are intervened upon. In this example, it is assumed that 25% of SEPDs 311,204 spans are affected by Ash (77,801 spans). This is indicative of the limited data we currently have of the affection level across our network.

In Table 8, three scenarios are presented which show the cost if the level of the disease affecting these spans were to differ, or if the impact if Ash is dealt with later in the disease cycle due to lack of visibility. Scenario 1 assumes that 89% of the Ash is Stage 1 or 2, whilst Scenario 3 assumes 67% of the Ash is dealt with at Stage 3 or 4.

Stage 1 and 2 Ash trees would be dealt with in the same way without additional risk related precautions being required. However, Stage 3 and 4 becomes significantly more complex and expensive due to the additional risk mitigations that are required to intervene upon these trees safely. Stage 3 Ash trees will require mechanical access arrangements to safely remove the tree.

Table 8: Example SEPD Variance in Ash Dieback Costs

[redacted]

Between Scenario 1 and 3, we see a cost difference of approx. £129m for SEPD alone. This demonstrates the potential cost risk to SSEN and our network customers associated with the uncertainty surrounding Ash dieback.

As such, it is critical that the Ash Dieback challenge is dealt with as efficiently as possible to minimise this unknown risk as effectively as possible. Key to this is understanding in detail exactly where Ash affects our overhead line network and the stage of disease of all this ash. This will allow us to design an intervention programme that minimising the cost to network customers by as much as possible.

To do this a detailed network survey is proposed to gather this data during the first two years of ED2. The scope and costs associated with this network survey is further described below.

Ash Survey Methodology

During the first two-years of ED2, we will inspect all of the spans identified as being impacted by vegetation from our LiDAR survey to understand the Ash volume, impact and current condition. This will act as a baseline and will be continually updated during the planned cuts of trees along our overhead line network to track the rate at which the disease progresses

The data available from LiDAR will be used to directly inform the number of spans which are affected by trees within falling distance of the overhead line network. Our current LiDAR data indicates that there are 311,204 spans in SEPD and 118,518 spans in SHEPD which fall into this category and require inspection.

The total cost of this two-year survey has been calculated as £[redacted] for SEPD and £[redacted] for SHEPD.

Given the risks imposed by Ash dieback and the potential rapid rate the disease can progress at, we think it is critical that all of these spans are inspected as soon as possible. During these inspections the following data will be recorded and combined with our current data sets:

- The coordinates of all Ash trees
- The span that each Ash tree corresponds to
- The current stage of the disease (Not Present, Stage 1, Stage 2, Stage 3, Stage 4)
- The maturity of the tree – used to indicate the potential rate at which the disease may progress.

This data will then be analysed with the existing LiDAR data set to understand the impact of the Ash tress adjacent to our network and provide a RAG status to highlight the risk it poses to the overhead line network based upon its height, distance to the overhead line and stage of disease.

This additional visual inspection data combined with our existing LiDAR data will allow us to fully understand the costs (Subject to disease rates and regional impacts) associated with the management of Ash dieback and apply this to any reopener during RIIO ED2 through the proposed Uncertainty Mechanism.

Once the Ash has been identified, this data can be added to future LiDAR flights assisting in the ongoing monitoring of any changes in these Ash tree as the disease progresses. This would be visible from the size of tree canopy and the 3D image it produces of each tree. Our existing ENA TS 43-8 tree cutting programme will also be used to continually update the baseline as we visit the spans affected by Ash.

5.5 Third Party Harvesting - Commercial Forestry

Northern Scotland is the most densely commercial afforested regions in the UK. Analysis of the national forest inventory indicated SHEPD have approximately 4,946km of 11kV and 1,791km of 33kV within falling distance. These tree crops are harvested regularly, often in close proximity to the electricity network.

Requires label Figure 9

HSE guidance as describes within FISA 804 states that commercial growers should not harvest crops that are within falling distance of OHLs with the network live. Trees within the “red zone” (within falling distance of the network) will either be harvested by the 3rd party with the line de-energised or by competent individuals authorised by the network operator.

Harvesting requests from commercial tree growers are assessed by a team of forestry specialists who process the applications to:

- Arrange mobile generation at our cost during network outages to allow third party tree harvesting.
- Carry out manual felling at our cost by SSEN authorised tree cutting staff where live cutting can be justified and “red zone” tree volume is low;

- Carry out live line harvesting at our cost where live cutting can be justified, and tree volumes exceed capability of manual felling teams.

We consider ourselves to be industry leaders having led the development of the ENA Engineering recommendation G96 – use of mechanical harvesters in vegetation management and made significant investment in the purchase of a specialist Tigercat harvester with fixed head.

There can be tree related faults due to commercial forestry – many commercial crops are unstable owing to species grown and site conditions and topography. Sitka spruce is the main commercially grown crop in the UK and is a non-native species. It is surface rooting and when grown in waterlogged or shallow upland soils will blow over particularly when in exposed locations resulting in faults and OHL damage.

This cost associated with commercial forestry related shutdowns, standby diesel generation and harvesting, including the investment in a live-line harvester, impacts the total cost of managing and securing the overhead line network. However, the costs associated with commercial forestry are difficult to predict as they are impacted by external factors such as international timber prices which can lead to unexpected harvesting of crops and additional outages etc.

Table 9 shows the additional costs that have been incurred by SHEPD from 2017/18 to 2020/21 due to commercial forestry. However, the 2020/21 costs were significantly impacted by the COVID-19 pandemic. If the costs incurred from 2017/18 to 2019/20 were averaged over the 5 years of ED2, SHEPD could expect to see additional costs of £5.8m during ED2 over and above the standard ENA TS 43-8 tree cutting programme.

Table 9: SHEPD Commercial Forestry Cost (2017-2020)

Work Type	2017/18	2018/19	2019/20	2020/21
Live line harvesting	£469,450	£477,521	£487,093	£245,704
Outages	£826,175	£695,614	£524,592	£377,812
Total	**£1,295,625**	**£1,173,135**	**£1,011,685**	**£623,516**

However, we have recently held stakeholder engagement forums with commercial forestry and renewable generator bodies. This engagement has captured concerns when commercial forestry related outages preventing renewable generators from generating. This has highlighted the need to proactively manage and align forestry activities to minimise impact on all network customers and consumers including renewable generators on non-firm connection agreements.

Stakeholder engagement has also found that [redacted] are losing a [redacted] subsidy of £250 million per annum and are being required to operate fully from their own income streams. As a result, [redacted] have given us notice that they are developing finance systems to better manage compensation events to account for this loss of funding.

Under the current master wayleave agreement, we are subject to significant liabilities that are likely to increase should [redacted] increase the number of claims they submit each year. This could cover claims associated with the following:

- Delays in arranging network outages that result in a reduction in the sale price of the harvested crops. The master wayleave agreement gives an 8-week notification period to arrange the required outages.
- Charges for the non-productive time of machinery if there are delays on the day the outage is planned.

- A £[redacted] claim for each “goal post” that is erected during harvesting to signpost the overhead line (safety signage). This covers all activities on the [redacted] estate including civils work, establishment and maintenance activities.

Currently, these costs (in addition to the live line harvesting and/or outage costs) are recorded against the ENA TS 43-8 budget. Given that these number of claims are likely to increase we expect an increase in the total ENA TS 43-8 spend which will be seen as a higher unit cost.

6 Tree Cutting Strategy and Intervention Options

This section of the report describes the tree cutting strategy that has been designed for RIIO ED2 and the intervention options that have been considered to deliver ENA TS 43-8 and ETR-132 compliance, whilst also managing ash dieback and commercial forestry requests.

6.1 Tree Cutting Strategy

The aim of our tree cutting strategy is to ensure that the overhead line networks remain compliant with statutory requirements whilst embracing industry best practice when undertaking vegetation management. The main statutory requirement is the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 (as amended).

Tree Cutting throughout our licence areas is required to ensure quality of service, network resiliency and most importantly to ensure the safety of the public and our employees, therefore we aim to:

- Have no vegetation related faults on our 132 kV.
- Have 20% of our 11kV and 33kV circuits resilient as to ETR-132 by 2031.
- Make our critical Primary and Grid Substations resilient to vegetation.
- Undertake the works efficiently to minimise cost and maximise benefit in terms of safety and quality of supply.
- Ensure that we develop and maintain excellent communications with key stakeholders.
- Endeavour to maintain a cyclical tree cutting cycle (4 years in SHEPD and 3 years in SEPD) to maintain the compliance and safety of our overhead line network between cuts.
- Meet specified clearances set out in ST-NET-ENG-009 that conform to compliance standards.

As the resilience of circuits is a key consideration, the main method of achieving this will be conducting an ETR-132 compliant cut. However, other opportunities for enhancing resilience that could be applied alongside resilient tree cutting could include the following: more robust construction standards of wood pole overhead lines; more robust construction standards for tower lines; enhanced network protection or automation; or network diversion and undergrounding. Commercial forestry has a large impact on the resiliency of the SHEPD network and so to ensure that the impact is minimised, amending the current contracts and land rights could directly reduce tree related faults from commercial forestry affected spans.

We will utilise LiDAR throughout both licence areas, using this data to manage and review overall vegetation growth and growth rates, as well as vertical and horizontal clearances. This is carried out once every 4 years across both licenced areas.

The data collected will enable us to develop robust and targeted tree cutting programmes of work. Using fault related information and LiDAR data, we will undertake ETR-132 compliance works on circuits that are performing poorly due to growing or falling trees and tree debris in storm events. Through cost benefit analysis, the specific requirements under ETR-132 will be determined.

LiDAR will be used to inspect the entire overhead line network in a more efficient and effective manner and the outputs will be used to prioritise network spans to be cut and to avoid the unnecessary inspection of spans that are not affected by trees. The outputs of LiDAR could also be used as a foundation of more accurate and detailed vegetation growth prediction and modelling in a changing climate. The use of LiDAR will produce savings of £2.18 million in SHEPD and £12.98 million in SEPD due to the avoided manual inspection of the overhead line network to determine affected spans. Please note this includes the cost of the LiDAR surveys.

6.2 Summary of Intervention Options

The intervention options captured below describe the activities that we undertake to manage the risks to the distribution network associated with vegetation growth and to meet compliance with the relevant industry standards and legislation.

6.2.1 Inspection of Affected Spans (LiDAR)

Historically, manual foot patrols of the overhead line network have been used to identify which spans are affected by tree and vegetation growth. To cover the entire overhead line network these manual inspections are very time consuming and costly. For this reason, moving forward we will undertake Light Detection and Ranging (LiDAR) surveys of the overhead line network as an alternative to manual inspections.

Once every 4 years we carry out aerial surveys of the overhead line network using LiDAR technology. This technology allows us to efficiently identify the number of spans at each voltage level that are affected by trees without the need to carry out separate and costly foot patrols of the network.

The LiDAR technology and data processing has advanced significantly allowing us to build up a detailed view of the entire overhead line network, including the distance of each individual tree to the overhead line network. The data can be used to identify high risk spans that are not compliant with standards and to prioritise the tree cutting programme to address overhead spans that are most at risk of vegetation related faults.

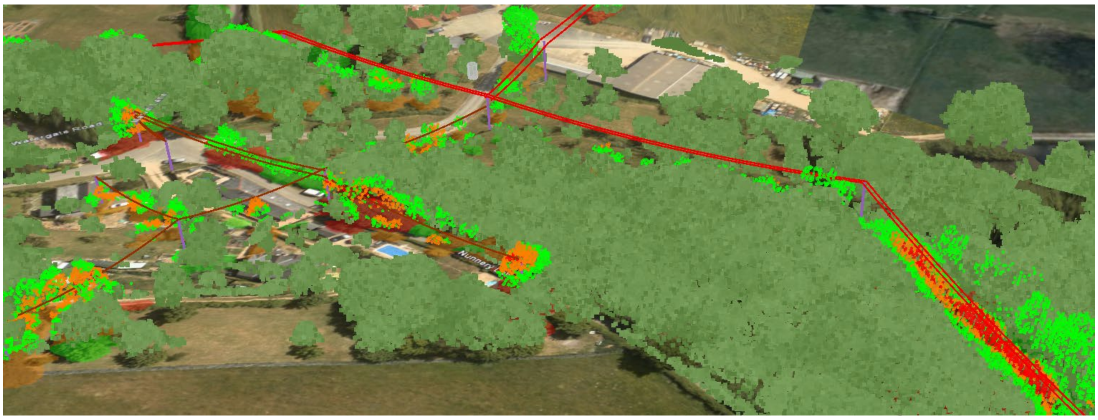
LiDAR locates our OHL network, maps out the environment around the OHL and records the vertical and horizontal clearances around our OHL network. LiDAR can inform both our OHL clearance (CV18 – OHL Clearances) and Tree Cutting (CV29 – Tree Cutting) strategies. For the purposes of this EJP, we are only considering the tree affection data that is identified using the LiDAR data.

There are some key benefits that LiDAR can provide over physical inspections, these are:

- The precision of the measurement is significantly improved
- Measurements & records are applied consistently across the entire network
- LiDAR flights can cover our entire network in a single year
- LiDAR can records areas that are difficult to access or navigate on foot
- Measurements and data can be mapped in a detail three-dimensional model environment

Figure 10 shows how the LiDAR data can be represented in a 3D model of the overhead line network. The data provides tree cutting teams which a risk grading for each span which includes the distance between the crown of each tree and the overhead line conductor. The image shows a densely populated LV network. The rest of the vegetation colour coded (RAG) based on clearance distance. The RAG coloured shapes on the floor represent a 'Canopy' i.e. tree crown size including its RAG status.

Figure 10: 3D LIDAR model of OHL network



Furthermore, the LiDAR survey data has also allowed us to make significant changes to the overhead line inspection cycle and maximise the efficiency of overhead line inspections by moving to an eight-year frequency from the previous four-year cycle. For these reasons, during RIIO ED2 LiDAR will be an integral part of our overhead line strategy and will replace the need to manual foot inspections going forward.

To drive cost efficiencies, we have staggered our LiDAR flights over SEPD and SHEPD by a single year. To have multiple aircraft and associated scanners to achieve a single year turnaround for both licence areas is not cost effective or practical. In addition, moving from one DNO area to the other in the same year would have also presented cost risks as it would force flights into the winter; therefore, exposing us to a higher risk of costly downtime due to poor weather and visibility.

Based on the above, we have prioritised safety and compliance across our licence areas by targeting SEPD first as the OHL network is in proximity to a higher population density than SHEPD. Therefore, there is higher probability of the public, industry and contractors potentially interacting with our OHL assets. However, when we complete our second cycle of LiDAR inspections in SHEPD, due to complete in March 2022, the initial staggered approach will be negated as we repeat each survey over a 4-yearly cycle.

6.2.2 Cutting of Affected Spans

As described above, during RIIO ED2 the LiDAR surveys will underpin the tree cutting programmes in both SHEPD and SEPD. The LiDAR surveys will determine which spans are affected by trees.

In SHEPD, each overhead span which is affected by trees will be visited once every 4-years to maintain the initial cut within compliance (restricted cuts will be visited more often).

Due to the faster growth rate a 3-year cut cycle is proposed in SEPD. The evidence which underpins the need for a shorter tree cutting cycle in the south is provided in Appendix 2. An independent analysis has been undertaken by ADAS to prove the increasing growth rates and the need to increase the tree cutting cycle to account for this.

The key findings from the independent ADAS report includes the following:

> ***"Having the highest proportion of broadleaved woodland coverage, along with the second highest proportion of ash coverage of all the DNOs means that the challenges of vegetation management for system resilience will also be greater in the SSE (Southern) region in comparison with the other DNOs."***
>
> ***"Rates of growth measured by USD varied greatly across the country and therefore across DNO regions. At baseline (1981-2010) the region with the greatest average USD was SSE (Southern) with an average growth rate of 1.33 m. The DNO region with the lowest average USD at baseline was the SSE region (Northern) with an average USD of 0.47 m. The mean USD across all DNO regions at baseline was 0.93 m."***

From the LiDAR data, spans which are clear of trees do not need to be visited in person by inspectors as was required in the past. However, those spans which are affected will require an in-person inspection ahead of the cut to plan the work that is required. During these visits we also record any prevalence of Ash and the Ash Dieback disease. This type of inspection is captured within the "spans cut" unit cost in the CV29.

Regional and contractor tree cutting teams will visit the spans affected by trees and assess the work that is required to ensure a compliant cut is made. During these visit discussions are held with the landowners to negotiate land access and to agree the cuts that will be made to the trees which are near the affected overhead line network.

Where possible we undertake a fully compliant ENA TS 43-8 cut which allows the spans to remain compliant for the duration of the tree cutting cycle. However, this is reliant on permission from the landowner which may only permit a shorter restricted cut. These restricted cuts are still considered compliant but must be maintained on a more frequent basis. We will endeavour to carry out full ENA TS 43-8 cuts as often as possible to reduce the number of restricted cuts that are carried out over RIIO ED2. Figure 11 shows a completed cut. As agreed in this example, the logs have been left in place for the landowner to reuse as fuel for a log burner.

Figure 11: Completed ENA TS 43-8 compliance cut

6.2.3 Management of Restricted Cuts

Landowners may refuse to allow the desired amount of vegetation to be removed. This is referred to as a restricted (or limited) cut. In both ENA TS 43-8 and ETR-132 standards, an allowance must be made for conductor swing when measuring the minimum clearances of the conductor. Whilst this restricted cut is still compliant, the span will need to be visited more frequently to maintain its compliance. All restricted cuts require a more frequent cutting cycle to account for the reduced cut and the reduce time before the span becomes non-compliant with ESQCR.

Circuits cannot be designated as resilient unless there is a very low likelihood of vegetation related faults, or suitable interventions have been deployed mitigating the effects of the restricted cuts. This is accounted for within the risk assessment for the 11kV and 33kV overhead line network.

Without landowner co-operation, the only mechanism to remove vegetation is the Statutory Powers that have been incorporated under the Electricity Act. In situations where access to land of permission to cut is not given, mitigating measures are considered prior to taking legal action, although legal action should not be discounted.

Mitigating measures may include diverting, undergrounding, shrouding or reinforcing the overhead line; and installing automation at either end of the circuit to designate either end of the circuit resilient, with the middle section designated non-resilient.

These measures all have a higher capital cost than revisiting the affected span more regularly, however, may save substantial costs in the medium and long-term. This must be assessed on a case-by-case basis to find the most cost-effective solution for such a span.

Currently, it is estimated that the percentage of tree cutting that are restricted cuts for SHEPD is: 17.5 % for LV; 5 % for HV; and 2% for EHV. For SEPD, this is: 17.5 % for LV; 1.3 % for HV; and 0.24 % for EHV.

6.2.4 ABC and Insuline Programme

The most recent LiDAR data available has highlighted the vast number of LV spans that are affected by tree growth. Maintaining ESQCR compliance on these spans would require a huge increase in the number of spans cut each year. There are approximately 162,400 LV spans which are affected by tree growth in SEPD alone. Given the rate of vegetation growth seen in the south of England, this would require approximately 54,000 spans to be cut each year to meet ESQCR compliance at huge expense to electricity network customers.

To minimise the cost to customers, we intend to carry out a programme of works across 1,000km of LV open wire circuits to reduce the requirement for 3-yearly tree cutting to meet ESQCR safety compliance. Currently, these bare wire spans are a risk to both network reliability and represent a serious safety concern to the public and employees if the vegetation growth cannot be maintained. The mechanical protection afforded by tree guards and the insulation is especially important in meeting the standards set out in Section 18 of the ESQCR (2002).

Aerial Bundled Conductor (ABC) is an insulated conductor which bundles the three phases and the neutral conductor together. As each phase is insulated, the risk of tree related phase-to-phase faults is minimised. Shrouding provides further protection and prevents trees from growing into the ABC conductor over time and causing unwanted damage. Figure 12 below shows an example of ABC and shrouding that has previously been installed on SEPD overhead line network.

Figure 12: Example of LV ABC and shrouding (left) and close up of protective shrouding (right)

Similarly, Insuline is another LV conductor shrouding that can help manage tree clearance issues. Insuline is wrapped around each conductor phase as a sleeve, instead of bundling the phases together and being installed at the top of the support pole e.g. ABC. A programme of fitting Insuline on at-risk spans was conducted over DPCR5 and this has proven successful in mitigating similar types of faults seen by LV conductors in comparison to ABC, although since it is much simpler and quicker to install, the unit cost is a lot lower when compared to ABC and tree guard installation.

During DPCR5, SEPD implemented a targeted LV ABC and Insuline programme delivering 852km of LV OHL replacement. This gives us confidence in our ability to deliver the proposed volume and the effectiveness of the solution to protect our LV overhead lines from vegetation growth. However, after this and during RIIO ED1, tree cutting alone was an effective solution to maintain the safety and compliance of the LV overhead network. However, recent LiDAR data has revealed the true number of LV spans affected by trees, significantly higher than previously thought.

As such, the most cost effective and safe solution is to replace our LV open wire circuits with ABC and Insuline whilst targeting the ongoing LV tree cutting at those spans most at risk. As such, during RIIO ED2 we intend to replace approximately 18% of the remaining open wire LV spans with either Insuline or ABC and tree guards where required, a total of 1,000km."

Both ABC and Insuline are effective methods to protect LV overhead line circuits and offer significant protection from vegetation growth, whilst delivering significant financial savings for network customers when compared to a 3-year tree cutting cycle of our 162,400 LV spans affected by trees.

The primary driver for this investment is to ensure the safety and compliance of our LV overhead line network for the public and our employees. However, we also expect this investment to reduce both Customer Interruptions (CI) and Customer Minutes Lost (CML) and create a more resilient and stable network. It will also allow us to reduce the frequency that the trees and vegetation alongside our LV overhead lines are cut to maintain ESQCR compliance. For the LV open wire circuit that is replaced with either ABC & tree guards or the Insuline, we intend to cut the trees once every 14 years rather than once every 3-years as with the higher voltage levels. The cost effectiveness of this investment is proven within the CBA that accompanies this Engineering Justification Paper.

Some conductor types, however, are not capable of supporting Insuline (it is estimated that this is up to 50% of the conductor types at LV) and therefore require ABC & tree guards to mitigate the issues that are present on the at-risk bare wire spans. The CBA results show that Insuline is the most beneficial option to manage tree-affected LV spans and so where this is technically viable it is the preferred option, and where spans are not able to support Insuline- ABC and tree guards will be installed. While this has a higher unit cost it still represents a cost-effective solution to manage LV tree affected spans compared to viable alternatives. The ABC and tree guard encompass the replacement of the conductor and therefore the costs sit in **CV7**, Insuline installation is classed as a maintenance activity since there is no need for replacement of conductor which means the costs will be under **CV31**.

Due to the aforementioned constraints and most recent data and documentation, this programme of works will consist of **500 km** of ABC and tree guard installation with an associated tree cut and **500 km** of Insuline installation. Prior to installation these spans will also be cut to meet ESQCR compliance.

6.2.5 Development of Growth Model

LiDAR represents a significant step forward in how we will manage the overhead line network in the future. These surveys are planned once every 4-years to capture a snapshot of the condition of the overhead line network and the affection level of tree and vegetation. Whilst this snapshot is extremely valuable it does not account for the variety in the growth rate of different tree species. This impacts the ability to accurately prioritise the tree cutting programme based upon the spans which are most at future risk of non-compliance and tree related outages.

During RIIO ED2, we will explore the development of growth models which can take the data provided by the LiDAR surveys and predict future growth rates across the entire overhead line network to better inform the tree cutting programme. This would ensure tree cutting crews are only sent to inspect and intervene on spans that truly require intervention and avoid late visit to spans which tree growth has already caused damage or faults.

A growth model that can identify tree species will also support our management of diseased Ash trees. As previously discussed, diseased ash will be proactively addressed during the normal ENA TS 43-8 tree cutting programme.

If all ash trees can be located via LiDAR this valuable information can be incorporated into the tree cutting programme to ensure the added risks associated with diseased ash is prioritised within the programme appropriately.

6.2.6 Live Line Harvesting

The Live Line Harvester (LLH) is a piece of equipment often used to fell trees in commercial forestry areas. Unlike a traditional Harvester, the LLH has been designed to provide additional strength which allows the operator to hold onto the tree after it has been cut. This allows the operator to relocate the tree after the cut has taken place and lay in down away from the overhead line. Traditional harvesters are unable to hold onto the tree once cut and the tree will fall as it would if cut with hand tools.

This process is much slower than traditional tree harvesting so it is only deployed where greater control of the cut tree is required alongside live overhead lines. A cost benefit analysis is undertaken before deploying the live line harvester. The cost of deploying the equipment is balanced against the diesel generation cost if an outage were to be arranged instead. High temporary generation costs would justify the use of the equipment to fell commercial forestry trees. Figure 13 below shows the Tigercat LLH machine in operation. In the image the tree has been cut and is being carried to where it will be laid down away from the overhead line mitigating the risk of the tree falling into the line.

Figure 13: Live Line Harvester in operation

6.2.7 Mulching Machine

We also have access to a specialised machine that is designed to clear small trees and shrubs underneath spans of overhead line network. Traditional methods to carry out similar work would rely on hand felling which requires excess cost through labour, fuel and vehicle hire. However, this is suitable for certain land topographies and land usage so may not be replicable everywhere.

During DPCR5 and early RIIO ED1, the Bushfighter mulching machine was used. This is a 100hp remotely operated mulcher mounted on a bobcat style skid steer unit. Without the need for a cab it has two distinct advantages. Firstly, it can cope with slopes of 45 degrees due to the low centre of gravity. Secondly it is lighter than similar manned units with a combined machine trailer weight of just under 3,500kg meaning it can be towed behind a Landrover. This is a major advantage over larger machines that require additional transportation that is not readily available in the tree cutting activity.

The transportability of the Bushfighter will make it a readily available tool for tree cutting teams. In terms of safety the operator is removed from the operation. In terms of efficiency the Bushfighter can deal rapidly with coppice re-growth on difficult terrain which is a very frequent type of site. Currently, we own two Bushfighters and two Robocuts.

However, moving forward the Robocut mulching machine will be used to efficiently handle small trees and shrubs underneath spans of overhead line network. This innovation has been tested during RIIO ED1 and will continued to be used throughout RIIO ED2. The Robocut mulching machine is a lightweight vehicle that is able to be towed by fleet vehicles, not requiring specialist vehicles unlike the Bushfighter. It also has a lower fuel consumption in comparison to the Bushfighter, while the maintenance and support are more readily available and therefore, moving forward the Robocut is preferred.

Figure 14below shows the Robocut mulching machine on the left and a completed cut on the right after the shrubs and small trees have been removed.

Figure 4: Robocut mulching machine (left), completed mulching cut (right)

7 Detailed Analysis

This section of the report provides further detail on the investment strategy that we have designed for Tree Cutting for RIIO ED2 across the chosen investment option through consultation with stakeholders.

7.1 Unit Costs

We have undertaken a thorough review of our Tree Cutting unit costs to ensure they represent best value for money for GB electricity network consumers. A unit cost has been developed that reflects the pre-cut inspection, design work, land consents and negotiations and the physical tree cutting activity we intend to proceed with, during RIIO ED2 within both SHEPD and SEPD. Further detail on our unit cost approach, cost efficiency and cost confidence for RIIO-ED2 can be found within our ***Cost Efficiency (Annex 15.1)***.

This includes analysis of the following:

- The number of spans to be cut each year during RIIO ED2.
- The affection level of each span.
- The material cost of additional equipment (i.e. mulching machine, live-line harvester) that may be necessary.
- The internal and contractor labour associated with carrying out compliant tree cuts.

This analysis has produced a RIIO ED2 unit cost for tree cutting for each voltage level, as seen below in Table 10.

Table 10: SSEN ED2 Tree Cutting Unit Costs

Activity	Voltage Level	Units	Unit Cost (£)	
			SEPD	SHEPD
ENA TS 43-8 Cut	LV	Spans	[redacted]	[redacted]
	HV	Spans	[redacted]	[redacted]
	EHV	Spans	[redacted]	[redacted]
	132kV	Spans	[redacted]	-
ETR-132 Initial Cut	HV	Km	[redacted]	[redacted]
	EHV	Km	[redacted]	[redacted]
	132kV	Km	[redacted]	-
ETR-132 Maintenance Cut	HV	Spans	[redacted]	[redacted]
	EHV	Spans	[redacted]	[redacted]
	132kV	Spans	[redacted]	-
Ash Dieback Survey	All voltage levels	Spans	[redacted]	[redacted]

Please note that there is no specific unit rate for LiDAR inspections per span as these surveys are conducted via multiple flights over the entire overhead line network irrespective of voltage. The unit rate used with the BPDTs has been calculated using the total LiDAR cost, informed by previous competitive tenders, and the length of the overhead line network.

7.2 Cost Benefit Analysis

A detailed Cost Benefit Analysis (CBA) exercise has been undertaken to support the investment strategy that is described within this EJP. Within the CBA an analysis has been undertaken on the costs and benefits associated with the replacement of LV bare wire spans with ABC and tree guards or the addition of Insuline, an insulated sleeve over the conductor phases, over the lifetime of the proposed investment.

7.2.1 CBA Methodology

The Ofgem CBA tool has been used to build a thorough CBA which accurately represents the costs and benefits associated with each investment option available for LV bare wire conductor spans**. The CBAs have been used to identify the most cost-effective investment option for the spans which have been identified as requiring intervention due to their conductor type and the insulation present.**

Each investment option has included the following inputs within the calculation of £m NPV associated with each investment option.

- **ABC Replacement Cost:** The Capex associated with each asset replacement with ABC and tree guards.
- **Insuline Installation Cost**: The Opex associated with the installation of Insuline on the existing conductor.
- **Tree Cutting Cost:** The Opex associated with the provision of an ENA TS 43-8 compliant tree cut on the spans that are intervened upon.
- **Network Reliability:** The IIS performance (annual CML/CI) associated with each option.

The **ENA TS 43-8 tree cutting programme (Baseline)** option within the CBA incorporates the costs associated with the cutting of trees to ensure the overhead spans affected by trees do not deteriorate in performance due to the adjacent growing vegetation. This will be scheduled in line with the tree cutting cycle in the SEPD region, which is 3 years. The proposed programme of works is based upon intervening on 1000 km (25,000 LV spans) over RIIO ED2 and therefore this option will compare cutting vegetation on that number of spans. It follows that in the first three years of RIIO ED2, 5,000 spans will be cut annually, however in the fourth year, in addition to the 5,000 spans requiring cut the first years cut will need to be maintained which gives a total of 10,000 spans to be cut. This methodology applies also for the fifth and final year of RIIO ED2 for this comparison. Regular tree cutting activities at LV are difficult to attain consents each tree cutting cycle and there is also difficulty in allocating the tree cutting teams to those spans due to the increasing growth rates in the region. This introduces an upfront CAPEX spend in ED2 and continues this expenditure requirement thereafter in order to manage the span effectively and maintain compliance on these affected spans.

The **replacement with ABC and tree guards or installation of Insuline options (Options 2-4)** also model the cost for tree cutting and maintenance activities, however this is done at a reduced frequency due to the protection the insulation provides and the minimised clearances that are required. The replacement of conductor with ABC or the installation of Insuline comes at a cost but offsets this due to the benefits seen in CIs and CMLs by the increased protection to faults offered by the now effectively insulated conductor. Whilst this introduces an upfront CAPEX spend in ED2, it prevents this expenditure being prevalent every year and reduces the frequency of the required tree cut.

In Option 2, the ABC and tree guard only option, every 12 years the tree guards will be replaced, and the adjacent vegetation will be cut, while the ABC will not need to be replaced over the length of the CBA due to the protection the ABC and tree guards provide.

In Option 3, the Insuline only installation option, every 12 years the Insuline will be replaced, and the adjacent vegetation will be cut.

In Option 4, the Insuline installation and ABC and tree guard option, half the spans (12,500 LV spans) will be installed with Insuline, and the other half will be replaced by ABC and tree guard. This is because of the inability of some conductor types to be able to support Insuline, the number is estimated as half of all LV overhead conductor and therefore this option has 50% of the spans being replaced by ABC and tree guard.

7.2.2 CBA Results

The results of the CBA indicate that the Insuline installation, Option 3, is the preferred option on a purely monetary basis. However, Option 3, the combination of Insuline installation and ABC and tree guard replacement is more aligned with the practicalities and constraints of the existing LV overhead line infrastructure. This is due to the number of conductors capable of supporting Insuline is only around half of all conductor types on the LV network and therefore the other half of bare wire spans would be better suited to ABC and tree guard. This option still delivers clear benefits to network customers and consumers even at a higher unit cost when compared across the options, and thus this investment option has been selected for deployment during RIIO ED2.

Within the CBA a comparison is made between the do-minimum option, ABC and tree guard only replacement, and the combination of both Insuline and ABC option. The Ofgem CBA tool has been used to build this CBA and includes for the following cost and benefit elements. The completed CBAs is included within the Tree Cutting Investment Decision Pack (IDP).

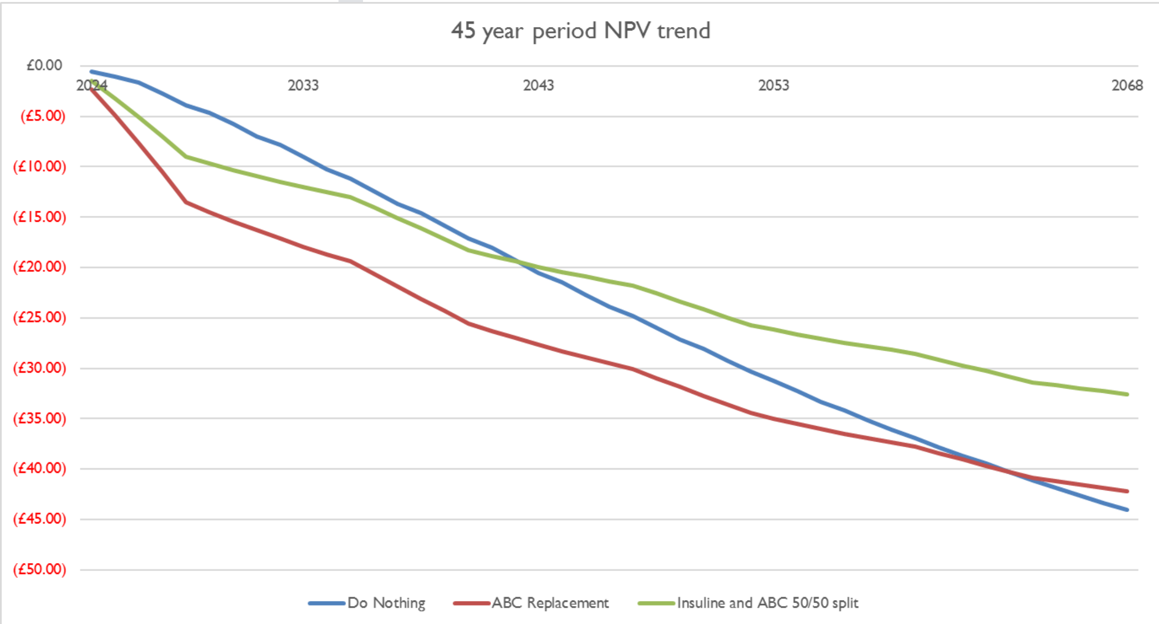
Table 11 shows the results of the CBA analysis that has been undertaken in support of this EJP in terms of the whole life £k NPV.

Table 11: Cost Benefit Analysis (CBA) Results

Option #	CBA Investment Option	CBA Results (£k NPV)
Option 1	Tree Cutting	-49,569 (SEPD)
Option 2	ABC and Tree Guard only replacement	-44,510 (SEPD)
Option 3	**LV ABC and Insuline Programme**	**-34,831 (SEPD)**

This is further illustrated in Figure 10 which shows how the £K NPV progresses over time for SEPD with the relevant CBAs.

Figure 10: LV ABC and Insuline Programme CBA Results – SEPD



7.3 Proposed RIIO ED2 Investment for CV29 Tree Cutting

Table 12 shows the high-level budget requirements for insulating LV overhead conductor and making these circuits more resilient. Furthermore, Table 12 and Table 13 show the detailed breakdown of volumes and costs associated with the Tree Cutting programme for both SHEPD and SEPD.

The latest LiDAR data has been used to inform the affection level in SEPD and hence the number of spans that need to be cut each year given the 3-year cutting cycle in SEPD. The latest data arising from the manual inspections of the overhead line network have been used to determine the number of spans that need to be cut over the 4-year cutting cycle in SHEPD. However, a LiDAR survey is scheduled to be undertaken across SHEPD in 2021 with the data being available for use in 2022.

The ETR-132 volumes included within the table below account for the cost to make an additional 0.5% of the overhead line network compliant each year through RIIO ED2, starting from the second year of RIIO ED2.

Table 12: CV29 Tree Cutting Total ED2 Spend - SHEPD

Category	2024	2025	2026	2027	2028	Total
ENA TS 43-8 Tree Cutting Prog. (£m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ETR-132 Tree Cutting Prog. (£m)	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
LIDAR Surveys (£m)	-	-	[redacted]	-	-	[redacted]
Ash Dieback Network Survey (£m)	[redacted]	[redacted]	-	-	-	[redacted]
Total (£m)	**8.7**	**10.2**	**11.7**	**9.4**	**9.4**	**49.4**

Table 13: CV29 Tree Cutting Total ED2 Spend - SEPD

Category	2024	2025	2026	2027	2028	Total
ENA TS 43-8 Tree Cutting Prog. (£m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ETR-132 Tree Cutting Prog. (£m)	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
LIDAR Surveys (£m)	-	[redacted]	-	-	-	[redacted]
Ash Dieback Network Survey (£m)	[redacted]	[redacted]	-	-	-	[redacted]
Total (£m)	**26.6**	**29.4**	**25.4**	**25.4**	**25.7**	**132.5**

All inspection volumes have been attributed to the LiDAR surveys and there are no plans to fund any manual inspections to determine affection levels of the overhead line network. Any requirement for in-person inspections is incorporated into the “cut” unit cost.

However, there is a need for a manual inspection of the overhead line network to inform the proposed Ash Dieback Uncertainty Mechanism (UM). The volumes and costs associated with this have been captured within the ENA TS 43-8 “Spans Inspected” section of the CV29 tables within our RIIO ED2 BPDTs.

Table 14: CV29 Tree Cutting Volumes for RIIO ED2 - SHEPD

Asset Category	Voltage	Unit	2024	2025	2026	2027	2028	Total
Spans Cut	LV	spans	11,633	11,633	11,633	11,633	11,633	**58,165**
	HV	spans	17,285	17,286	17,286	17,286	17,286	**86,429**
	EHV	spans	3,974	3,974	3,975	3,975	3,975	**19,872**
LiDAR	LV	km	0	0	3,816	0	0	**3,816**
	HV	km	0	0	21,469	0	0	**21,469**

	EHV	km	0	0	5,746	0	0	**5,746**
ETR-132 Initial Cut	HV	km	-	107.4	107.4	107.4	107.4	**429.7**
	EHV	km	-	28.7	28.7	28.7	28.7	**114.8**
ETR-132 Maintenance Cut	HV	spans	-	-	-	-	2,420	**2,420**
	EHV	spans	-	-	-	-	512	**512**
Ash Dieback Survey	LV	spans	21,214	21,214	-	-	-	**41,428**
	HV	spans	31,736	31,735	-	-	-	**63,471**
	EHV	spans	6,310	6,309	-	-	-	**12,619**

Table 15: CV29 Tree Cutting Volumes for RIIO ED2 - SEPD

Asset Category	Voltage	Unit	2024	2025	2026	2027	2028	Total
Spans Cut	LV	spans	21,959	21,959	21,959	21,959	21,960	**109,796**
	HV	spans	31,031	31,031	31,031	31,031	31,031	**155,156**
	EHV	spans	6,352	6,352	6,352	6,352	6,352	**31,760**
	132kV	spans	1,097	1,097	1,097	1,097	1,097	**5,485**
LiDAR	LV	km	-	9,173	-	-	-	**9,173**
	HV	km	-	12,075	-	-	-	**12,075**
	EHV	km	-	3,273	-	-	-	**3,273**
	132kV	km	-	1,951	-	-	-	**1,951**
ETR-132 Initial Cut	HV	km	-	59.1	59.1	59.1	59.1	**236.3**
	EHV	km	-	26.2	25.9	25.5	25.2	**64.7**
	132kV	km	-	16.2	16.2	16.2	16.2	**39.1**
ETR-132 Maintenance Cut	HV	spans	-	-	-	-	520	**520**
	EHV	spans	-	-	-	-	120	**120**
	132kV	spans	-	-	-	-	32	**32**
Ash Dieback Survey	LV	spans	114,691	114,691	-	-	-	**229,382**
	HV	spans	34,539	34,538	-	-	-	**69,077**
	EHV	spans	5,505	5,504	-	-	-	**11,009**
	132kV	spans	868	868	-	-	-	**1,736**

Table 16: CV29 Tree Cutting Costs for RIIO ED2 - SHEPD

Asset Category	Voltage	Unit	2024	2025	2026	2027	2028	Total
Spans Cut	LV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

	EHV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
LiDAR	LV	£m	-	-	[redacted]	-	-	[redacted]
	HV	£m	-	-	[redacted]	-	-	[redacted]
	EHV	£m	-	-	[redacted]	-	-	[redacted]
ETR-132 Initial Cut	HV	£m	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	EHV	£m	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ETR-132 Maintenance Cut	HV	£m	-	-	-	-	[redacted]	[redacted]
	EHV	£m	-	-	-	-	[redacted]	[redacted]
Ash Dieback Survey	LV	£m	[redacted]	[redacted]	-	-	-	[redacted]
	HV	£m	[redacted]	[redacted]	-	-	-	[redacted]
	EHV	£m	[redacted]	[redacted]	-	-	-	[redacted]

Table 17: CV29 Tree Cutting Costs for RIIO ED2 - SEPD

Asset Category	Voltage	Unit	2024	2025	2026	2027	2028	Total
Spans Cut	LV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	HV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	EHV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	132kV	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
LiDAR	LV	£m	-	0.6	-	-	-	[redacted]
	HV	£m	-	0.8	-	-	-	[redacted]
	EHV	£m	-	0.2	-	-	-	[redacted]
	132kV	£m	-	0.1	-	-	-	[redacted]
ETR-132 Initial Cut	HV	£m	-	0.6	[redacted]	[redacted]	[redacted]	[redacted]
	EHV	£m	-	0.3	[redacted]	[redacted]	[redacted]	[redacted]
	132kV	£m	-	0.2	[redacted]	[redacted]	[redacted]	[redacted]
ETR-132 Maintenance Cut	HV	£m	-	-	-	-	[redacted]	[redacted]
	EHV	£m	-	-	-	-	[redacted]	[redacted]
	132kV	£m	-	-	-	-	[redacted]	[redacted]
Ash Dieback Survey	LV	£m	[redacted]	[redacted]	-	-	-	[redacted]
	HV	£m	[redacted]	[redacted]	-	-	-	[redacted]
	EHV	£m	[redacted]	[redacted]	-	-	-	[redacted]
	132kV	£m	[redacted]	[redacted]	-	-	-	[redacted]

7.4 Ash Dieback Network Survey

As previously discussed, we plan to undertake a detailed survey of our overhead line network in the first two years of RIIO ED2 to determine the affection level of ash across our network and the progress of the diseases amongst these trees.

The data arising from this survey will directly inform the Uncertainty Mechanism (UM) that is proposed to account for the additional costs over and above our ENA TS 43-8 budget when dealing with the Ash dieback diseases within falling distance of our overhead lines.

The total cost of this survey has been calculated to be £[redacted]for both licence areas. More specifically, £[redacted]is required to undertake the survey in SEPD and £[redacted]is required for SHEPD. This is based upon the number of spans with trees within falling distance as informed by our latest LiDAR surveys.

Whilst the survey is on-going, we will record all additional cost incurred by the business associated with the management of diseased ash within our spans over and above our normal ENA TS 43-8 activities.

Table 18 and Table 19 below shows how the cost associated with this survey has been calculated for both SEPD and SHEPD.

Table 18: SEPD Ash Dieback Survey Cost and Volumes

Voltage Level	No. of Spans (2024)	No. of Spans (2025)	Cost per Span (£)	Total Cost (£m)
LV	114,691	114,691	[redacted]	[redacted]
HV	34,539	34,538	[redacted]	[redacted]
EHV	5,505	5,504	[redacted]	[redacted]
132kV	868	868	[redacted]	[redacted]
Total	**155,602**	**155,602**	**Total**	[redacted]

Table 19: SHEPD Ash Dieback Survey Cost and Volumes

Voltage Level	No. of Spans (2024)	No. of Spans (2025)	Cost per Span (£)	Total Cost (£m)
LV	21,214	21,214	[redacted]	[redacted]
HV	31,736	31,735	[redacted]	[redacted]
EHV	6,310	6,309	[redacted]	[redacted]
Total	**59,259**	**59,259**	**Total**	[redacted]

7.5 Deliverability of Proposed Volumes

Between our draft and final Business Plans we have carried out a more detailed deliverability assessment of our overall plan as a package and its component investments. Using our draft Business Plan investment and phasing as a baseline we have followed our deliverability assessment methodology. We have assessed any potential delivery constraints to our plan based on:

In-house workforce capacity and skills constraints based on our planned recruitment and training profile and planned sourcing mix as well as the efficiencies we have built into our Business Plan (detailed in our documents: ***Workforce Resilience Strategy (Annex 16.3)*** and ***Costs Efficiency (Annex 15.1)***

- Assessment of the specific lead and delivery timelines for the asset classes in our planned schemes
- We have evaluated our sourcing mix where there were known delivery constraints to assess opportunities to alleviate any constraints through outsourcing

We have engaged our supply chain ***(Supply Chain Strategy (Annex 16.2))*** to explore how the supply chain could support us to efficiently deliver greater volumes of work and how we could implement a range of alternative contracting strategies to deliver this

- We have also engaged with the supply chain on the delivery of work volumes that sit within Uncertainty Mechanisms to ensure we have plans in place to deliver this work if and when the need arises
- We have assessed the synergies between our planned load, non-load and environmental investments to most efficiently plan the scheduling of work and minimise disruption to consumers
- Based on our assessment of delivery constraints and potential solutions to resolve them, we have revised our investment phasing accordingly to ensure our Business Plan is deliverable, meets our consumers' needs and is most cost efficient for our consumers

Table 19 and Table 20 below shows a comparison of spans cut within the first 5 years of RIIO ED1 compared to our proposal for RIIO ED2. Overall, our RIIO ED2 volumes represent a significant increase compared to the volumes that have been delivered in the first five years of RIIO ED1, especially in the SEPD region where a large LV ABC programme is proposed and new LiDAR data combined with the recent (2020) cutting programme highlighted the scale of the tree affection rate and the necessity to maintain large volumes of cut spans, when compared to previous ED1 delivery years.

Table 19: SEPD RIIO ED2 volumes compared against five years of ED1

Compliance standard	Voltage	Type	ED1 (first 5 years)	ED2 Proposed Volumes	Percentage Change
ENA TS 43-8	LV	Spans	18,412	84,292	+358%
	HV	Spans	99,093	155,156	+57%
	EHV	Spans	16,023	31,760	+98%
	132kV	Spans	7,105	5,485	-23%
ETR-132	HV	Km	40	236.3	+491%
	EHV	Km	40.7	64.7	+59%
	132kV	Km	0	39.1	-

Table 20: SHEPD RIIO ED2 volumes compared against five years of ED1

Compliance standard	Voltage	Type	ED1 (first 5 years)	ED2 Proposed Volumes	Percentage Change
ENA TS 43-8	LV	Spans	46,901	58,165	+24%
	HV	Spans	76,299	86,429	+13%
	EHV	Spans	16,679	19,872	+19%
ETR-132	HV	Km	783.2	429.7	-45%
	EHV	Km	187.4	114.8	-39%

7.6 Climate Resilience Strategy

Electricity networks, as all infrastructure, will be affected by the physical impacts, as well as the societal and financial impacts, of climate change. Recent extreme climate events illustrate the extent of this potential exposure, demonstrated in the 2021 Texas Power Crisis that saw widespread power outages, extensive property damages and loss of life.

In the UK, an increase in the frequency of heatwaves is already felt, affecting electricity networks' assets such as substations, transformers and switchgear. At the same time an increase in the use of air conditioning in offices and homes and a national transition to greener energy is leading to higher demand for electricity, adding strain to electricity networks across the country.

We operate in different regions of the UK, from densely urban regions on the southern coast of England to scarcely populated farmland areas in the Scottish Highlands. Our commitment to our 3.8 million customers for reliable energy delivery in the coming decades is challenged by the adverse risks of climate change, such as an increase in flooding, extreme temperatures, drought and wildfires.

We are committed to understand these challenges, find sustainable solutions to tackle them and adapt to a changing climate. As a result, we have produced a Climate Resilience Strategy and this strategy sets out a Climate Adaptation Action Plan.

8 Stakeholder Engagement

In preparation for our RIIO ED2 business plans several stakeholder engagement exercises have been undertaken to better understand what will be important to our network customers during RIIO ED2 and to ensure the views of our stakeholders are reflected in the cost and volumes we are proposing for each asset category in line with our ***Enhanced Engagement (Chapter 3).***

Below is a summary of the key outcomes from this engagement from some of our critical stakeholders. The summary below provides details of our stakeholder feedback and their views on the importance of improving network reliability.

Consumer Feedback

- 88% of stakeholders in SEPD and 72% in SHEPD either agreed or strongly agreed with our asset management proposal to target assets with the highest probability of failure for ED2.
- 71% consumers thought it was very important SSEN are committed to reliability, which was the second highest priority for them (after affordability).
- In terms of reliability, domestic and SME customers' top priorities were 'Restoring the electricity supply as quickly as possible in the event of a power cut' (particularly for those aged 65+ or in vulnerable situations) and 'Keeping my power on with minimal power cuts'.

Local Authority and Government

- Stakeholders strongly urged us to strike a balance between maintain a reliable network by simply fixing older assets now and replacing assets (at a higher cost now) so that the network is ready for future use.
- SSEN needs to ensure reliability and disruptions are minimised, suggesting proactive actions such as providing generators during bad weather and new technologies to 'master' the network.
- Resilience partnerships are a good start for mitigating issues.

Community Energy Groups and Interest Groups

- Both old and new communities need to be resilient - must ensure the transition does not leave people behind.
- SSEN needs to think about current and future populations in areas now in order to plan its investments most effectively.

Summary of Findings

On the topic of safety, customers felt strongly that SSEN should continue to meet all safety-regulated legal requirements and remove redundant equipment from unoccupied sites. Customer expressed that that health and safety outputs are essential and should be delivered to customers as a minimum requirement. With regards to tree cutting this sentiment is reflected in our proposed approach of ensuring the compliance with ESQCR, ENA 43-8 and ETR-132.

In addition, stakeholders also highlighted that network reliability was a high priority, greater than sustainability but below value for money. Stakeholders communicated that reliability is expected as they depend on electricity for so many things in everyday life, and this is increasing, for example, with more households working from home and the electrification of heating and transport. These expectations and views validate Ofgem's IIS targets and Guaranteed Standards, so on this basis we have set our ambition to meet these levels of network performance.

9 Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that we intend to implement during RIIO ED2 for the management of trees and vegetation growth alongside our overhead line network.

The primary investment driver described within this EJP is the safety of the overhead line network for the public and our employees, and compliance with mandatory Health & Safety Executive (HSE) legislation.

As described, unmanaged vegetation growth represents a significant risk to the reliability and most importantly the safety of the network if not managed carefully. Over time, unmanaged tree and vegetation growth can cause serious physical damage to overhead line supports, fittings and stay wires etc. Falling branches on overhead line conductors also cause network faults and outages which negatively impacts network customers.

Historically, manual foot patrols of the overhead line network have been used to identify which spans are affected by tree and vegetation growth. To cover the entire overhead line network these manual inspections are very time consuming and costly. From RIIO ED2 onwards, **LiDAR** flights will be used to more efficiently and accurately capture the affection level across our overhead line network and to provide a 3D image of the entire network. LiDAR surveys will be undertaken once every 4-years within both SHEPD and SEPD. The data arising from these surveys will be used to directly inform the tree cutting programme and will help prioritise spans which are of highest risk to the safety of the network and the continuity of supply.

Recent **LiDAR** flights in SEPD has highlighted the vast number of LV overhead line spans that are affected by tree and vegetation growth, where nearly 170,000 spans of LV open wire circuits are near trees. To manage spans safely and efficiently an **Aerial Bundled Conductor (ABC) and Insuline programme** has been planned to replace 1,000km of LV open wire conductor. This will significantly reduce the volume of LV spans that need to be cut each year to an achievable and affordable level whilst maintaining the safety of the network and ESQCR compliance.

This EJP has also described the challenge that is arising from **Ash Dieback.** In the coming years, disease is expected to kill the vast majority of Ash Trees in the UK. This disease represents a significant risk to the distribution network, particularly due to falling trees on overhead lines. We will continue the on-going inspection of the network to identify exactly where Ash is in close proximity to the distribution network. Within the first two years of RIIO ED2 this will then be incorporated into the ENA TS 43-8 programme to efficiently address Ash Dieback as and where is it found.

The additional costs associated with this will be recorded alongside a **dedicated £[redacted] network survey** to better determine exactly where Ash affects our network and to create a tailored programme of works to manage the disease as efficiently as possible. This survey and the work undertaken in the first two years will directly inform the **Uncertainty Mechanism** that is proposed to account for the incremental costs associated with Ash.

Within the SHEPD licence area, Commercial Forestry is an important industry. SHEPD works closely with this industry to manage the felling of these crops alongside the overhead line network. This is an expensive process which requires either live line harvesting equipment to be deployed or outages to be arranged with diesel generation used to maintain supplies to the affected network customers. We will continue to work closely with the commercial forestry industry manage this affectively as efficiently as possible, whilst minimising the impact on other network customers such as renewable generators on non-firm connections.

From recent stakeholder engagement, it is expected that the costs associated with Commercial Forestry will continue to increase over RIIO ED2 as the industry looks to increase the number of compensation claims it submits to SSEN.

Our ***Environmetal Action Plan (EAP) (Annex 13.1)*** sets out the steps we are taking to mitigate the environmental impact of our activities to maintain a safe and resilient network, including the planting of trees to offset those cut alongside the overhead line network.

In total, **£189.7m** is required to manage the trees and vegetation alongside our overhead line network during RIIO ED2 **(£140.3m in SEPD and £49.4m in SHEPD).** Included within this is a **LiDAR survey** of our entire overhead line network at a cost of **£**[redacted] **(SEPD) and £**[redacted] **(SHEPD)** respectively, the cut of approximately 473,000 spans of overhead line network, and a **£**[redacted] **Ash Dieback survey** across both licenced areas.

10 Appendix 1: Relevant Policy, Standards, and Operational Restrictions

The policies, manuals and standards and operational restrictions which govern the management of Tree Cutting are listed below in Table 21.

Table 21: Tree Cutting relevant documents

Policy Number	Policy Name / Description
ENA TS 43-8	Overhead Line Clearances
ENA ETR-132	Improving Network Performance under Abnormal Weather Conditions by Using a Risk-based Methodology near Electric Overhead Lines
ENA ETR-136	Vegetation Management Near Electricity Equipment Principles of Good Practice
ST-NET-ENG-009	Vegetation Management near Overhead Electrical Equipment
PR-PS-340	Application of Clearances to Overhead Lines at LV to 400kV
WI-NET-OHL-003	Tree Cutting on D & T
WI-NET-OHL-005	ETR-132 Resilience Survey Guidance
PO-COR-029	Asset Management Policy
ST-NET-ENG-001	Strategic Asset Management Plan
ST-NET-ENG-002	Asset Risk Management Principles Strategy Document
BS 3998	Tree work. Recommendations
ENA ER G55	Safe Tree Working in Proximity to Overhead Electric Lines
ENA ER G96	Use of Mechanical Harvesters in Vegetation Management
N/A	The Electricity Act, 1989
N/A	The Electricity Safety, Quality and Continuity Regulations 2002 (as amended).
N/A	The Guidance on the Electricity Safety, Quality and Continuity Regulations 2006.
N/A	Natural Environment and Rural Communities Act 2006
N/A	Wildlife and Countryside Act 1981 (as amended)

11 Appendix 2: Independent ADAS Report on Tree Growth Rates

An independent report has been completed by ADAS to provide further evidence of the cut cycles required by both SHEPD and SEPD over the course of RIIO ED2. The report also produces useful insights into the likely impact that Ash Dieback will have on both our licenced areas. A summary of the key finding from this independent report are provided below. The full report is also available upon request and will be included in the final ED2 submission pack.

Summary of Key Findings:

- **Key Finding 1**

  The SSE (Southern) region experiences the highest average USD at baseline. This will likely also continue to be the case into the next decade according to UKCP18 climate projections.

  Having the highest proportion of broadleaved woodland coverage, along with the second highest proportion of ash coverage of all the DNOs means that the challenges of vegetation management for system resilience will also be greater in the SSE (Southern) region in comparison with the other DNOs."

  Rates of growth measured by USD varied greatly across the country and therefore across DNO regions. At baseline (1981-2010) the region with the greatest average USD was SSE (Southern) with an average growth rate of 1.33 m. The DNO region with the lowest average USD at baseline was the SSE region (Northern) with an average USD of 0.47 m. The mean USD across all DNO regions at baseline was 0.93 m.

- **Key Finding 2**

  Having the highest proportion of broadleaved woodland coverage, along with the second highest proportion of ash coverage of all the DNOs means that the challenges of vegetation management for system resilience will also be greater in the SSE (Southern) region in comparison with the other DNOs.

- **Key Finding 3**

  Overall the burden of managing the potential risk to the OHL network from trees in the SSE (Southern) region can be expected to become more complex, time consuming and costly as climate change continues to cause the region to experience warmer and drier conditions.

  The relatively high number of trees across the region, particularly of those species which are already being affected by known pests and pathogens, represents a larger responsibility for the DNO in terms of monitoring and cutting of trees when compared with the other DNOs in the UK.

12 Appendix 3: LiDAR Data Assurance

The data gathered from our LiDAR flights has the potential to significantly improve our understanding of the overhead line network and maximise the efficiency of our tree cutting operations. As described within this EJP, the data provided from the LiDAR flights will directly inform our tree cutting programmes during RIIO ED2. Therefore, the validation of this data is critical. This Appendix describes the steps that we and our previous LiDAR providers have taken to validate, and quality assure the data that is now being used to inform our tree cutting activities.

We appointed Airbus Defence and Space to provide Quality Assurance and Data Validation services to quality check LiDAR, aerial imagery and associated products as part of their Distribution Network data capture and analysis programme. A two-step validation process was implemented, the aim of which was to provide us with the confidence that the data/products supplied were of a high level of accuracy and that they met the required technical specification, this in turn allowed us to make far more accurate investment decisions on the basis that the data supplied was of the highest quality.

Firstly, a capture validation was completed to check the raw data captured throughout the Aerial Surveys, this included the following activities:

- Verification of LiDAR coverage.
- Point density checks.
- Flight and instrument settings check.

Secondly a processed data validation check was completed to verify that the products met the technical specification.

- Data integrity checks.
- Further point density and data classification checks.
- Point quality checks on poles and wires to assess the distribution of LiDAR points.
- Checks on wire return visualisation to provide profiles and images for visual representation.

Following the successful completion of checks on the most recent data captured in the SEPD region, it has been confirmed by Airbus Defence and Space that the data supplied met all the of the required standards.

13 Appendix 4: Acronym Table

Acronym	Description
ABC	Aerial Bundled Conductor
BaU	Business as Usual
BPDT	Business Plan Data Table
CapEx	Capital Expenditure
CBA	Cost Benefit Analysis
CEG	Customer Engagement Group
CI	Customer Interruption
CML	Customer Minutes Lost
CO_2e	Carbon Dioxide equivalent (can be suffixed by t (tonnes))
CV	Cost and Volume
DNO	Distribution Network Operator
DPCR5	Distribution Price Control Review for five years from 1 April 2010 to 31 March 2015
DSO	Distribution System Operator
EHV	Extra High Voltage, Voltages > 22kV and < 132kV , in SSEN these assets are usually 33kV and 66kV.
EJP	Engineering Justification Paper
ENA	Energy Networks Association
ENA TS 43-8	Energy Networks Association Technical Standard 43-8
ESQCR	Electricity, Safety, Quality and Continuity Regulations
ETR 132	Engineering Technical Report 132
EU	European Union
GB	Great Britain
HSE	Health and Safety Executive or Health, Safety and Environment
HV	High Voltage, Voltages > 1kV and < 22kV , in SSEN these assest are usually 6.6kV and 11kV.
IIS	Interruption Incentive Scheme
kV	Kilovolt
LCT	Low Carbon Technology
LiDAR	Light Detection and Ranging
LV	Low Voltage, Voltages < 1kV, in SSEN these assest are usually ~400V.
MRP	Monetised Risk Points
MVA	Megavolt Ampere
NaFIRS	National Fault and Interruption Reporting Scheme
NEDeRs	National Equipment Defect Reporting Scheme
NPV	Net Present Value

Ofgem	Office of Gas and Electricity Markets
OHL	Overhead Line
OpEx	Operational Expenditure
RIIO	Ofgem's price control framework first implemented in 2013
RIIO-ED1	First price control for Electricity Distribution companies under the RIIO framework from 1 April 2015 to 31 March 2023
RIIO-ED2	Second price control for Electricity Distribution companies under the RIIO framework from 1 April 2023 to 31 March 2028
SEPD	Southern Electric Power Distribution PLC
SHEPD	Scottish Hydro Electric Power Distribution PLC