SP Energy Networks 2015-23 Business Plan

Updated March 2013

Annex

LV ESQCR and Overhead Line Strategy

SP Energy Networks

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LV ESQCR and Overhead Line Strategy

March 2014

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1. Scope

This annex summarises SP EnergyNetwork's Non-Load Related Expenditure (NLRE) capital investment plans for our LV overhead line network during RIIO-ED1.

There are two principal work programmes covered in this annex:

- *LV ESQCR – the rectification of clearance distance infringements to bare wire conductors, as specified in the Electricity Safety, Quality and Continuity Regulations (2002)*

- *LV 'Village Modernisation' – the replacement and refurbishment of LV overhead line assets*

Both programmes have overlapping drivers and network impacts, and are both discussed in this document to provide an encompassing view of our strategy.

Our HV ESQCR hazard clearance programme for RIIO-ED1 is not covered in this annex. This is covered in **Annex C6 – 33kV and 11kV Overhead Line Strategy – SPEN**.

2. Table of Linkages

This strategy supports our ED1 Business Plan. For ease of navigation, the following table links this strategy to other relevant parts of our plan.

Document	Chapter / Section
SP Energy Networks Business Plan 2015-2023	Chapter C6 - Expenditure
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – 33kV and 11kV Overhead Line Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – 33kV and 11kV Overhead Line Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Asset Health and Criticality Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Cost Benefit Analysis – SPEN

3. Introduction

3.1. Executive Summary

Our LV overhead line assets are amongst some of the oldest on our network. Our principal objectives for this legacy network during the RIIO-ED1 period are to rectify clearances to meet modern safety standards and manage asset age and condition.

They are essential to delivering a number of our primary outputs, particularly public and employee safety, reliable network performance for our customers and reduced environmental impact. We have invested significantly during DR5 and plan to continue these strategies through ED1.

LV ESQCR - RIIO-ED1					
Activity	Unit	SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
ESQCR hazards removed	#	43,914	41.5	47,760	47.5

Table 3-1: LV ESQCR volume / expenditure forecast for RIIO-ED1

LV Village Modernisation - RIIO-ED1					
Activity	Unit	SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
LV Conductor	km	460	10.1	964	20.94
LV Pole Replacement	#	9,832	8.88	17,888	16.13
LV Pole Refurbishment	#	3,120	0.66	6,344	1.36
LV Underground cable	km	45	3.47	96	7.49
Total expenditure	**-**	**-**	**23.1**	**-**	**45.9**

Table 3-2: LV Village Modernisation volume / expenditure forecast for RIIO-ED1

Our HV ESQCR hazard clearance programme for RIIO-ED1 is not covered in this annex. This is covered in **Annex C6 – 33kV and 11kV Overhead Line Strategy – SPEN**.

3.2. Overview

There are two key drivers for our LV overhead line modernisation strategy during ED1. Firstly, our existing commitment to the HSE to achieve full compliance with ESQCR clearances across our distribution licences by 2020; second, to maintain our aging asset base to an adequate condition.

Consequently we have two corresponding activities which form the basis of our plans; a targeted ESQCR programme to meet our 2020 target and an incremental replacement and refurbishment programme, 'Village Modernisation', which focuses on more comprehensive asset modernisation activities within localised networks. Both of these were established in DR5.

These two drivers are interdependent and in combination will drive the investment planning, prioritisation and delivery processes. Their overlapping outputs will both contribute to our plans to improve public safety, asset condition and network performance.

During DR5 we completed a full and comprehensive inspection of our LV overhead line network for ESQCR information. This supported our industry leading programme of removing these hazards from the system, prioritised by risk. The extensive information that we have collated in this process, along with other datasets, has also fed into our targeting of LV network rebuilding (through Village Modernisation) where these overhead lines are at end of life.

"ESQCR" in this context refers specifically to regulations 17 and 18 of the Electricity Safety, Quality and Continuity Regulations (2002). These set out the minimum heights and distances to roads and buildings for uninsulated overhead line conductors. These standards have increased since much of our network was constructed in the 1950s, so there is a continuing programme of overhead line upgrading for statutory reasons. This programme has been arranged with advice from the HSE and we appreciate that HSE and OFGEM will likely include inter-departmental liaison with respect to any impact of such works on regulated monopoly expenditures.

"Village Modernisation" refers to our strategy of LV overhead network replacement and refurbishment which is directed at specific locales, typically within villages and other small communities, which are identified and prioritised on condition, hazard and defect data.

3.3. RIIO-ED1 Strategy

During ED1 we plan to:

- *Meet our commitment to the HSE to achieve full ESQCR clearance compliance by 2020 through the removal and rectification of approximately 90,000 ESQCR hazards on our LV networks (there are also approximately 10,000 hazards on our HV networks which are accounted for as a part of our HV asset replacement/refurbishment strategy).*

- *Improve safety, asset condition and operational performance by modernising approximately 2% of the LV network every year in both our licence areas, SPD and SPM.*

We have developed and revised our methodologies during DR5. The transition into ED1 will maintain continuity in our resources, processes and efficiencies. With the very high number of LV overhead assets we identify condition through a combination of sample inspection surveys and some use of age as a proxy for condition.

Our plans to modernise 16% of our networks over ED1, and meet our HSE obligations in the ESQCR programme, will enable us to manage a potential spike in our network age/condition profile to acceptable levels into ED2.

3.3.1. LV ESQCR

During the RIIO-ED1 period, we plan to rectify over 90,000 ESQCR clearance hazards on our LV network by 2020. We disaggregate these hazards into two main types: 'low ground clearance', the height of the conductor above ground at lowest point, and 'proximity', clearances to buildings, objects and structures.

Our current ESQCR strategy, developed during DR4 and DR5, originates from policies and work programmes that we have agreed with the HSE (Health and Safety Executive).

The majority of this activity will be delivered by a targeted standalone programme, enabled by our extensive ESQCR datasets. This will be a continuation of our DR5 process, where we prioritise hazards by our assessment of their inherent risk.

As with DR5, we plan that a proportion of these ESQCR hazards will be rectified through our wider LV Village Modernisation programme (this is discussed in more detail in **section 5.5**). These will be funded by LV overhead line replacement and refurbishment activity, and are not counted against the ESQCR programme costs.

LV ESQCR - RIIO-ED1 Forecast					
Activity	Unit	SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
ESQCR hazards removed via Village Modernisation	#	4,532	N/A	6,019	N/A
ESQCR hazards removed via dedicated ESQCR programme	#	39,382	41.5	41,742	47.5

Table 3-3: LV ESQCR Volume / cost ED1 forecast, split by work programme

3.3.2. LV Village Modernisation

Our LV overhead line assets are amongst some of the oldest on our network, with many of these small, localised networks built around the 1950s. During ED1 we will manage the age and condition of these assets, which is key to delivering our outputs of safety, legal compliance and customer performance.

We target our modernisation through a prioritisation process primarily based on ESQCR non-compliance, asset age and condition. Our extensive ESQCR datasets provide a proxy for the overall condition of the network and an indication where more extensive investment is prudent to rectify the network to a manageable and legally compliant condition.

Our Village Modernisation programme is based on a 50 year turnover, 2% per annum of the LV network length in both our licence areas. Modernisation work includes a combination of reconductoring with ABC, pole replacement, pole refurbishment and undergrounding.

LV Village Modernisation - RIIO-ED1 Forecast						
Activity	Unit	SPD		SPM		
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
LV Conductor	km	460	10.1	964	20.94
LV Pole Replacement	#	9,832	8.88	17,888	16.13
LV Pole Refurbishment	#	3,120	0.66	6,344	1.36
LV undergrounding (cable)	km	45	3.47	96	7.49

Table 3-4: LV Village Modernisation volume / cost forecast, split by activity

3.4. Policy

SPEN has a two-fold strategy for managing the LV overhead line network. Firstly, to achieve full compliance with ESQCR clearance hazards across both our distribution licences by 2020; second, to manage the degradation of our aging asset base by modernising 2% of our LV networks per annum.

Our strategy and delivery methodologies are supported by our internal Asset Management practices.

SPEN manages all physical assets utilising an Integrated Management System which combines the requirements of the Asset Management System specification (PAS55, now superseded by ISO55001), the Quality Management System international standard (ISO9001), the Occupational Health & Safety Management System international standard (ISO18001) and the Environmental Management System international standard (ISO14001).

Specifically for our LV network, we utilise the following key internal documents (all policy documents are available on request):

Document Title	Internal Reference
Asset Health Methodology	ASSET-01-019
Hazard & Defect Management Policy	EPS-01-002
Hazard & Defect Management Policy for 33kV, 11kV and LV Overhead Lines	EPS-01-009
Asset Inspection and Condition Assessment Policy	ASSET-01-021
LV Overhead Line Modernisation Policy	ASSET-04-062

Table 3-5: LV overhead line asset management documentation

4. Network Analysis

4.1. Overview

LV overhead lines are most commonly found in rural areas and neighbouring communities, where the installation costs were lower and loading and safety risks more acceptable, as opposed to urban areas where underground cables predominate. These are most extensively found in villages or housing estates. Much of our LV overhead line network was constructed in the 1950s. In many cases the original installations do not meet modern clearance safety standards, as defined in current legislation (ESQCR). Our LV main lines are constructed from two reportable asset types: conductor and wood poles.

Asset	Unit	SPD	SPM
LV conductor	km	3,067	6,601
LV Poles	#	61,317	127,763

Table 4-1: LV overhead line asset population

The vast majority of our LV overhead line network is constructed to an open wire design. Typically this is with bare copper conductors that are durable but which present a potential public safety risk via inadvertent contact. This risk can be heightened in some circumstances as these lines are commonly located in close proximity to domestic, public and industrial premises. We have focused on quantifying this risk during our inspection process.

We have previously standardised on ABC (Aerial Bundled Conductor), an insulated conductor, for new and modernised LV overhead lines.

All LV overhead line conductors on our network are supported by wood poles. These decay over time but are impregnated with Creosote to slow down this process. Eventually these reach an irreparable state, at which point they cannot safely be climbed or used for operational purposes, such as supporting additional tension for replacing conductors.

Fittings and other apparatus (e.g. stays, anti-climber devices) on our LV poles are not reportable to Ofgem. However, these form part of our condition assessments prior to work, and are replaced as required.

4.2. Age Profiles

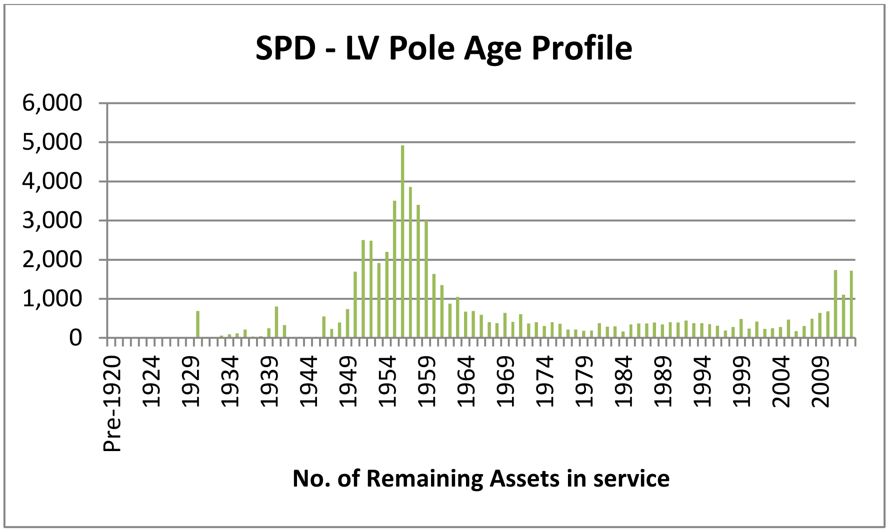

Table 4-2: SPD LV wood pole age profile by installation date

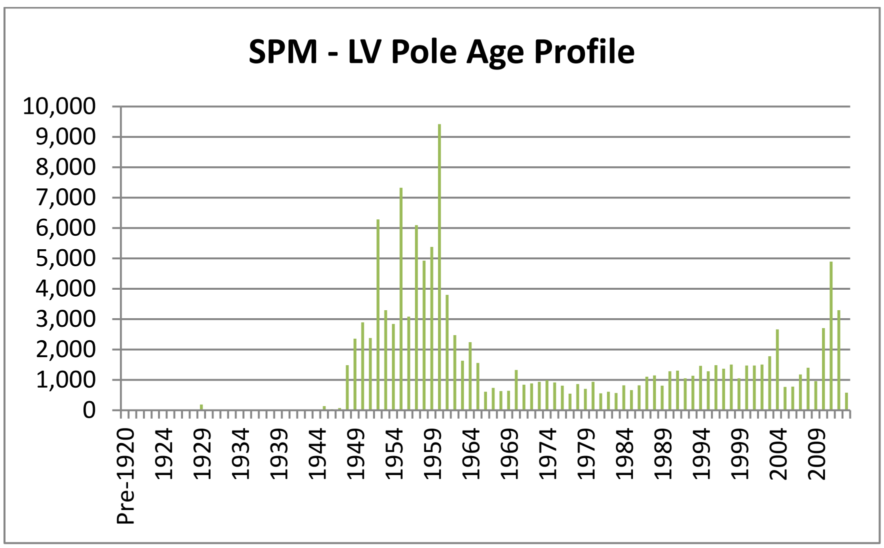

Table 4-3: SPM LV wood pole age profile by installation date

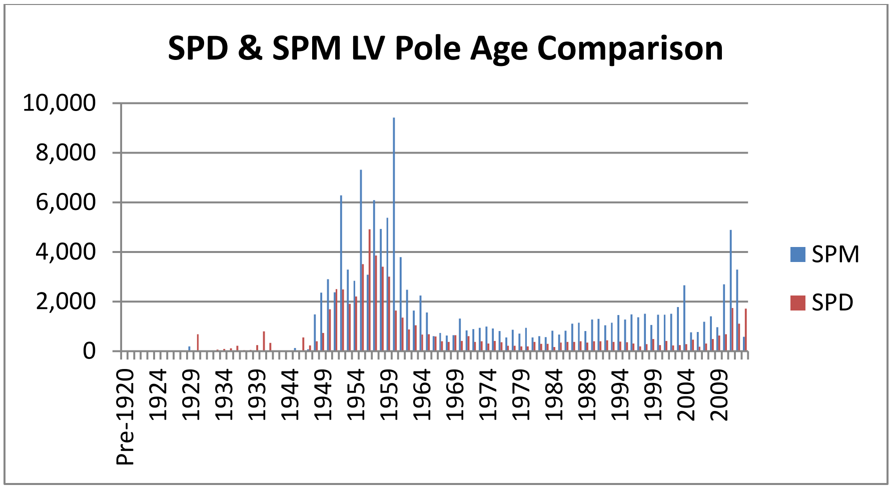

Table 4-4: SPD and SPM LV wood pole comparison by installation date

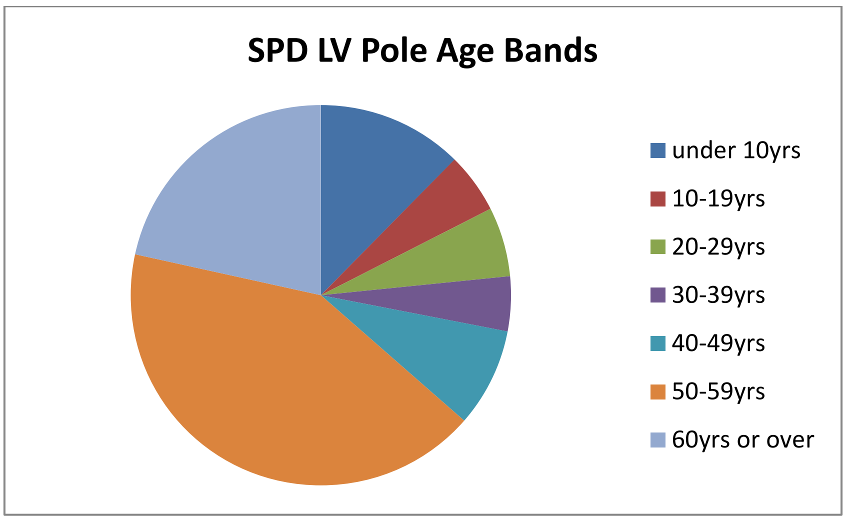

Table 4-5: SPD LV wood pole volume by age band

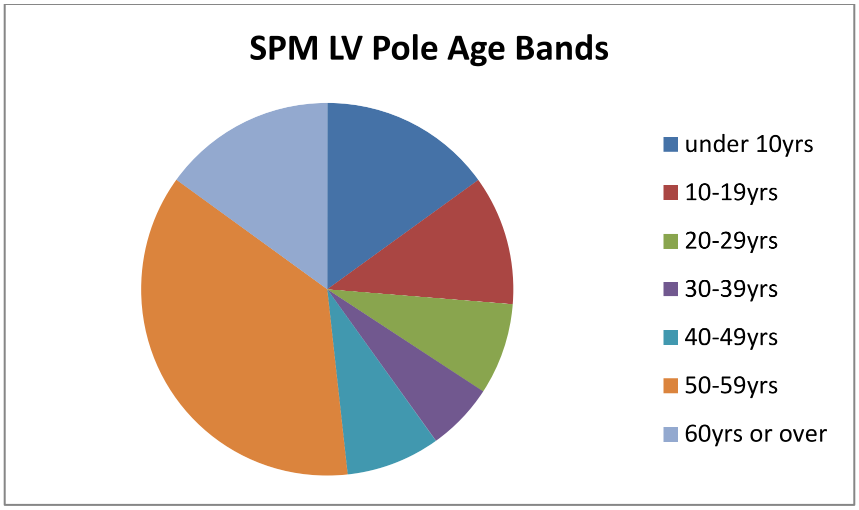

Table 4-6: SPM LV wood pole volume by age band

5. LV ESQCR

5.1. Investment Drivers

Our LV ESQCR programme is driven by the requirements of UK legislation to establish minimum clearance distances to our conductors. SPEN has established an industry leading approach to managing these outstanding issues, and this is reflected in our historic and planned work activity.

5.1.1. Legislative Requirements

As the distribution network owner and operator, we work in accordance with a variety of legal and statutory obligations and industry guidance and best practice. The Electricity Safety, Quality and Continuity Regulations (2002) specify many requirements on DNOs, but regulations 17 and 18 focus on clearance distances to overhead line conductors (both to ground and nearby buildings/objects). This is reinforced by ENA TS (ENA Technical Specification) 43-8, which provides more detail on specific instances.

SCHEDULE 2 — Regulation 17(2)

MINIMUM HEIGHT ABOVE GROUND OF OVERHEAD LINES

Column 1 *Nominal Voltages*	*Column 2* *Over Roads*	*Column 3* *Other Locations*
Not exceeding 33,000 volts	5.8 metres	5.2 metres
Exceeding 33,000 volts but not exceeding 66,000 volts	6 metres	6 metres
Exceeding 66,000 volts but not exceeding 132,000 volts	6.7 metres	6.7 metres
Exceeding 132,000 volts but not exceeding 275,000 volts	7 metres	7 metres
Exceeding 275,000 volts but not exceeding 400,000 volts	7.3 metres	7.3 metres

Figure 5-1: Minimum clearance heights, ESQCR (2002) Excerpt

Table 6.4 - Clearance to Buildings and Structures

Location	Minimum Clearance (m)
Vertical clearance to any surface or structure that is accessible without access equipment (see Fig. 5).	3.0
Horizontal distance to any surface of a building or structure which is accessible without access equipment (see Fig. 5).	1.0
Clearance to parts of a building or structure not normally accessible (see Fig. 5). See note 1.	0.5
Clearance to free-standing apparatus such as street lighting columns, traffic signs, British Telecom poles or columns (see Fig. 5).	0.3

Figure 5-2: Proximity clearances, ENATS 43-8 excerpt

5.1.2. HSE

The Health and Safety Executive is the public body responsible for guidance and enforcement of our obligations under the ESQCR,

Since 2002, SPEN has been in discussions with the HSE over the removal and remediation of low ground and proximity clearance hazards under ESQCR.

As any infringement of these heights represents a legal non-compliance, we have proactively engaged with the HSE to develop our extensive inspection, prioritisation and delivery programmes. As part of our agreements in 2008, prior to DR5, the HSE approved of our long term plans to achieve full compliance on our LV network by 2020.

The key points on this timeline is summarised below:

- ***2003/4** – initial discussion regarding ESQCR compliance*
- ***2005** – Start of initial sample inspections for LV OHL ESQCR compliance*

- ***2008** – Review of clearance data and agreement for long-term work programme with HSE (John Steed and Peter Vujanic); DR4 Reopener on ESQCR compliance;*

- *Initial DR5 submission.*

- ***2011** – 29,000 low ground clearance hazards removed (above forecast). Commence full inspections of LV OHL network in an advanced, 1 year programme.*

- ***2012 / 2013** – Further meetings with HSE to update on progress and confirm ongoing strategy.*

We appreciate that HSE and OFGEM will likely include inter-departmental liaison with respect to any impact of such works on regulated monopoly expenditures.

5.2. Plan Development

5.2.1. Inspections

As part of our strategy to remove these clearance hazards from our LV network, we developed a tailor made IT solution. This utilises our existing corporate systems; discrete asset data, e.g. wood pole condition data, is stored in our SAP system, while distributed asset data, e.g. height measurements on spans of overhead conductor, is stored in our ESRI Geographic Information System (GIS).

The principle advantages of developing an IT solution within our existing infrastructure are:

- *Avoiding the inherent risk in using custom made software platforms that may be unsupported in the near future*

- *Maintaining ownership of asset data that impacts asset health, risk and criticality.*

- *Ability to issue, track and audit the work done by our inspectors quickly and easily.*

- *Utilising the expertise already within the business on our current systems*

We provide ‘Toughbook’ laptops to all of our inspectors, a widely established and proven hardware solution. We also provide electronic laser measurement devices to accurately measure the clearance distances to our overhead line conductors. Again, these are widely available and established technology.

Retaining all of this information on our corporate systems allows for a single source for all of our data relating to condition, ESQCR hazards and defects. We can correlate these issues using our ESRI software system and create manual reports that allow us to analyse areas for delivery and update our output and progress reports.

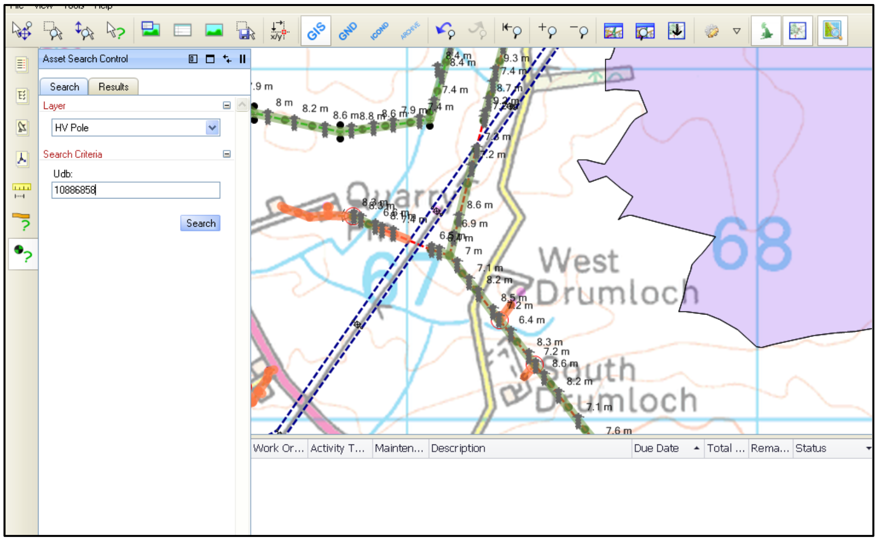

Figure 5-3: Screenshot of ESQCR height inspection software showing measured heights of spans

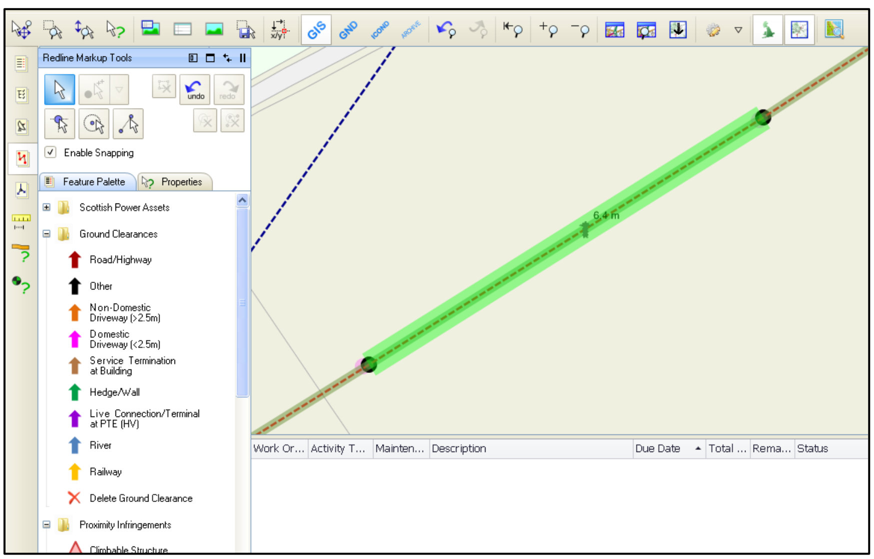

Figure 5-4: Screenshot of ESQCR span height measurement software showing categorisation

5.2.2. Ground Clearance

Ground clearance to conductors is measured by our inspectors using a laser based measuring device (‘TruPulse’). This measures ground clearance to the lowest conductor at the lowest point of the span.

Figure 5-5: 'TruPulse' laser measurement tool for identifying clearance to conductors from ground/objects

All heights are captured, not only non-compliances. We categorise the risk of ground clearances infringement according to the use of the land immediately below. Legislation and industry guidance provides high level assessments (e.g. across roads), but we believe that further granularity in this information provides a more nuanced understanding of inherent risk.

A sample of our low ground clearances categorisations is set out below:

Hazard Type	Severity *(Nature of Equipment & Nature of Hazard)*	Locational Risk		
		Higher than Normal	Normal	Lower than Normal
LGC Road	All	5	5	5
LGC Other	< 5.2 - ≥ 5.0m	3	3	2
	< 5.0 - ≥ 4.6m	4	4	3
	≤ 4.6m	5	4	4
LGC Railways	<7.3 - ≥ 7m	3	3	3
	< 7 - ≥ 6.6m	3	3	3
	<6.6 - ≥ 6m	3	3	3
	≤ 6m	5	5	5

Table 5-1: LV ESQCR low ground clearance risk categorisation, as per SPEN document EPS-01-009

5.2.3. Proximity to Buildings & Objects

Overhead line proximity hazards are also measured by our inspectors using the laser based measuring device ('TruPulse').

Categorisation of proximity by object is detailed in ENA TS 43-08. We additionally provide an assessment on the type of LV conductor. We also categorise proximity hazards caused by trees that are also identified as either climbable or un-climbable. This is managed via our Tree Management Policy (OHL-01-005).

An extract of our categorisation of proximity hazards is detailed below:

Hazard Type	Severity (*Nature of Equipment & Nature of Hazard)*	Locational Risk		
		Higher than Normal	Normal	Lower than Normal
Proximity	< 0.8m, not effectively insulated (un-climbable)	3	2	2
	< 3m, not effectively insulated (climbable)	4	3	2
	< 0.5m, effectively insulated (un-climbable)	3	2	2
	< 0.5m, effectively insulated (climbable)	3	2	2

Table 5-2: Extract of ESQCR proximity hazard categorisations

5.2.4. Condition

As detailed in section 4.1, the inspector assess the condition of every pole through a qualitative assessment of its HI (Health Index). This is an assessment of age, physical condition and other key indicators (i.e. presence of scarf mark), as per our categories below:

HI Category	Description
HI.1	<10 years old, good condition
HI.2	>10 years old, Good condition
HI.3	Minor Visual Damage
HI.4	Suspect decay, Further test required
HI.5	Major damage / decay

Table 5-3: Wood pole Health Index categorisation

Our trained inspectors use the industry standard 'hammer test' to sound every pole for the presence of rot/decay, and make a visual assessment to identify damage. Age provides a guide to whether the pole may be 'end of life'.

Invasive tests can be used to confirm the extent of decay within a pole. Due to time/cost implications, we typically use this as a final method of condition assessment prior to interventions (such as Village Modernisation).

Our wood pole Health Index methodology is detailed in appendix 8.3.

5.2.5. Location

During inspections, we assess the ‘Location Risk’ at every span and pole. Locations are classified according to type/ use of the land and on a qualitative assessment of inadvertent contact with live conductors. These Location Risks are classed as ‘Higher than Normal’, ‘Normal’ and ‘Lower than Normal’:

Higher than Normal Risk

- *Schools and children’s play areas*
- *Disconnected/De-energised customer substations*
- *Caravan and/or camping sites;*
- *Fishing areas*
- *Sailing waters, boat launching/storage areas & marinas*
- *Parks and leisure areas*

Normal Risk

- *Residential areas/Housing estates*
- *Equipment attached to, or in, Customers Properties*
- *Public open space*
- *Commercial sites*
- *Industrial sites*
- *Agricultural sites*
- *Commercial Forests*

Lower than Normal Risk

- *Moorland*
- *Heath-land*
- *Forest & Natural Woodland*
- *Pasture*
- *Grazing*

This allows us to prioritise the most severe hazards by their proximity to the public and subsequent risk of inadvertent contact.

5.2.6. Other Hazards & Defects

Other ESQCR hazards, such as missing 'Danger of Death' signage, and equipment defects, which impact operational capability, are categorised on the same basis of risk weightings as clearance non-compliances.

5.3. ESQCR Risk Matrices

Our inspections of ESQCR clearance hazards provide an effective means of understanding and managing risk. Using the distance measurement and the location risk, as assessed on site, we are able to develop a matrix approach.

Following our accelerated LV ESQCR inspections that have been completed during DR5, we can specify in detail the location and severity of our ESQCR clearance non-compliance hazards.

These are categorised by total, inherent risk using two indicators:

- *Hazard risk – the extent of clearance/distance infringement (e.g. how low the conductors are). This is based on assessment of 1 (low risk) to 5 (very high risk).*

- *Location risk – land use, proximity to the public (e.g. what is likelihood of inadvertent contact). This is categorised via 'Lower than Normal', 'Normal' and 'Higher than Normal'.*

This level of granularity has allowed us to quantify the risk via a matrix approach for internal reporting and planning purposes. The tables below demonstrate the split between hazard and location risk.

For clarity, the hazard risk in these matrices is on the vertical axis, on the 1 to 5 scale described above. The location risk is simplified to 'High', 'Medium' and 'Low' on the horizontal axis.

5.3.1. SPD ED1 Forecast

LV total combined hazards (low ground clearances and proximity)

Hazard Risk	**Location Risk**			**Total**
	High	**Medium**	**Low**	
5	7	1,338	3	***1,348***
4	6	3,305	93	***3,404***
3	165	10,149	102	***10,416***
2	367	24,966	859	***26,193***
1	31	2,507	15	***2,552***
Total	***576***	***42,265***	***1,072***	***43,913***

Table 5-4: SPD ED1 forecast of total ESQCR hazards

LV low ground clearances hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	7	1,338	3	***1,348***
4	6	3,305	93	***3,404***
3	67	1,668	102	***1,838***
2	125	10,868	532	***11,525***
1	0	0	0	***0***
Total	***206***	***17,180***	***730***	***18,115***

Table 5-5: SPD ED1 forecast for ground clearance hazards

LV Proximity hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	0	0	0	***0***
4	0	0	0	***0***
3	97	8,481	0	***8,578***
2	242	14,098	328	***14,668***
1	31	2,507	15	***2,552***
Total	***370***	***25,085***	***342***	***25,798***

Table 5-6: SPD ED1 forecast for proximity hazards

5.3.2. SPM ED1 Forecast

LV Total hazards (low ground clearances and proximity)

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	3	627	10	***640***
4	3	1,170	24	***1,197***
3	112	8,130	96	***8,337***
2	431	28,889	2,605	***31,925***
1	81	5,201	380	***5,662***
Total	***630***	***44,016***	***3,115***	***47,761***

Table 5-7: SPM ED1 forecast of total ESQCR hazards

LV Low ground clearances only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	3	627	10	***640***
4	3	1,170	24	***1,197***
3	74	4,754	96	***4,924***
2	192	14,434	1,664	***16,290***
1	0	0	0	***0***
Total	***272***	***20,984***	***1,795***	***23,051***

Table 5-8: SPD ED1 forecast for ground clearance hazards

LV Proximity hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	0	0	0	***0***
4	0	0	0	***0***
3	38	3,376	0	***3,414***
2	239	14,455	940	***15,634***
1	81	5,201	380	***5,662***
Total	***357***	***23,032***	***1,321***	***24,710***

Table 5-9: SPD ED1 forecast for proximity hazards

5.4. Building the Plan

Using the extensive inspection data that we retain on our corporate systems, we can build up a forecast for our LV ESQCR requirements.

The variation in our forecasts between the 2013 and 2014 ED1 submissions show a change in this forecast. This is due to an updated assessment for the current regulatory period and an updated view of the data on our corporate systems, which feeds into our internal forecasts.

Our primary objective for the end of DR5 is the removal of our most severe low ground clearances – those across roads.

Into ED1, our objective is the removal of all ESQCR clearance hazards by 2020, as we have previously agreed with the HSE. This agreement is in place for the LV network, but we believe that we can also deliver full compliance to ESQCR clearances with the HV network. This continues to be a leading model for the industry.

For our ED1 plans, we have factored in estimates of LV pole replacement that will occur as a direct result of ESQCR works. For example, if we need to replace conductors to resolve a low ground clearance hazard, we will also replace any adjacent poles that are found to be at HI5.

5.5. ED1 Volumes and Expenditure

5.5.1. SPD

Our ESQCR programme will complete by 2020. The volumes in the ED1 submission table (CV2) do not allow us to disaggregate by type of clearance hazard (i.e. ground clearance or proximity), so that the total budget costs represents two different activities at two different unit costs. This means that the CV2 costs cannot be divided by units to derive a meaningful unit cost comparator.

ESQCR clearance type	Volume at start of ED1	To be cleared in Village Modernisation	To be cleared in ESQCR	ESQCR Total Expenditure (£m)
Cat 4/5 Low Ground Clearance (not road crossing)	4,752	1,239	3,513	5.6
Cat 2/3 Low Ground Clearance	13,363	2,195	11,168	17.6
Proximity	25,798	1,098	24,701	19.8
Total	43,913	4,532	39,382	43.0

Table 5-10: SPD LV ESQCR programme ED1 volume/expenditure forecast

ESQCR hazards cleared through the Village Modernisation programme are not funded from the CV2 tables, and are instead cleared as part of the asset replacement works, funded from CV3. The costs in table 5-10 above are for CV2 ESQCR expenditure only. The volumes for ESQCR hazards in the table are included here for a complete view of our ED1 plan.

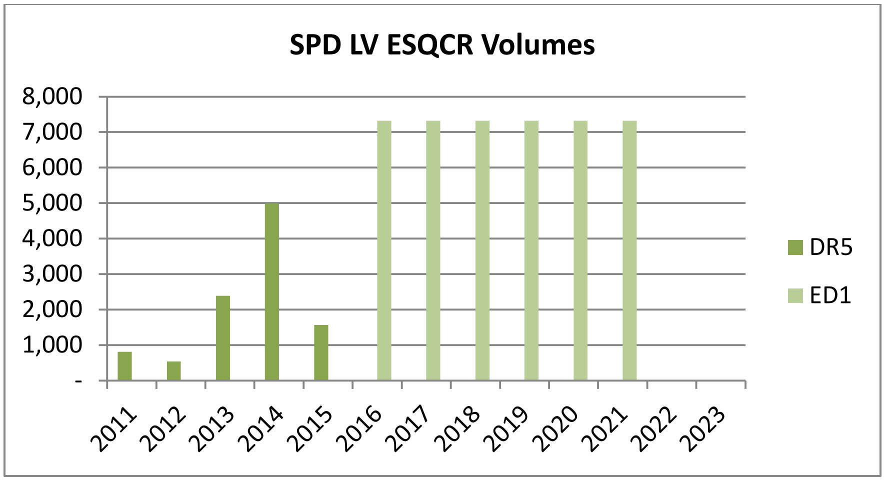

Figure 5-6: SPD LV ESQCR Volumes, DR5 and ED1

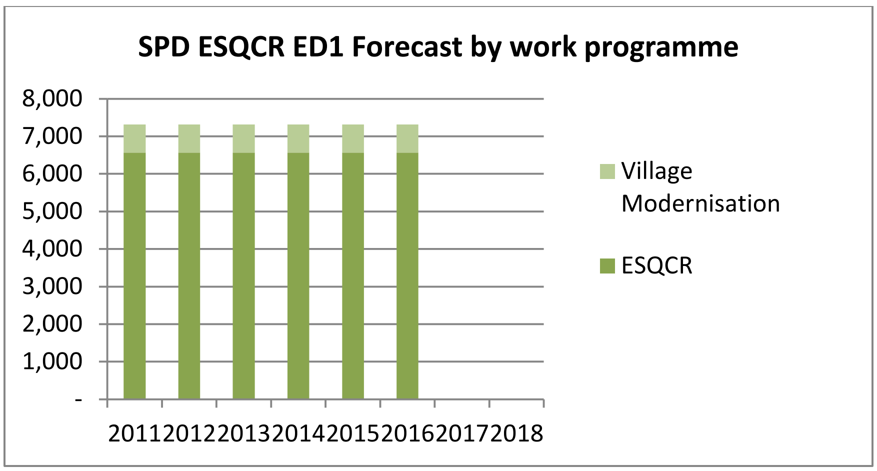

Table 5-11: SPD ESQCR hazard removal contribution by work programme

5.5.2. SPM

ESQCR clearance type	Volume at start of ED1	To be cleared in Village Modernisation	To be cleared in ESQCR	Total Expenditure (£m)
Cat 4/5 Low Ground Clearance (not road crossing)	1,837	919	919	1.4
Cat 2/3 Low Ground Clearance	21,214	1,850	19,364	30.6
Proximity	24,710	3,250	21,460	17.2
Total	47,761	6,019	41,743	49.2

Table 5-12: SPD LV ESQCR programme ED1 volume/expenditure forecast

ESQCR hazards cleared through the Village Modernisation programme are not funded from the CV2 tables, and are instead cleared as part of the asset replacement works, funded from CV3. The costs in table 5-13 above are for CV2 ESQCR expenditure only. The volumes for ESQCR hazards in the table are included here for a complete view of our ED1 plan.

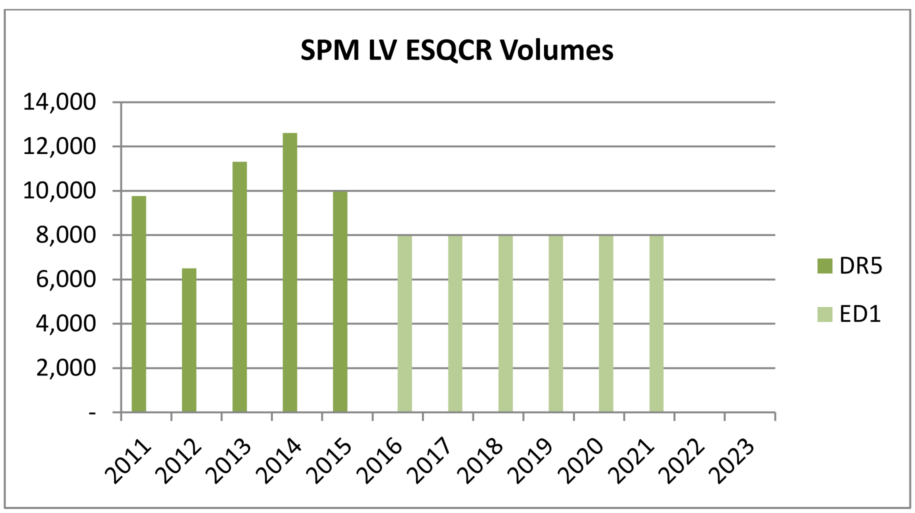

Table 5-13: SPD LV ESQCR Volumes, DR5 and ED1

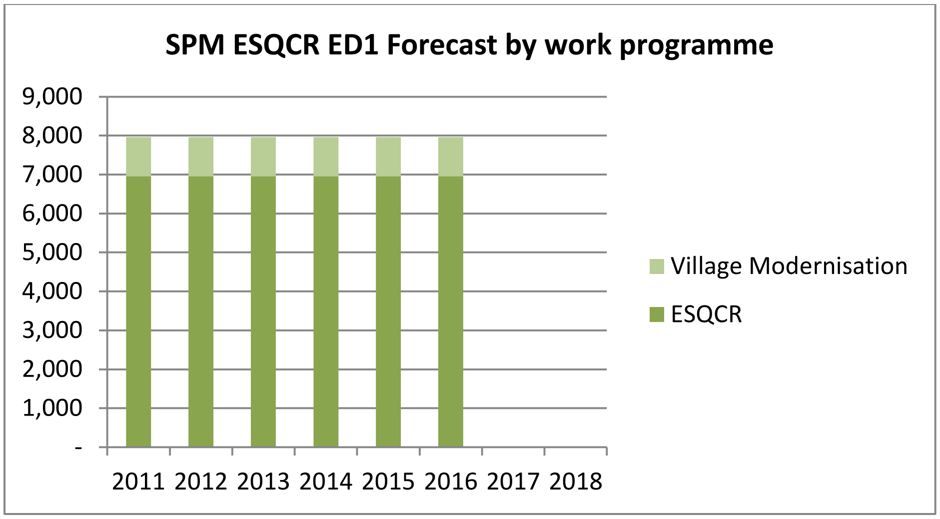

Table 5-14: SPD ESQCR hazard removal split by work programme

6. LV Village Modernisation

6.1. Investment Drivers

6.1.1. Asset Condition

The condition of our wood poles is one of the key drivers of our LV overhead line modernisation. The age of the pole can function as a proxy for condition, but can be too broad an indicator. Wood poles are simple, organic assets that naturally decay over time. All poles are impregnated with Creosote during manufacture to help slow the rate of decay. The environment of a pole can be a significant factor in the rate of decay.

We assess the condition of our LV wood poles during inspections because they are a good indicator of overall circuit condition. However, during our inspections we separately assess the condition of steelwork, insulators and plumbing of the pole (alongside hazards, defects and locational factors).

We quantify the condition of our LV network through the management of wood pole asset Health Index (HI). Health Indices for all of our reportable assets is detailed in our 'Asset Health, Criticality and Outputs Methodology' policy document (internal reference: ASSET-01-019). The excerpt on wood poles is provided in appendix 8.3. This sets out our processes for assessing the Health Index of an asset based on age, type, condition, defects and operability.

Due to their construction, wood poles we use a linear, simplified approach to calculating HI, as opposed to switchgear or transformers, for example, which have many more discrete components that can affect asset health. The HI of a pole can be readily derived on site in a single visit.

Our inspectors assess and log the HI of every wood pole based on:

- *Year of pole manufacture from the 'scarf mark'*
- *Visible decay / damage – e.g. cracks, damage from machines, woodpecker holes.*
- *Assessment of rot using a hammer test (industry standard approach) or, if discrepancy in decision or pole revisited prior to work, an invasive drill-based test.*

Where no condition assessment information is available, we use wood pole age to derive an assumed HI.

6.1.2. Network Resilience

Our analysis of previous storm performance has shown that our low voltage overhead line network typically contributes to the long duration interruptions greater than 2 days; known as the "tail of the storm")[1]. In addition to managing the deterioration of an ageing LV network, installing effectively insulated conductors in conjunction with cyclic vegetation management to ENATS 43-08 delivers an enhanced resilience to severe weather and reduces long duration interruptions.

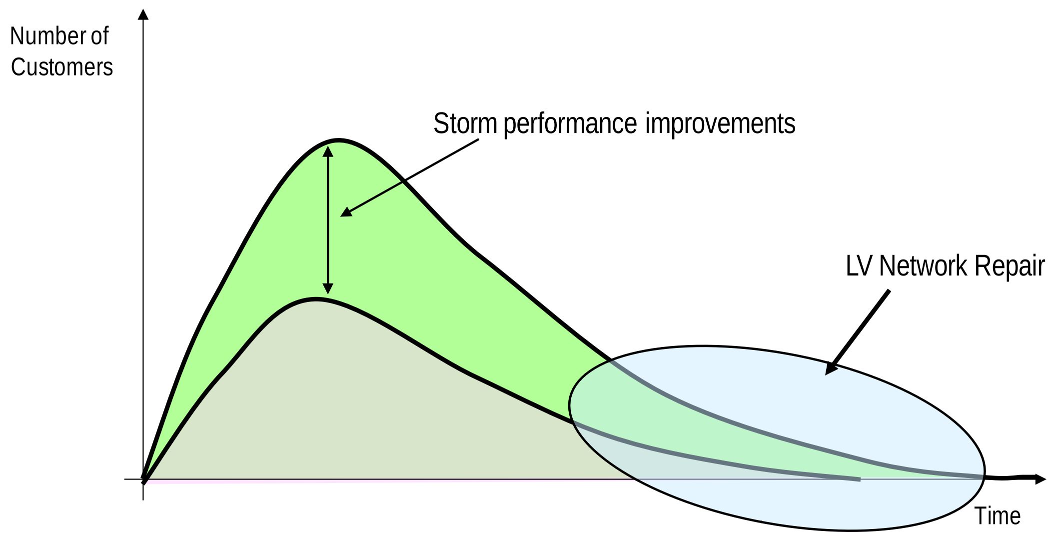

Figure 6-1: LV network contribution to storm CI/CML

6.1.3. Hazards & Defects

In addition to clearance hazards, the ESQCR specify other safety related issues for wood poles, including the presence of appropriate 'Danger of Death' signage and anti-climbing devices. We note these 'hazards' during our inspections.

Distinct from hazards, we also inspect for 'defects' on our LV network – the degradation or damage to equipment that impacts its operational capability. For example, damage to conductor connectors ('jumpers').

Condition data is collected and collated on our corporate IT systems, so that we can effectively manage these hazards and defects. Where clusters of hazards and/or defects are identified we would consider programming remedial work under our LV village modernisation. Alternatively, we can develop targeted programmes to remedy specific instances. In each programme we make selective use of internal and contractor resources.

6.1.4. ESQCR

ESQCR clearance hazard data functions as a useful proxy for condition and therefore form the basis of our prioritisation process.

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[1] KEMA Report G07-1652 February 2007, Iain Wallace: An Assessment of HV Overhead Storm Resilience

Where we have a high density of ESQCR hazards then this indicates that the local network is most likely in a poor condition and that it may be more cost-effective to rebuild in this area. For example, multiple clearance hazards supported by 'HI5' rotten poles in a dense urban area. In these situations, it is more prudent to consider this locality for a wider engineering solution rather than resolving only ESQCR issues.

Our Village Modernisation programme contributes to a proportion of ESQCR hazards removed from the system, but this is funded through asset replacement activity alone.

6.2. Building the Plan

We plan in ED1 to modernise 2% of the entire LV network per annum, in both SPD and SPM. This is a continuation of our DR5 strategy which has delivered strong output performance.

Our LV 'village modernisation' programme involves the rebuilding and refurbishment of whole networks in rural communities which are served by overhead networks. These are identified and prioritised predominantly on the volumes of high risk ESQCR hazards. A 'village' generally qualifies for modernisation dependent on several criteria:

- *There is a cluster of more than 20 properties, AND*
- *If more than 30% of the LV poles supporting the circuit have an associated category 4 or 5 anomaly, AND*
- *If more than 70% of the LV poles supporting the circuit have an associated category 1 to 5 anomaly,*

The majority of our LV modernisation works involve reconductoring with ABC and a mixture of pole replacement and refurbishment, with re-sagging of existing open-wire construction lines.

Our cost benefit analysis, discussed in **Annex C6 – Cost Benefit Analysis – SPEN** (CBA 12), has found that it is cost effective to deliver a proportion of undergrounding during LV overhead modernisation. This is in order to provide additional network capacity to reduce losses, accommodate anticipated growth in low carbon technology, and minimize the environmental/visual impact associated with very large overhead line conductors.

Our LV wood pole age profile presents a challenge for us to manage potentially high volumes of 'end of life' poles, towards the end of ED1. An industry-wide assessment by the HSE[2] found the likelihood of pole decay to generally occur in excess of this age range, as detailed below

[2] HSE Report 1 February 2008: Condition Assessment Survey of Wood Pole Lines on Distribution Networks in Great Britain

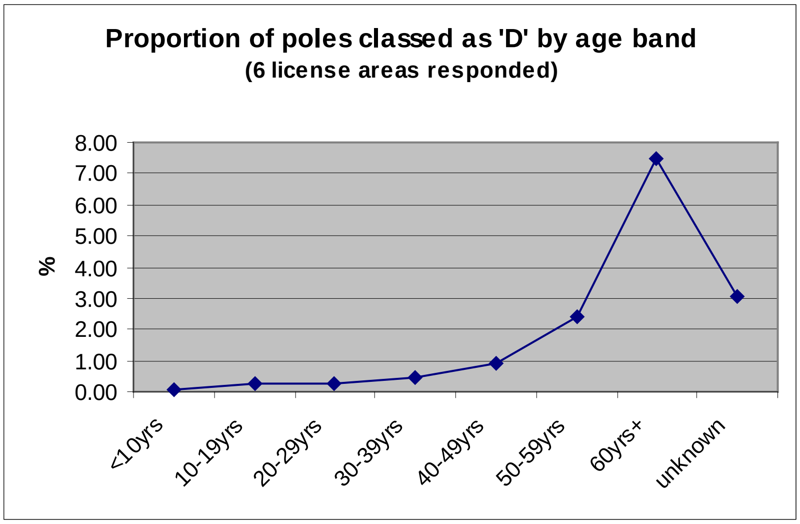


Figure 6-2: Profile of pole age vs. ‘D’ classifications, survey of all UK DNOs (P. Vujanic, HSE 2008)

We continue to use a mid-point pole asset life of 63 years, by when marked deterioration and occurrence of internal rot and decay can be expected to occur.

In order to reach an adequate pole replace rate during ED1, we have taken into account the number of poles we would expect to replace during our village modernisation and ESQCR programmes. This should achieve a satisfactory replacement rate through ED1 and into ED2 (where the contribution from our substantive ESQCR programme will have ended).

Our Health Index assessments of wood poles on the LV network are currently ongoing, and so the age profile provides an effective indicator of ‘end of life’.

Continuing into ED2 (from 2023/4), we believe that we will have attenuated the pole condition profile to a reasonable level, appropriate for the quality of supply required by our customers. Our substantive ESQCR programme will have been completed during the ED1 period, and therefore we plan to deliver our network condition – and pole HI – improvements by means of asset replacement/Village Modernisation only.

Our LV modernisation volumes are also in keeping with our primary output of increasing the storm resilience of our overhead line networks. LV lines typically contribute to the ‘tail’ of the storm, increasing the durations of outages for some customers. Following reconductoring with ABC, a fully insulated conductor, twinned with our cyclic tree cutting to ENATS 43-08, we anticipate that an additional 16% of our LV network will be storm resilient by the end of ED1.

6.3. Asset Risk

6.3.1. SPD

A matrix of HI and CI interventions, indicating the movement in HI and CI volumes between the start and end of ED1, are shown in the tables below for our EHV and HV wood pole assets in both licences. The relative risk measures for each asset category with and without investment are also profiled in the graphs below.

Our HI and CI methodology is detailed in **Annex C6 – Asset Health and Criticality Strategy – SPEN**.

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	7749	-1004	-1043	-971	-5042	**-311**
CI2	11561	-1560	-1526	-1317	-7622	**-464**
CI3	1505	-159	-158	-135	-1114	**-61**
CI4	1481	-173	-170	-152	-1046	**-60**
Total HI	**22296**	**-2896**	**-2897**	**-2575**	**-14824**	-896

Table 4-1: SPD LV wood pole asset risk matrix

Our LV pole asset risk profile with / without intervention is shown below:

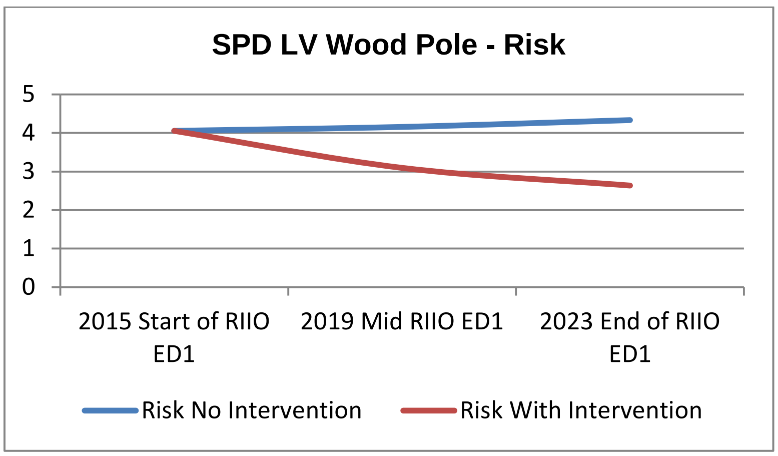


Figure 4-2: SPD LV wood pole asset risk profile during ED1

6.3.2. SPM

A matrix of HI and CI interventions indicating the movement in HI and CI volumes between the start and end of ED1 is indicated in Table 4-7. Our HI and CI methodology is detailed in **Annex C6 – Asset Health and Criticality Strategy – SPEN**.

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	15730	-2439	-2420	-2230	-9543	**-902**
CI2	12514	-2050	-2077	-1823	-7282	**-718**
CI3	2974	-464	-469	-383	-1828	**-170**

CI4	2408	-397	-384	-320	-1445	**-138**
Total HI	**33626**	**-5350**	**-5350**	**-4756**	**-20098**	**-1928**

Table 4-3: SPM LV wood pole asset risk matrix

Our LV pole asset risk profile with / without intervention is shown below:

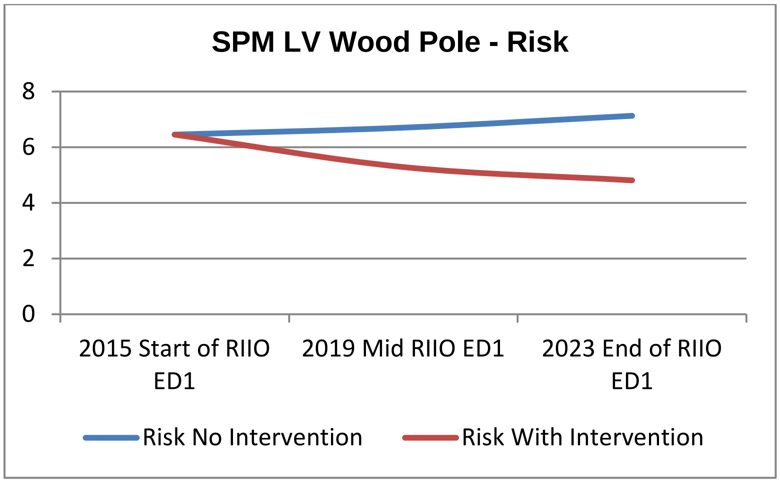


Figure 4-4: SPM LV wood pole asset risk profile during ED1

6.4. ED1 Volumes & Expenditure

6.4.1. SPD

Activity	Unit	Total Volume	Total Expenditure (£m)
Reconductor	km	459	10.3
Pole Replacement	#	9,833	9.1
Poles Refurbishment	#	3,120	0.7
Undergrounding	km	45	3.5
Total			***23.6***

Table 6-5: SPD LV OHL asset replacement/refurbishment volumes & costs for ED1

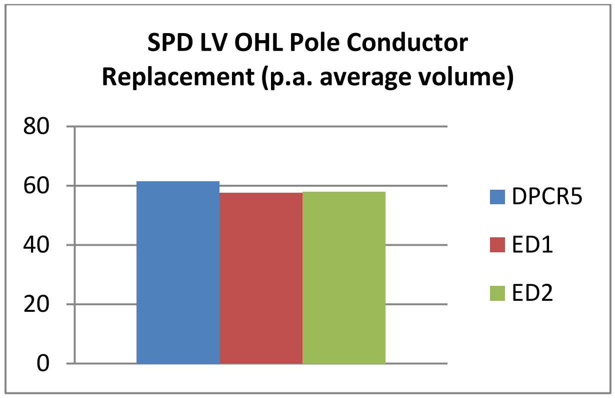


Figure 6-3: SPD LV main conductor replacement comparison (average per annum)

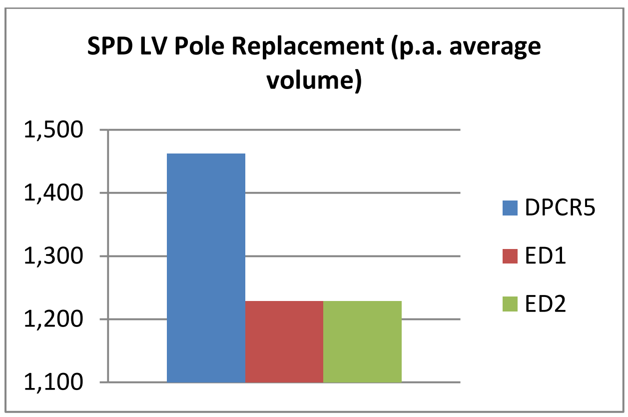


Figure 6-4: SPD LV pole replacement comparison (average per annum)

6.4.2. SPM

Activity	Unit	Total Volume	Total Expenditure (£m)
Reconductor (km)	km	964	21.79
Pole Replacement (#)	#	17,888	16.10
Poles Refurbishment (#)	#	6,344	1.27
Undergrounding (km)	km	96	7.49

Total			***46.64***

Table 6-6: SPM LV OHL asset replacement/refurbishment volumes & expenditure for ED1

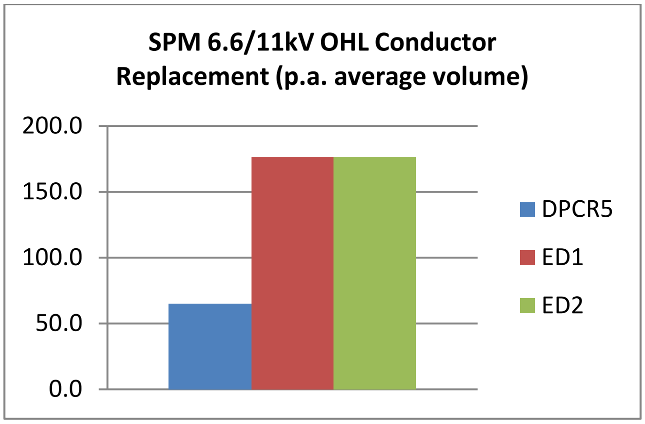


Figure 6-5: SPM LV main conductor replacement comparison (average per annum)

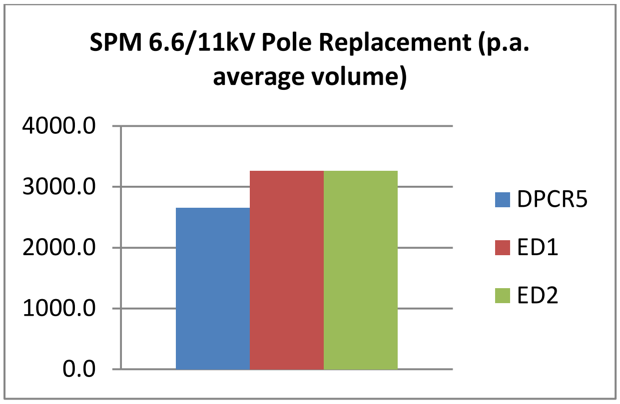


Figure 6-6: SPM LV pole replacement comparison (average per annum)

6.4.3. Commentary on DR5

During DR5 we have built up our delivery resources to meet our output targets.

We anticipate a temporary drop in our reconductoring activity in 2015/16 as we prioritise our most severe low ground clearances across roads for completion before ED1.

We plan to maintain our investment levels seen in DR5 during ED1 so as to achieve our strategic objectives.

6.4.4. Unit cost development

Our unit costs for resolving these ESQCR hazards during ED1 are based our experience of actual costs incurred during DR5. We have a toolbox approach for managing these hazards and we always seek to deliver the most efficient and cost-effective solutions for our customers.

Low ground clearances are generally resolve by two methods:

- *Replacing the bare wire conductors with ABC; or*
- *Where existing pole unable to comply with ABC technical requirements, replacing the pole (plus those on either side, as necessary) and reconductoring with ABC*

Safe working practice for replacement of rotten (i.e. HI.5) poles may require the replacement of adjacent poles if they are also rotten (as they are not climbable or may not be able to take the weight/tension of conductors). These are not accounted for in our unit costs, and these are separate from the ESQCR hazard and are counted as 'asset replacement'. Poles replaced that are directly related to the ESQCR hazard are counted in the unit cost and the pole disposal/addition is reflected in the 'other movements' tables.

Proximity hazards tend to be found at overhead services to buildings and structures. Reconductoring of services less frequently involves replacement of poles so that these unit costs are lower.

7. Delivery

There will be a degree of modernisation achieved by ESQCR, for example any HI.5 poles replaced in order to increase overhead line ground clearance. Similarly, dense areas of ESQCR hazards are prioritised as part of our village modernisation programme. ESQCR hazards which are replaced as a part of our village modernisation works are included in Ofgem's ESQCR tables without any additional expenditure so as to avoid any "double counting".

7.1. Prioritisation

We are obliged by HSE to complete our ESQCR programme by 2020. As a consequence we attribute a high priority to this work.

Where there are clusters of ESQCR infringements and where the condition of the network is poor, then this locality will be a candidate for village modernisation. Use of the word 'Village' in this context is indicative only; for example, we would also use this term to refer to modernising work on a small housing estate adjacent to an urban area.

We use a combination of our SAP asset data and our ESRI GIS data to create more detail of ESQCR compliance in rural areas. This is done by creating visualised 'heat maps', and can also be done for pole HI, for example. Following this, we can then categorise the specific work necessary before we arrange a more rigorous condition-based assessment on site prior to issuing work instructions.

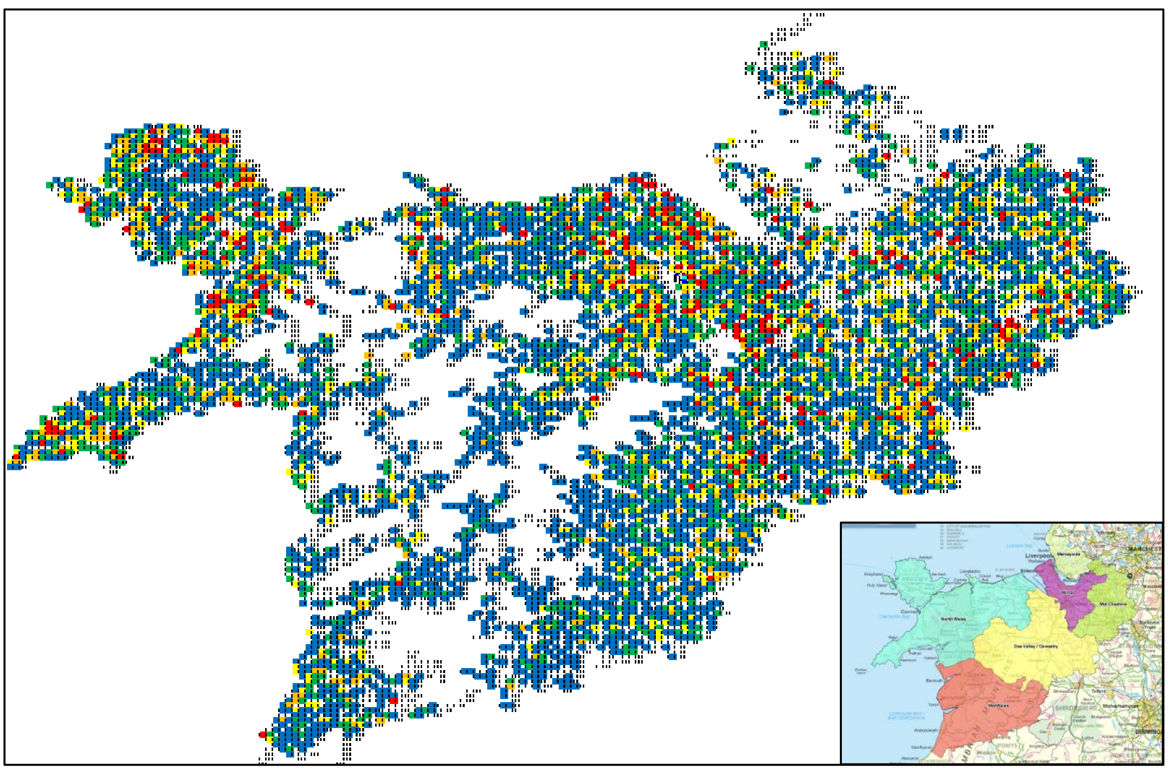


Figure 7-1: LV ESQCR clearance hazard 'heat map' for SPM network

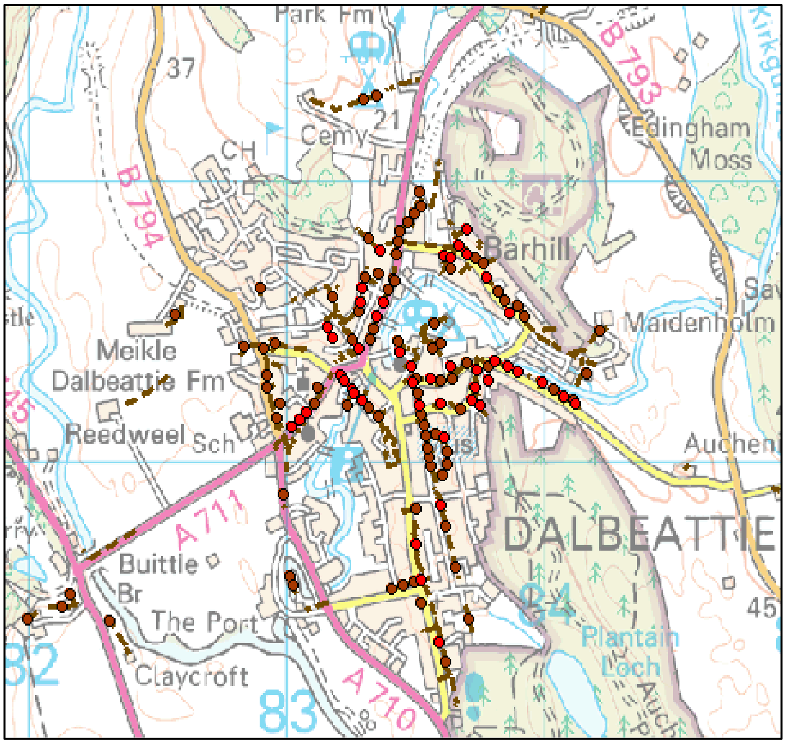


Figure 7-2: ‘Heat map’ of ESQCR hazard severity in Dalbeattie, SPD

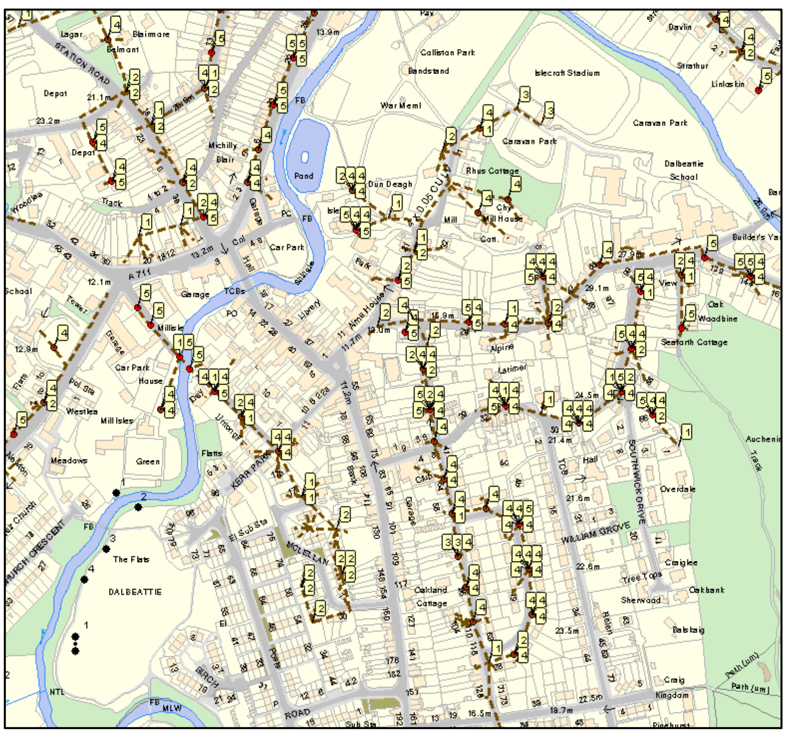


Figure 7-3: Detailed ESQCR hazard map, Dalbeattie

7.2. Local Engagement

Our LV overhead line networks are frequently in close proximity to populated areas, such as in rural villages, and so it is vital to engage with our key stakeholders before we commence work that may affect their day to day activities. This also promotes our investment in their network and allows our customers to better understand scale of the activities we undertake and which they fund.

Prior to any work we have an established process of communication, contacting MPs and other governing representatives, local government councils, community bodies and other relevant institutions. We also use local press and social media to reinforce our message.

We first establish the scope and range of works we will be undertaking, which is crucial to minimise disruption if other utilities or works are planned in the area.

Direct engagement with the local communities are generally initiated through meetings held in local halls, where our delivery engineers and managers can inform the public, respond to any requests and resolve potential issues. For example, potential issues with the position of our apparatus, or confirming what identification our staff will be using when on site (to avoid ‘bogus callers’).

As we will be coordinating outages in many instances for changeover of supplies, and renewing conductors/poles that may be in or near their properties, we also conduct door-to-door discussions with those residents who will be directly affected.

7.3. Deliverability

Key delivery issues that we have considered in developing our plan include:

- *We have completed full inspections for ESQCR clearances across the network, providing a comprehensive view of work programme.*
- *We will have all severe LGCs across roads complete by end of DR5.*
- *Contractor linesman resources now established at consistent level as our programme continues in DR5 and in preparation for ED1.*
- *We have established linesman training courses at local colleges in both SPD and SPM with the aim of adding to our contractor linesman base.*
- *Maintaining position as industry leader in this area, and providing long term stability to our service partners.*
- *Internal and contractor volume/HI reporting processes reviewed and improved.*
- *As our HV overhead line refurbishment rolling cycle progresses in ED1, there is scope for driving further efficiencies in delivery volume, cost and customer service.*
- *Updates to our inspector question sets, further refining the data specificity.*
- *Customer service challenges, internally and via Ofgem incentive mechanisms.*

8. Risks and Mitigation

Potential Risk	Mitigation Actions
Potential effect on unit costs due to variance in solutions required – e.g. more undergrounding.	Unit costs developed over extensive variety of solutions employed in DR5, anticipate this being comparable in ED1. Consistent reviews to identify any variances in costs vs. outputs.
Increase in activity during ED1 may result in more linespersons requiring SPEN Authorisations at LV and hence more strain on our training centres.	DR5 activity has established adequate resource base in SPD and SPM licence areas. Long term stability of work programme to assist service partners in recruitment and SPEN in resource availability at training centres. SPEN programmes with local colleges already established for streamlining linesmen into contractor positions. SPEN authorisations
Increase in Road Crossings during ED1 will result in additional outages on the LV network and SPEN will need to be able to handle these additional requests.	Detailed customer service plans required at job planning stages to identify potential issues over multiple / extensive outages. Review community engagement plans to ensure appropriate welfare arrangements.
On rare occasions customers may refuse permission for SPEN to carry out the works required where this involves their property or land. This may result in outstanding hazards, requiring more expensive, tailored solutions or further discussions with our wayleaves department.	Issues to be identified at early stages of projects. Ensure sufficient internal resourcing to accommodate more extensive interfaces for these situations. Experience during DR5 is that these are not common events.
Forecast is based on currently available OHL resources. This is limited across the UK and is subject to change dependant on other DNO needs and priorities	SPEN has established industry leading programme. Stable continuation of work programmes through DR5 and into ED1 will provide long term stability for service partners.
Forecast has been sourced from IT (SAP and ESRI). Update process needs to be reviewed to ensure that no anomalies exist between the two IT systems.	Next update of ESQCR IT system due in 2014. Further reviews required prior to ED1 to identify potential issues and rectification through our data management processes.
Insufficient regulatory funding for completion of ESQCR programme. Non-compliance with legislative requirements and HSE. Potential legal and safety risk.	Proactive discussions with HSE and Ofgem outlining delivery capability and forecast. Agreement over programme extent in ED1.
EU legislation has led to a review of Creosote as a preservative for wood. Electricity industry exemption could be removed during the ED1 period. This would result in shorter wood pole asset lives with higher turnover rates required in the future. Potentially higher capital costs as alternative techniques are explored for pole preservation and/or alternatives used (undergrounding).	EU legislation changes would impact UK electricity industry as a whole. SPEN will proactively engage with Ofgem and industry bodies and working groups to establish collaborative mitigation efforts.

8.1. Images

Figure 8-1: LV Village Modernisation works underway, SPM

Figure 8-2: LV overhead lines prior to Village Modernisation, SPD

Figure 8-3: LV overhead lines following Village Modernisation, SPD

8.2. Conformance to RIGs

The Ofgem RIGs (Regulatory Instructions and Guidance) document provides a clear definition of how we report our work programmes.

Our ESQCR programmes are spread across three lines in table CV2 – reconductoring, rebuild and part of other planned work.

Reconductoring with ABC – an effectively insulated conductor - is our primary method of removing our ESQCR hazards, and therefore we have grouped our standalone programme into this category for our ED1 forecasts:

- Reconductoring: Is the activity of removing existing bare overhead line conductors and erecting insulated conductors in order to address instances on non compliance with Electricity Supply Quality & Continuity Regulations (2002) (as amended) regulations 17 and 18.

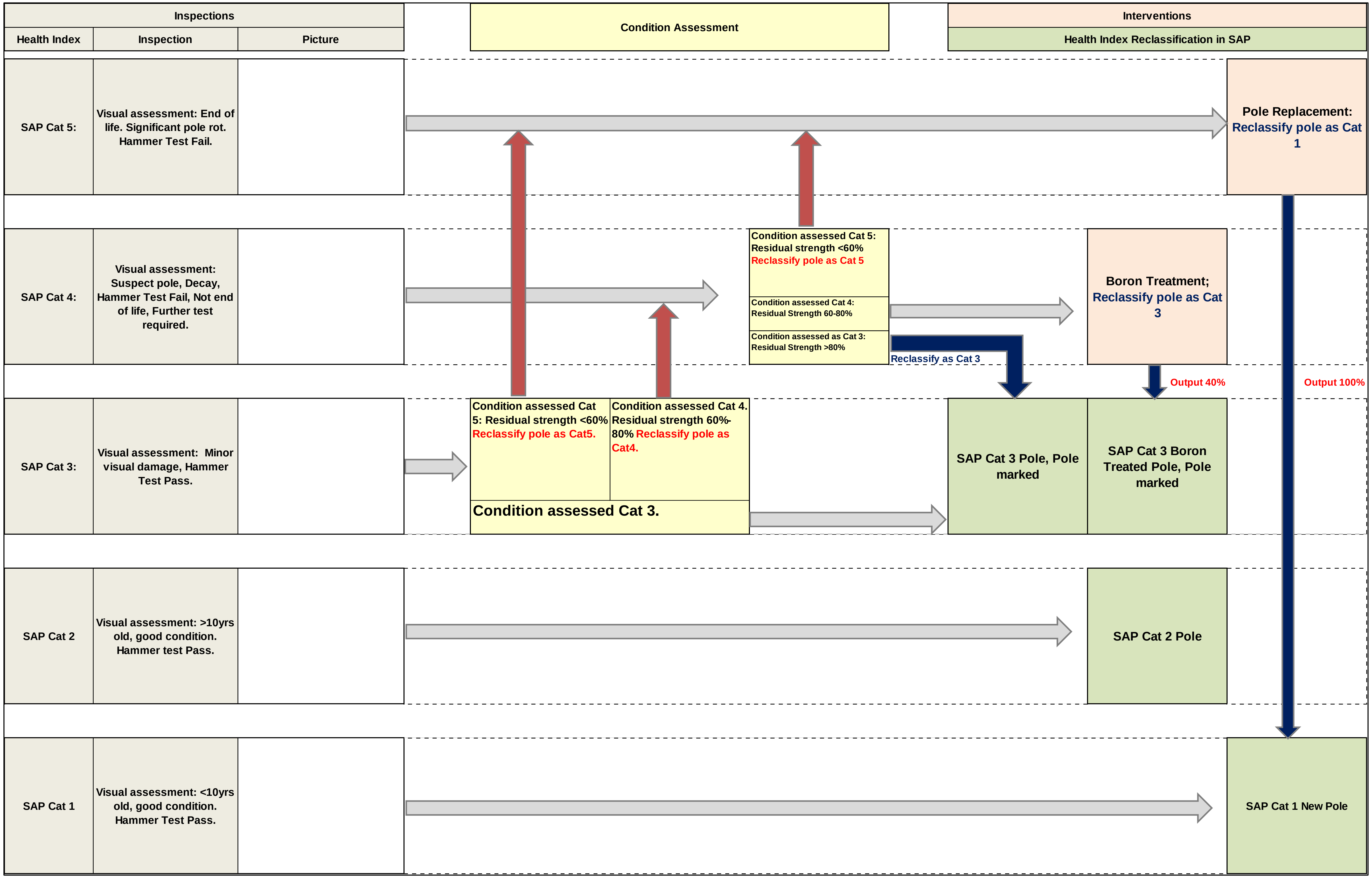
We will be resolving ESQCR hazards through our LV 'Village Modernisation' programme in ED1. We have forecast the volumes of hazards to be resolved by this Workstream, based on per km rates. These are not funded through the ESQCR table, instead being delivered as a consequence of asset replacement activity, although ESQCR clearance hazards form a substantial part of this programme's delivery process.

- Part of Other Planned Work: Is the resolution of an instance of non compliance with Electricity Supply Quality & Continuity Regulations (2002) (as amended) regulations 17 and 18, achieved as a by-product of work undertaken for other reasons. For example the dismantlement of a non compliant overhead line as part of a general reinforcement project.

All of our ESQCR regulation 17 and 18 clearance hazard programmes are included in table CV2. We have used the Legal and Safety table for other ESQCR hazards (e.g. Danger of Death plates, anti-climber devices) excluding regulations 17 and 18

- Legal and Safety: Investment or intervention where the prime driver is to meet safety requirements and to protect staff and the public. This does not include assets replaced because of condition assessment or to meet ESQCR regulations 17 and 18.

8.3. Wood Pole Health Index Methodology



9. Glossary

ABC	Aerial Bundled Conductor, overhead line conductors insulated with plastic
Bare (Open) Wire	Uninsulated copper overhead conductors
Defect Risk Weighting	Severity of apparatus defect related non-conformance, specified in SPEN policy
Effectively Insulated	Plastic insulated LV conductor with a low risk of persons receiving an electric shock, other than as a result of mechanical damage.
ESQCR	Electricity Supply Quality and Continuity Regulations 2002
ESRI	Environmental Systems Research Institute, suppliers of SPEN GIS software
Hazard Risk Weighting	Severity of risk associated with ESQCR related non-conformance, specified in SPEN policy
Location Risk Weighting	Severity of risk of contact with SPEN apparatus – including overhead lines – from members of the public (either inadvertent or intentional)
SAP	SPEN’s Asset Management and financial Software Suite