Scottish & Southern Electricity Networks

RIIO-ED2 Engineering Justification Paper (EJP)

33kV & 132kV Overhead Tower Line

Investment Reference No: 425_SSEPD_NLR_33kV&132kV_TOWERS

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Investment Summary Table

Table 1 below provides a high level summary of the key information relevant to this Engineering Justification Paper (EJP) and the replacement of 33kV & 132kV overhead towers, fittings and conductor.

Table 1: Investment Summary

Name of Programme	33kV & 132kV Overhead Line Towers, Conductor and Fittings CAPEX Intervention						
Primary Investment Driver	Non-Load - Condition						
Investment category	425_SSEPD_NLR_33kV&132kV_TOWERS						
Output type	• 33kV Overhead (OHL) Tower Line Conductor • 33kV Towers • 33kV Fittings • 132kV Overhead (OHL) Tower Line Conductor • 132kV Towers • 132kV Fittings						
Cost (£m)	25.05						
Delivery Year	RIIO-ED2 (2024 – 2028)						
Reporting Table	CV7: Asset Replacement CV9: Refurbishment SDI						
Outputs in RIIO-ED1 Business Plan?	No						
Spend Apportionment	**Licenced Area**	**ED1**	**ED2 (£m)**	**ED3+**			
	SHEPD	-	1.61	-			
	SEPD	-	23.44	-			
RIIO-ED2 Spend (£m) – 33kV Overhead (OHL) Tower Line Conductor*							
CV9 Refurbishment RIIO-ED2 Spend (£m)	**Year**	**2024**	**2025**	**2026**	**2027**	**2028**	**Total**
	SHEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
RIIO-ED2 Spend (£m) – 33kV Towers*							
CV9 Refurbishment RIIO-ED2 Spend (£m)	**Year**	**2024**	**2025**	**2026**	**2027**	**2028**	**Total**
	SHEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	SEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
RIIO-ED2 Spend (£m) – 33kV Fittings*							
CV7 Asset Replacement RIIO-ED2 Spend (£m)	**Year**	**2024**	**2025**	**2026**	**2027**	**2028**	**Total**
	SHEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	SEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

RIIO-ED2 Spend (£m) – 132kV Overhead (OHL) Tower Line Conductor*							
CV7 Asset Replacement RIIO-ED2 Spend (£m)	Year	2024	2025	2026	2027	2028	Total
	SEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
RIIO-ED2 Spend (£m) – 132kV Towers*							
CV9 Refurbishment RIIO-ED2 Spend (£m)	Year	2024	2025	2026	2027	2028	Total
	SEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
RIIO-ED2 Spend (£m) – 132kV Fittings*							
CV7 Asset Replacement RIIO-ED2 Spend (£m)	Year	2024	2025	2026	2027	2028	Total
	SEPD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

*** For total costs, refer to appropriate Business Plan Data Tables (CV7/CV9); rounding affects total additions.**

RIIO-ED2 Volumes – 33kV Overhead (OHL) Tower Line Conductor (km)							
CV7 Asset Replacement RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SHEPD	3.0	4.0	4.0	4.0	4.2	**19.2**
RIIO-ED2 Volumes – 33kV Towers							
CV9 Refurbishment RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SHEPD	-	-	-	34	33	**67**
	SEPD	4	5	5	5	5	**24**
RIIO-ED2 Volumes – 33kV Fittings							
CV7 Asset Replacement RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SHEPD	24	26	29	29	28	**136**
	SEPD	18	23	24	24	24	**113**
RIIO-ED2 Volumes – 132kV Overhead (OHL) Tower Line Conductor (km)							
CV7 Asset Replacement RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SEPD	11.0	14.0	15.0	15.0	16.6	**71.6**
RIIO-ED2 Volumes – 132kV Towers							
CV9 Refurbishment RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SEPD	70	76	84	86	86	**402**
RIIO-ED2 Volumes – 132kV Fittings							
CV7 Asset Replacement RIIO-ED2 Volumes	Year	2024	2025	2026	2027	2028	Total
	SEPD	276	356	383	383	384	**1,782**

1 Executive Summary

Our proposed investment for 33kV & 132kV towers, conductor and fittings will deliver improved network reliability through providing intervention on 493 33kV & 132kV towers, 2031 tower line fittings and 90.9km of tower line conductor in the SHEPD and SEPD licence area. This investment is required to meet our 'Delivering a safe, resilient and responsive network' Business Plan priority.

The primary driver for this category is the condition or health of each asset. For 33kV & 132kV towers, conductor and fittings the investment works have been identified using a Condition Based Risk Management (CBRM) tool, developed using the Common Network Asset Indices Methodology (CNAIM). CBRM is supplemented by an asset management software, CyberHawk iHawk, that records data captured from drones, helicopters or ground patrols and converts it into powerful and usable management information that is fed back into **CBRM**. Further information can be found in our document: ***Safe and Resilient (Annex 7.1)***.

Without intervention in this asset category, we can expect a significant number of 33kV & 132kV towers, conductor and fittings asset defects which would impact directly on network reliability, customer satisfaction and the safety of our staff. In addition to the key primary driver, there are a number of secondary drivers such as the number of customers, network outages or future network trend analysis that will also impact the programme of intervention works proposed.

For 33kV & 132kV towers, conductor and fittings the options used to address the proposed interventions have been considered in detail in this paper. These options are:

- Do Minimum
- Full Rebuild of Section/Span
- **Reconductor Overhead Tower Line**
- **Insulators and Fittings Replacement**
- **Tower Painting & Steelwork Replacement**

The outcome from the optioneering analysis found that the only viable options are reconductoring of overhead line, insulators and fittings replacement, tower paintings and tower steelwork replacement.

We will spend **£25.05m** on **33kV & 132kV towers, conductor, and fittings** throughout the ED2 regulatory period to reduce the risk of asset failure; 33kV & 132kV towers, conductor, and fittings are integral to the operation of our safe and reliable network. These replacements & refurbishments are intended to maximise the capacity and availability for all network customers.

2 Introduction

This Engineering Justification Paper (EJP) describes our proposed non-load related investment plan for the 33kV & 132kV Overhead Line Towers, Conductor and Fittings asset category during RIIO-ED2.

The primary driver considered within this paper is the condition of 33kV & 132kV Overhead Line Towers, Conductor and Fittings as measured through our inspection and maintenance regimes and our Condition Based Risk Management (CBRM) model which aligns with Ofgem's Common Network Asset Indices Methodology (CNAIM).

Section 3 discusses the primary and secondary investment drivers for these assets. The main driver is the poor condition of the asset. We then provide high-level background information for this asset category and explain the importance of this asset for our electricity distribution network and our network customer, as well as providing detail on the systems we use to identify the need for intervention to ensure our 33kV & 132kV Overhead Line Towers, Conductor and Fittings are in good health over the course of RIIO-ED2 and beyond.

Section 4 describes the key learnings from our stakeholder engagement activities and its relevance to the management of 33kV & 132kV Overhead Line Towers, Conductor and Fittings.

Section 5 presents a table of intervention options for the 33kV & 132kV Overhead Line Towers, Conductor and Fittings with additional sections providing greater detail on each option to indicate whether the option is taken forwards or not.

Section 6 describes the cost and volumes arising from the preferred intervention options.

Section 6 also describes how we have established the cost efficiency of the plan with reference to the unit costs that have been chosen, and the deliverability of the plan with respect to our ability to replace the volume of 33kV & 132kV Overhead Line Towers, Conductor and Fittings indicated within this paper during RIIO-ED2 for the cost allowance requested.

Section 7 concludes with a summary of the EJP and its recommendations.

The Appendices start from Section 8 with a Table of Acronyms, followed by Appendices and relevant internal standards and policies.

3 Background Information

This section of the report provides useful background information on our 33kV & 132kV Towers, Conductor and Fittings asset category. This includes a description of the assets under consideration, the importance of these assets to network customers, and the approach used to identify those that most require intervention during RIIO-ED2.

3.1 33kV & 132kV Towers, Conductor and Fittings

A steel tower overhead line route is a complex, composite asset of many individual towers holding high voltage electrical conductors above the ground. The towers are based on a reinforced concrete foundation that supports the whole structure in all weather and system conditions. Towers have fittings, conductors, earth wire associated with two separate circuits. 33kV & 132kV Overhead Tower Line assets are utilised to distribute electricity across our network, connecting grid & primary substations across the licence areas.

Overhead line towers and associated assets have several principal consequences of failure. First, towers and associated assets in poor condition can present a critical risk to the public in their vicinity or our staff conducting planned or unplanned maintenance work. Second, poor condition critically low sagging conductors can violate the safety clearances and present an electrical safety risk.

In addition, the fallen conductor can cause an overhead line trip, which will lead to an outage of that part of the network. Finally, a full or partial tower collapse could happen if the steelwork and foundations are not maintained adequately, leading to some or all the above consequences and costly damage to the tower close by and the overhead line circuit.

Overhead line tower circuits failures usually do not occur during everyday environmental conditions when towers, conductor, fittings and all the other associated assets are properly maintained. However, asset defects with a combination of harsh conditions like strong winds, lightning storms, snowstorms or ice loadings could lead to widespread failures at a time, when the reliability is most needed by the general public.

As such, it is critical that we maintain the condition of this asset category to prevent a reduction in the quality of supply for customers and to maintain the safety of our Overhead Tower Lines for our staff and the public.

Preventing the end-of-life failure of these Overhead Tower Lines will also avoid costly reactive replacement which can be significantly more expensive than the cost associated with planned proactive replacement before failure.

As the health of each Tower, Conductor & Fitting deteriorates over time the Probability of Failure (PoF) increases. To prevent unwanted failures before they happen and to avoid costly reactive replacement of failed towers, fittings and conductor, we calculate a Health Score for each of the assets.

Figure 1 to 7 below show examples of typical 33kV & 132kV Overhead Towers, Fittings and 132kV overhead tower line conductor on our distribution network.

Figure 1: Melksham-Andover 132kV Overhead (Tower) Line

Figure 2: Typical Rust Degraded Insulator Fittings

Figure 3: Typical 132kV Overhead Line Conductor (ACSR)

Figure 4: Healthy 33kV Tower. SSEN PKE Circuit

Figure 5: Degraded 33kV Tower. SSEN PKE Circuit

Figure 6: Healthy 33kV Tower Fitting. SSEN 33kV RMA Circuit

Figure 7: Rusted 33kV Tower Fitting. SSEN 33kV RMA Circuit

Table 2 show the quantity of 33kV & 132kV Towers, Fittings and Overhead Tower Line conductor within both our licenced areas and the average age of the asset category in both regions.

Table 2: Number of 132kV Towers, Fittings and Overhead Line Conductor

Asset Category	SEPD		SHEPD	
	Average Age	No. of Units	Average Age	No. of Units
33kV OHL Tower Line Conductor	39.9 years	232.7km	49.6 years	227.8km
33kV Towers	82.0 years	700	66.6 years	229
33kV Fittings	39.9 years	1,145	49.8 years	338
132kV OHL Tower Line Conductor	38.2 years	1854.8km	-	-
132kV Towers	63.8 years	3922 towers	-	-
132kV Fittings	37.0 years	7070 fittings	-	-

Figure 8 to Figure 16 shows the Age Profile for 33kV & 132kV Towers, Conductor and Fittings category in SHEPD and SEPD regions. These show the number of assets installed during each calendar year. It is important to note that due to how 33kV & 132kV Towers are maintained, it is difficult to depict the tower's age as a whole, as parts of the towers steel structure can vary in age.

There is a correlation between age and asset health, as the condition of each asset will generally reduce over time. However, our CBRM models calculates a specific Health and Criticality score for each asset and it is these values that are used to determine the number of assets that required condition related intervention each year. The age profiles below are provided for information purposes only and cannot be used in isolation to justify any investment in the asset category.

However, these Age Profiles demonstrate the variance in the rate at which the network was built over time. This variance in the rate at which the network was initially built can result in a sudden increase or decrease in future investment as the Fittings and Overhead Tower Line installed in the same time period collectively reach the end of life condition. As a result, it is likely that there will be a shift in the number of Fittings and Overhead Tower Line Conductor that require intervention from one regulatory period to the next.

Figure 8: Age Profile for 33kV Towers SHEPD

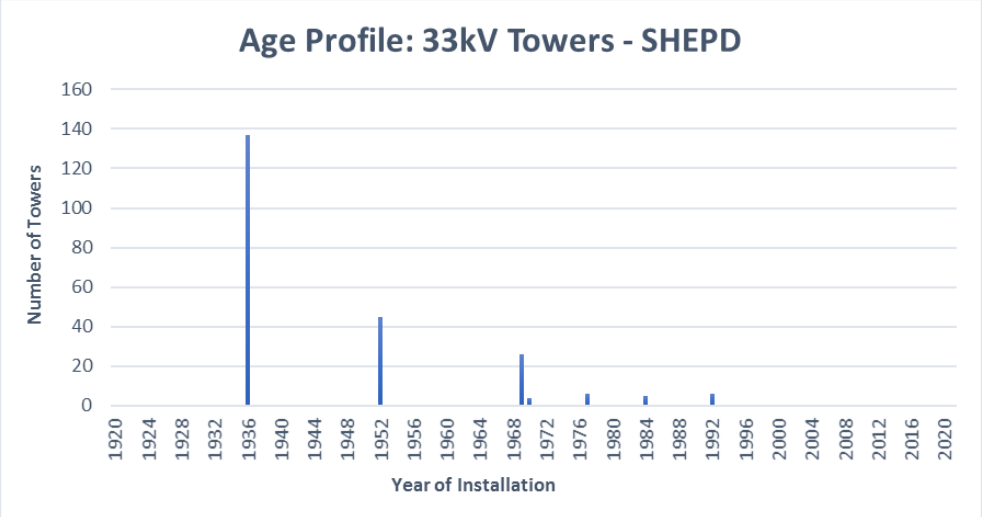


Figure 9. Age Profile for 33kV Tower Line Conductor SHEPD

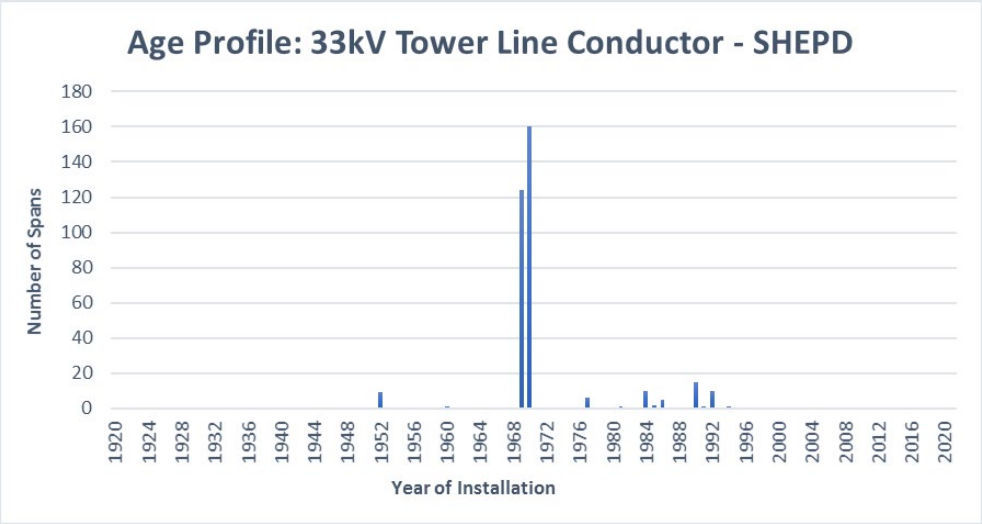


Figure 10. Age Profile for 33kV Fittings SHEPD

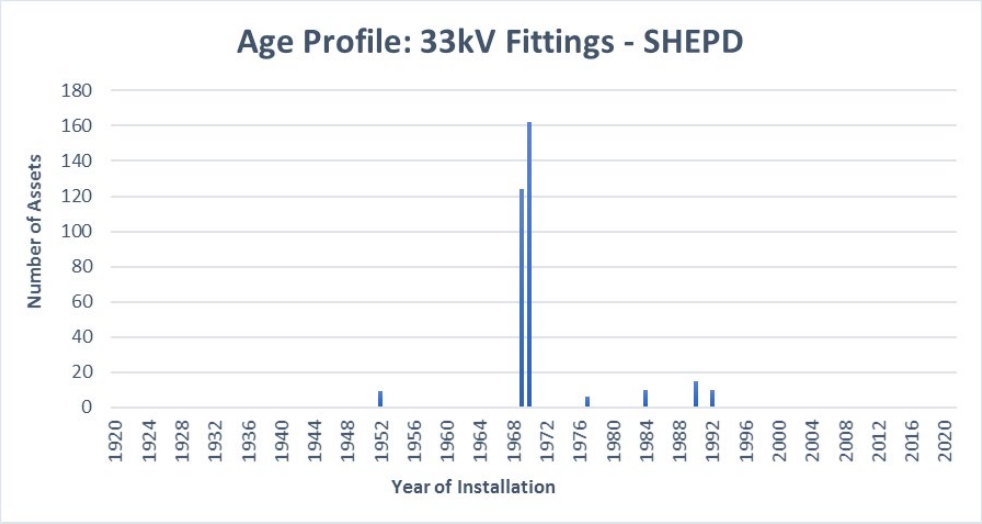


Figure 11: Age Profile for 33kV Towers SEPD

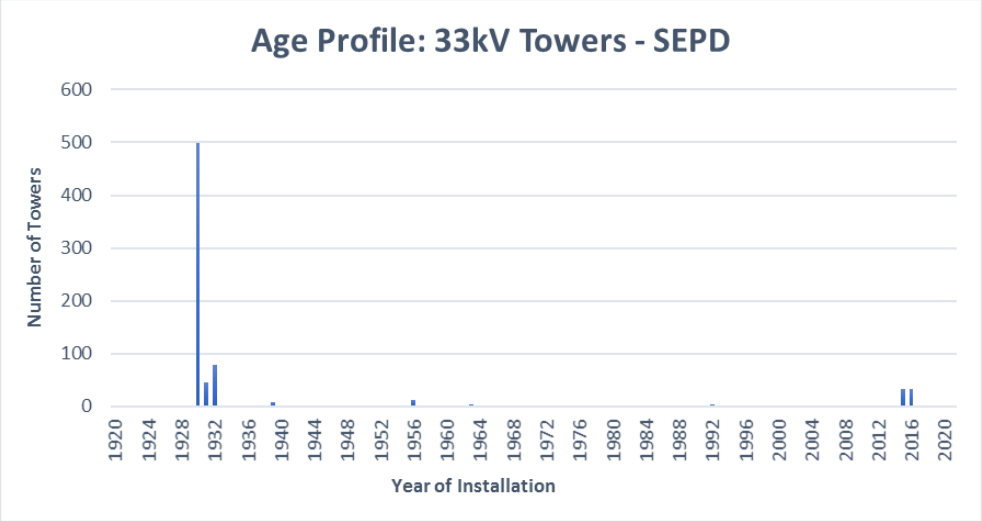


Figure 12: Age Profile for 33kV Tower Line Conductor SEPD

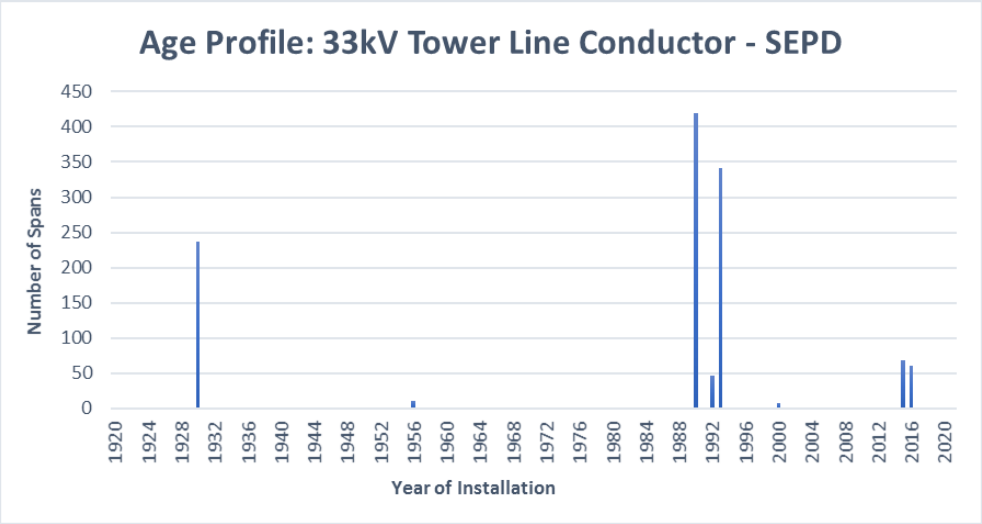


Figure 13: Age Profile for 33kV Tower Fittings SEPD

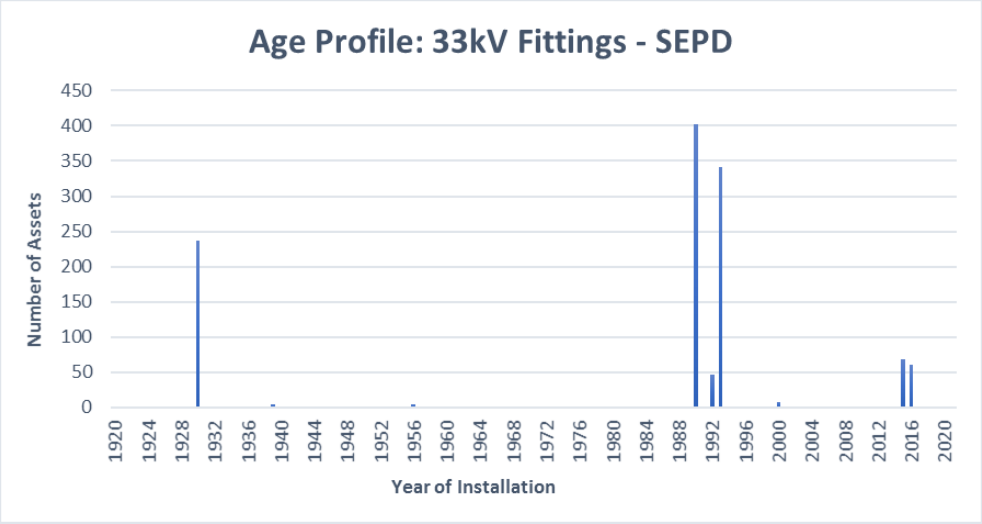


Figure 14: Age Profile for 132kV Towers - SEPD

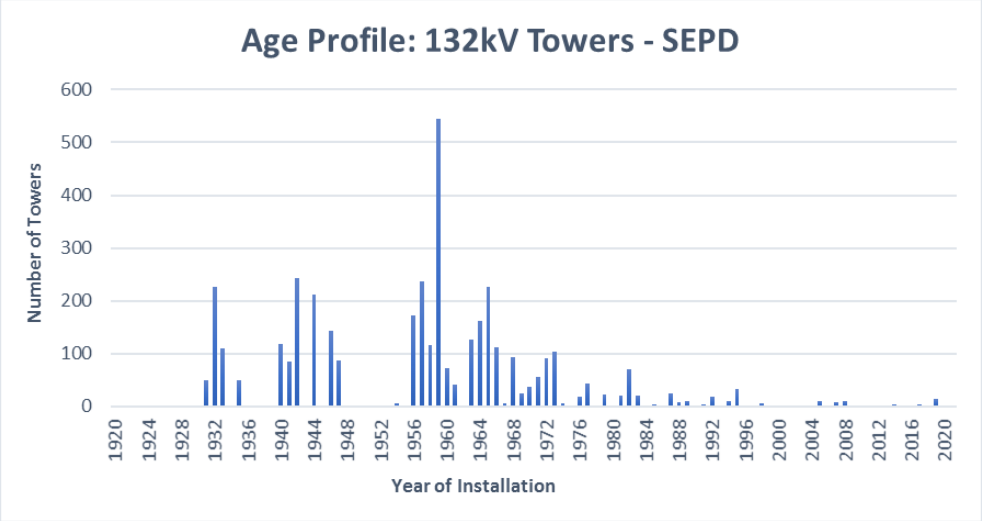


Figure 15: Age Profile for 132kV Tower Line Conductor SEPD

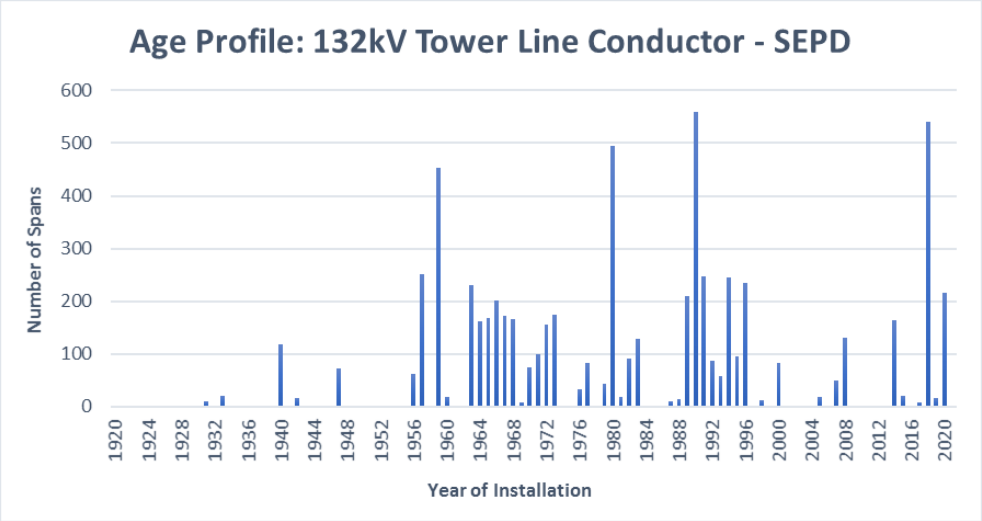
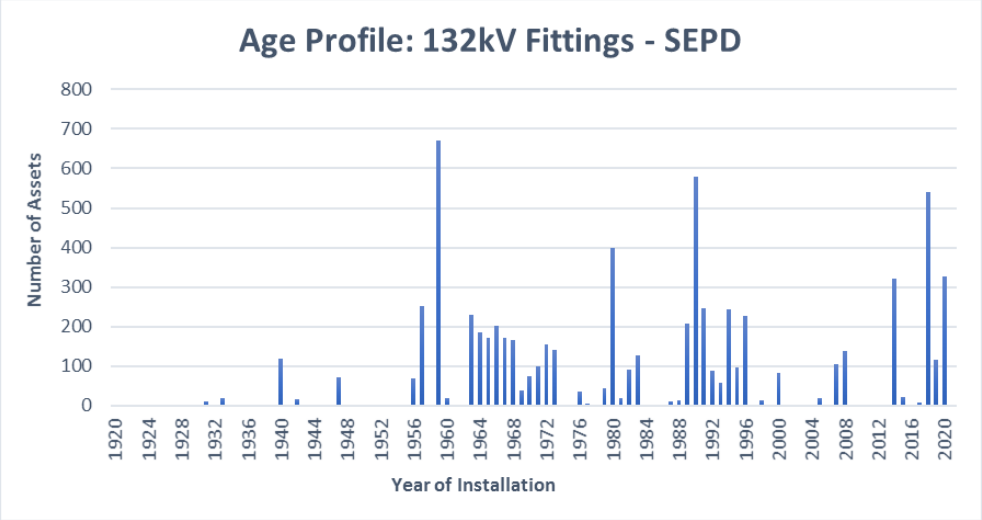


Figure 16: Age Profile for 132kV Overhead Tower Fittings SEPD



3.2 Primary Investment Drivers

For 33kV & 132kV Towers, Conductor, and fittings the primary driver relates to the health and criticality of the assets. This asset category is tracked by our Condition Based Risk Management (CBRM) system and informed by Cyberhawk iHawk system. A key part of the CBRM calculation of Asset Health is the presence of deterioration and rusting within the asset group

The primary investment drivers described above correlate to the following Cost and Volumes (CV) tables within the RIIO-ED2 Business Plan Data Tables (BPDT). The costs and volumes associated with each CV table and corresponding asset category depend upon the investment strategy and options that are chosen for each primary and secondary investment driver.

- **CV7 – Asset Replacement:** The replacement of network assets due to their health and criticality of each asset as defined by the CBRM policy.
- **CV9 – Refurbishment (SDI):** The refurbishment of network assets due to their health and criticality of each asset as defined by the CBRM policy.

The CBRM models maintained by us provide a Health, Criticality, and Risk score for each individual asset. The risk score (asset health and criticality) attributed to each asset by the CBRM models is a key metric that triggers a need for investment into this asset category. This is calculated using a variety of asset-specific data which include basic parameters in addition to the observed and measured condition of each asset.

Table 3 lists the data that may be used to inform whether an individual overhead Tower Line asset requires investment for non-load related purposes. As seen below, this data is often captured by CBRM and is used to calculate the risk score for each asset. However, occasionally the data list below is analysed separately alongside the CBRM scoring to determine if the asset requires non-load related investment (such as operational restrictions).

Table 3: Primary data relevant to condition lead investment into 33kV & 132kV Overhead Tower Line

Category	Factor included in CBRM
Basic Asset Parameters	Asset age
	Expected lifetime
	Fault history
	Corrosion monitoring
	Thermal imaging
Observed Condition	External condition
	Defects
	Local environment
Location Factor	Distance from coast
	Altitude
	Environment
	Corrosion category index

3.3 Secondary Investment Drivers and associated CV Tables

Whilst this investment pack is intended to inform the management of 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor assets for non-load related purposes, the investment options described within this EJP are **also coordinated with alternative investment drivers** that have influenced the final investment option that has been selected for each overhead tower line project.

It is important to ensure that these alternative investment drivers are also considered carefully alongside the asset health replacement proposals to identify potential efficiencies and prevent double counting within our RIIO-ED2 business plans.

This includes the consideration of future network trends to ensure sustainable investment decision are identified which represent best value for money for our network consumers and customers, whilst enabling the transition to Net Zero.

The alternative investment drivers that influence the investment options within this EJP are quality of supply, primary reinforcement, and visual amenity. These alternative drivers correlate to the following additional CV tables within the BPDT:

- **CV1 – Primary Reinforcement:** The replacement of assets due to load related growth. This includes upgrading/replacing overhead line assets and/or undergrounding assets to meet future demand.
- **CV15 – Quality of Service:** The replacement, refurbishment, or retrofit of network assets to improve customer quality of service. This can include the upgrading of network automation.
- **CV 20 – Visual Amenity:** The replacement of overhead lines to reduce the visual impact of overhead lines in National Parks, Areas of Outstanding Natural Beauty and National Scenic Areas, and this can be an investment driver if overhead lines need to be replaced by less intrusive options.

When selecting the investment option for each individual project the following factors and secondary investment drivers were also considered to ensure the optimal solution is identified which best represents value for money for network consumers and customers:

- **Network Criticality:** When assessing the investment options available it is also important to consider the number of consumers and customers associated with the overhead tower lines and the number of network outages. This will inform the criticality of the asset and inform the most appropriate investment solution.
- **Network Load Forecast:** Future network trend analysis must also be carried out for each individual project to determine if sustained load growth can be expected for the 33kV & 132kV overhead tower line assets in question. If load growth can be proven with a high level of confidence, a solution may be chosen which is not like-for-like, but one which can facilitate the future load growth that has been forecast. Similarly, the asset may be decommissioned if it can be demonstrated that other network assets can accommodate the forecasted network demand.

3.4 Condition Based Risk Management (CBRM)

We introduced our Condition Based Risk Management (CBRM) system in 2014 following the RIIO-ED1 Business Plan submission. However, since August 2017, we switched over fully to maximise utilisation of the Common Network Assets Indices Methodology (CNAIM) modelling for all asset classifications applicable for the RIIO-ED1 requirements with the data inputs outlined in the Information Gathering Plan (IGP).

The RIIO-ED2 Business Plan submission has been based on the latest version of the industry standard CNAIM v2.1 which was approved for use in RIIO-ED2 by Ofgem in April 2021. The supporting data used in the modelling of this submission is based on the reported position of our asset condition for RIIO-ED1 Year 6 at the end of March 2021, and subsequently reported to Ofgem in the summer of 2021.

The full details of the Energy Network Association's NARMs Electricity Distribution Working Group (NEDWG) publication on CNAIM v2.1 is available on Ofgem's website. For further detail on our RIIO-ED2 NARMS strategy please see ***Safe and Resilient (Annex 7.1)***.

The output from CBRM has been used to inform the intervention criteria utilising our internal Network Asset Indices Methodology (NAIM) on how the assets are selected for prioritised investment. This is based on the assets relative position in the standard CNAIM reporting Risk Index matrix as illustrated by Table 4 to Table 9 below, which shows the value of Monetised Risk attributed to each asset according to its attributed Health and Criticality within each cell, providing a reference risk value in £. However, consideration is given to the specific Health Score within the selection criteria for a more granular consideration than purely consideration of the wider Monetised Risk (HI/CI) classification only.

The specific Health Score Intervention Criteria we have established for this asset category has been developed within a number of internal workshops with our subject matter expert with the objective of finding the optimal balance of risk between proactive and reactive asset intervention. This approach has also been tested and ratified through targeted stakeholder engagement and intends to maximise both the reliability and importantly the affordability of the network for our customers.

A fuller understanding of our NAIM and how the specific Health Score Intervention Criteria for each specific asset category was reached is available in our thin section 8 and the associated referenced technical guidance document TG-NET-ENG-026 (NAIM).

Table 4: 33kV Tower Conductor Risk Index Matrix

		Health Index				
Criticality Index		HI1	HI2	HI3	HI4	HI5
	C1	650	2659	5453	8605	12561
	C2	929	3798	7791	12293	17945
	C3	1393	5697	11686	18440	26917
	C4	2322	9495	19477	30733	44861

Table 5: 33kV Towers Risk Index Matrix

Criticality Index	Health Index				
	HI1	HI2	HI3	HI4	HI5
C1	1664	4259	9212	15275	26860
C2	2377	6085	13160	21822	38372
C3	3566	9127	19740	32732	57557
C4	5943	15212	32900	54554	95929

Table 6:33kV Fittings Risk Index Matrix

Criticality Index	Health Index				
	HI1	HI2	HI3	HI4	HI5
C1	102	611	990	1319	1714
C2	146	873	1414	1884	2448
C3	218	1310	2121	2826	3672
C4	102	611	990	1319	1714

Table 7: 132kV Tower Conductor Risk Index Matrix

Criticality Index	Health Index				
	HI1	HI2	HI3	HI4	HI5
C1	899	3678	7544	11905	17378
C2	1285	5254	10778	17007	24825
C3	1927	7881	16167	25510	37238
C4	3212	13135	26944	42517	62063

Table 8: 132kV Towers Risk Index Matrix

Criticality Index	Health Index				
	HI1	HI2	HI3	HI4	HI5
C1	4078	10438	22576	37435	65826
C2	5826	14912	32251	53478	94038
C3	8739	22368	48377	80218	141056
C4	14566	37279	80628	133696	235094

Table 9: 132kV Fittings Risk Index Matrix

		Health Index				
Criticality Index		HI1	HI2	HI3	HI4	HI5
	C1	166	997	1614	2152	2796
	C2	238	1425	2306	3074	3994
	C3	356	2137	3459	4611	5991
	C4	594	3562	5766	7684	9985

The specific selection criteria for each asset classification is detailed more specifically later in this EJP in identifying the volume of the specific asset classification requiring intervention.

3.4.1 Health Index

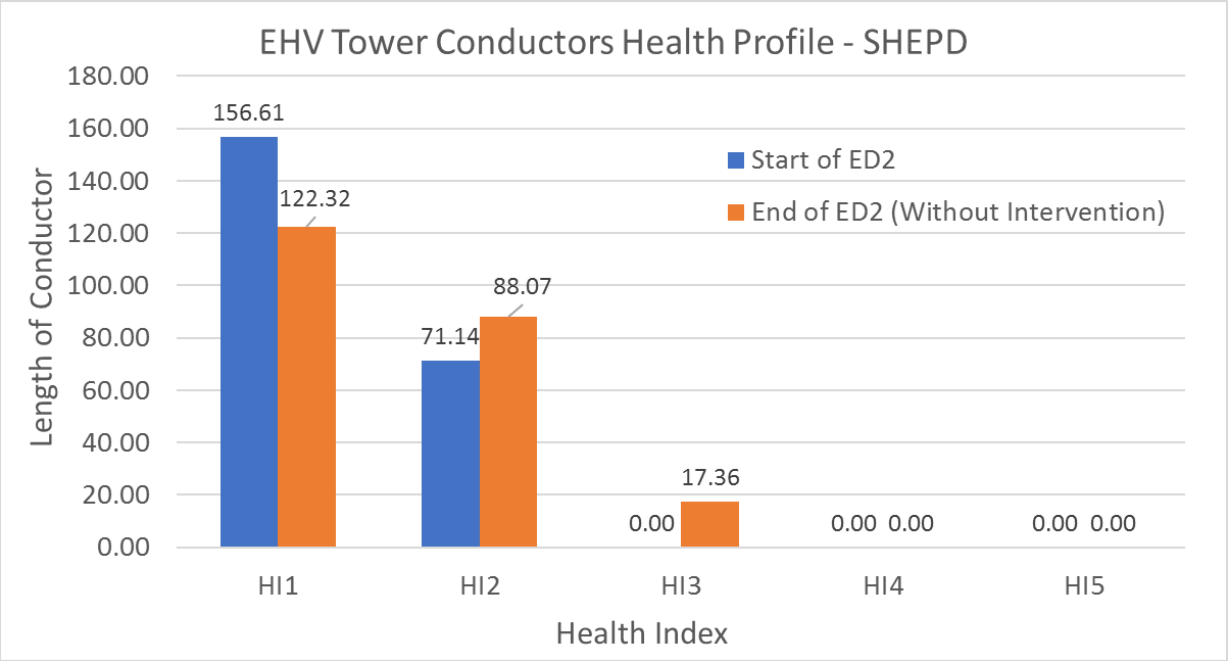
The Health Index is a key output of the CBRM policy. This measure provides a view on the condition of the asset relative to its Normal Expected Life. For 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor the Normal Expected Lifetimes are:

- For 33kV & 132kV Towers;
  - Steelwork is 80 years
  - Fully encased concrete foundations are 95 years
  - Earth grillage foundations are 60 years
  - Galvanising Paint Systems are 30 years
  - Painting is 20 years
- 40 years for 33kV & 132kV Tower Fittings;
- 50 - 60 years for 33kV & 132kV Overhead Tower Line Conductor;

Figure 17 to Figure 25 shows the Health Profile for 33kV & 132kV Towers, Conductor and Fittings for SHEPD & SEPD. The figures compare the profiles at the start of ED2 and then at the end of the period without investment in the asset category.

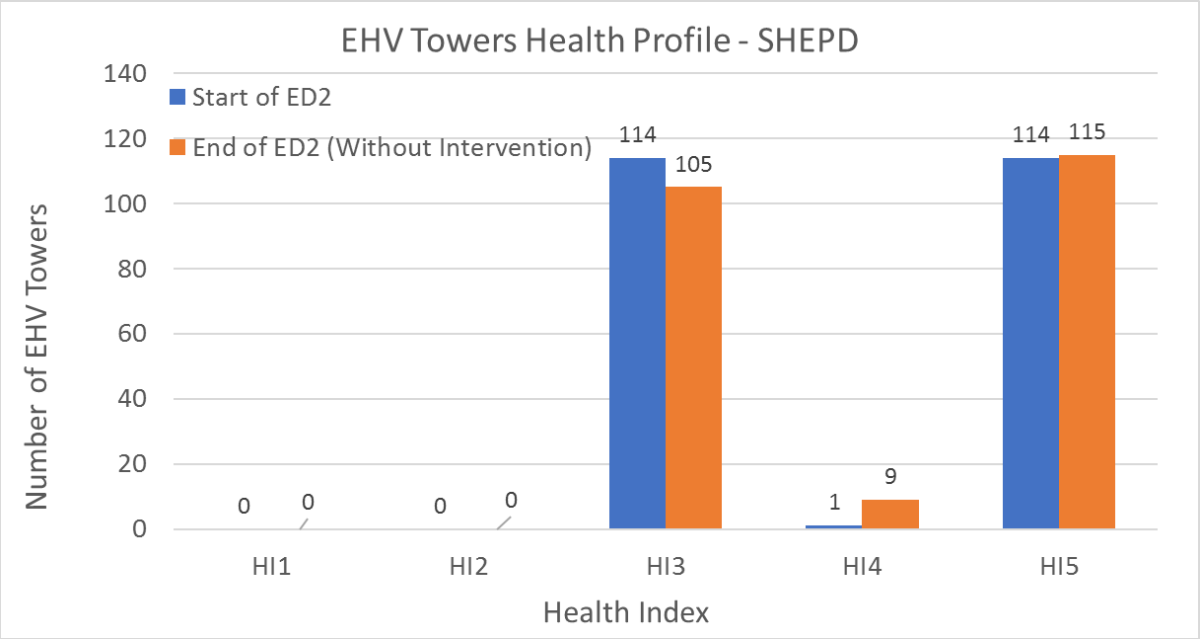
Figure 17 shows the EHV tower conductors (SHEPD) are in good condition with all the conductor line (227.75 km) in health index (HI) bands 1 and 2. By the end of ED2, 7.6 % has moved into HI band 3.

Figure 17: Health Profile for 33kV Tower Line Conductor SHEPD



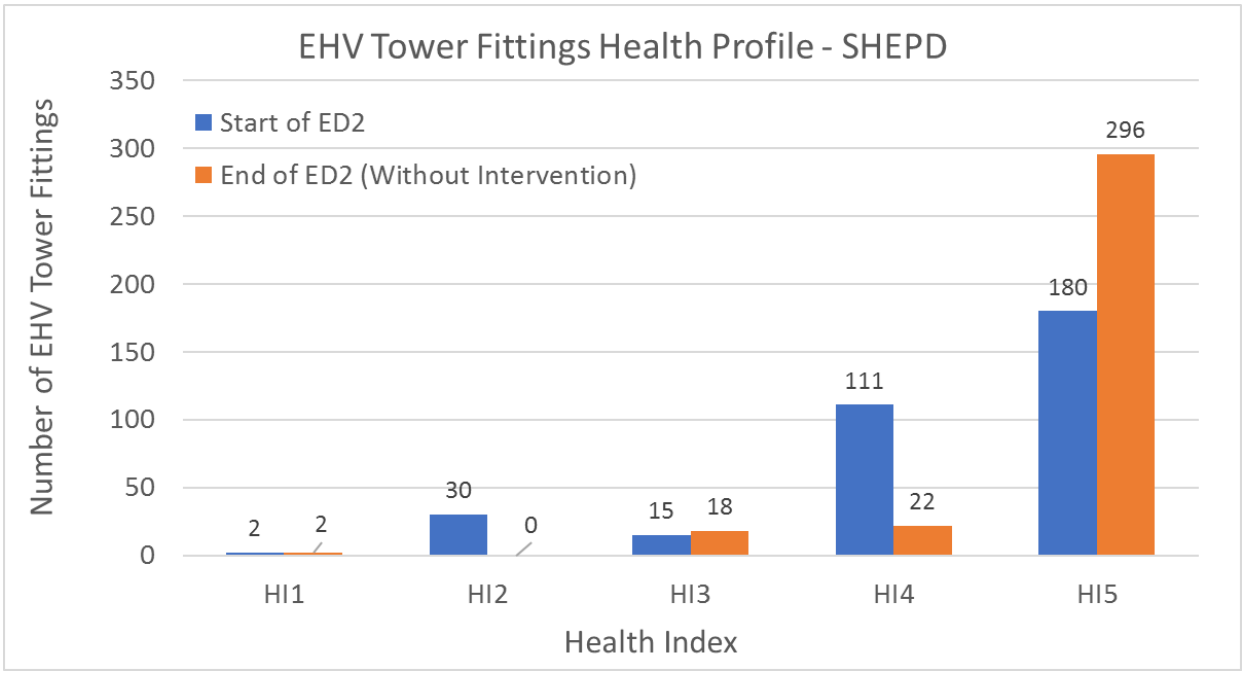
However, the EHV towers (SHEPD) health profile (Figure 18) indicates that there are already 114 towers at HI5 at the start of ED2 with another 114 at HI3. At the end of ED2, there are over 50 % of towers at HI5 and about 4 % of the total population now at HI4 indicating a need for intervention with this asset category.

Figure 18: Health Profile for 33kV Towers SHEPD



EHV Tower Fitting (SHEPD), Figure 19, shows a considerable increase (64 %) in HI5 assets by the end of ED2 without intervention. This is due mainly to the current HI4 assets becoming HI5 by the end of ED2.

Figure 19: Health Profile for 33kV Fittings SHEPD



As with SHEPD's tower conductors, the health profile for SEPD's conductors (Figure 20) also shows an asset class with no assets in poor condition. Indeed, only 20 % of the total km length of conductor will be at HI3 by the end of ED2.

Figure 20: Health Profile for 33kV Tower Line Conductor SEPD

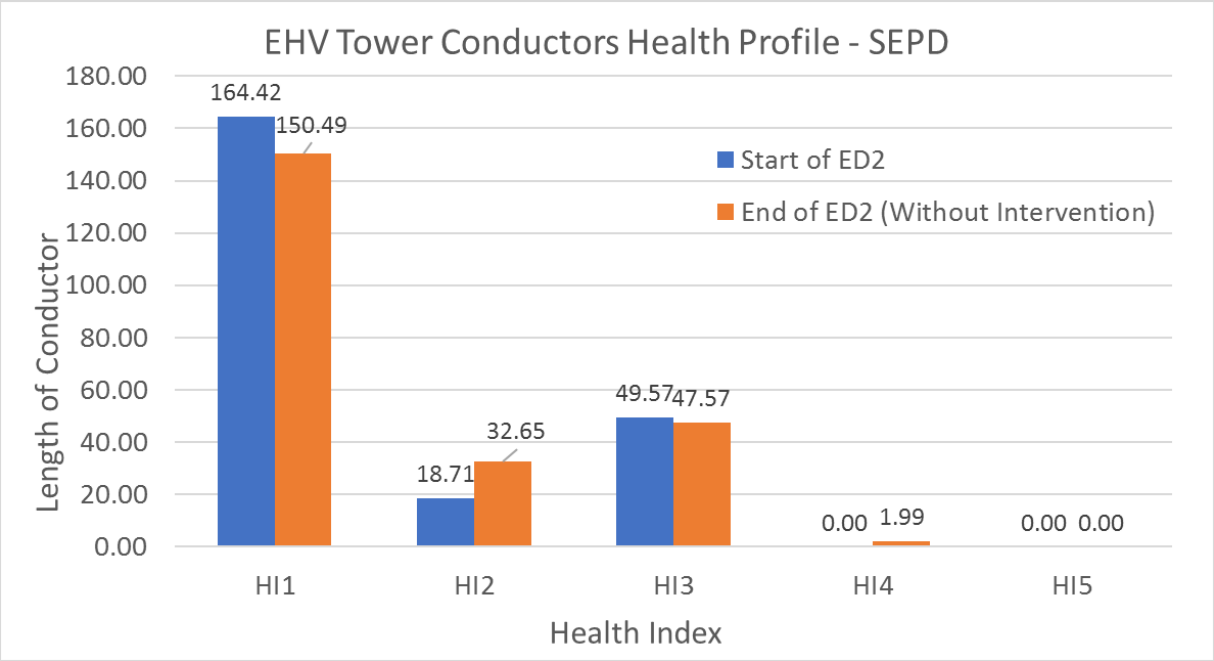
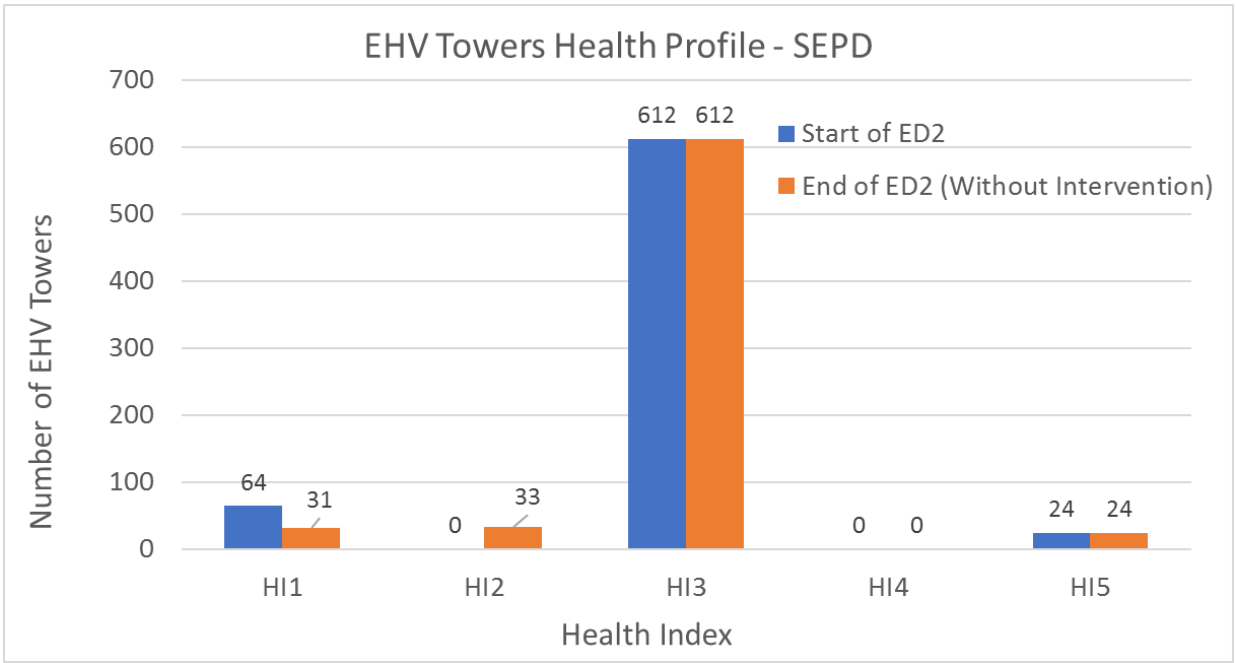


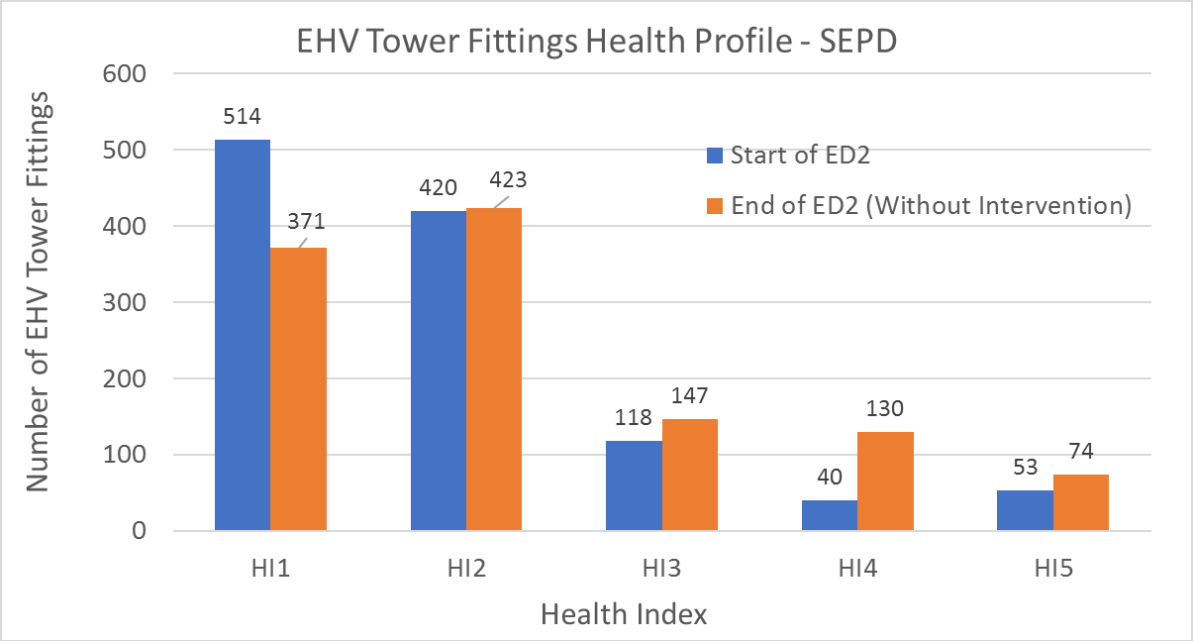
Figure 21 shows the health profile for SEPD Towers. There are 24 assets (3.4 %) HI5 for the duration of ED2, however, there are a large number (87 %) of assets at HI3 which could move to higher health indexes in future years beyond ED2. This is a large group of assets which would require maintenance to ensure that all assets do not fall into a high health category at the same time.

Figure 21: Health Profile for 33kV Towers SEPD



Although 82 % of EHV Tower Fittings are at Health index HI1 and HI2 (Figure 22), there are 18 % of assets at a higher health index (HI3-HI5) at the start of ED2. By the end of ED2 the number of assets at HI3-HI5 has increased to 30 % of assets with over 6 % at HI5.

Figure 22: Health Profile for 33kV Fittings SEPD



Although at 132kV (SEPD) at the start of ED2 there are only 5 % of tower conductor length at HI4 and HI5 (Figure 23), by the end of ED2 there are 31 % of total conductor length in these health bands, with the most significant increase in the health index HI4. Without intervention, a proportion of km length may become of danger to the safety of staff and of the public.

Figure 23: Health Profile for 132kV Tower Line Conductor SEPD

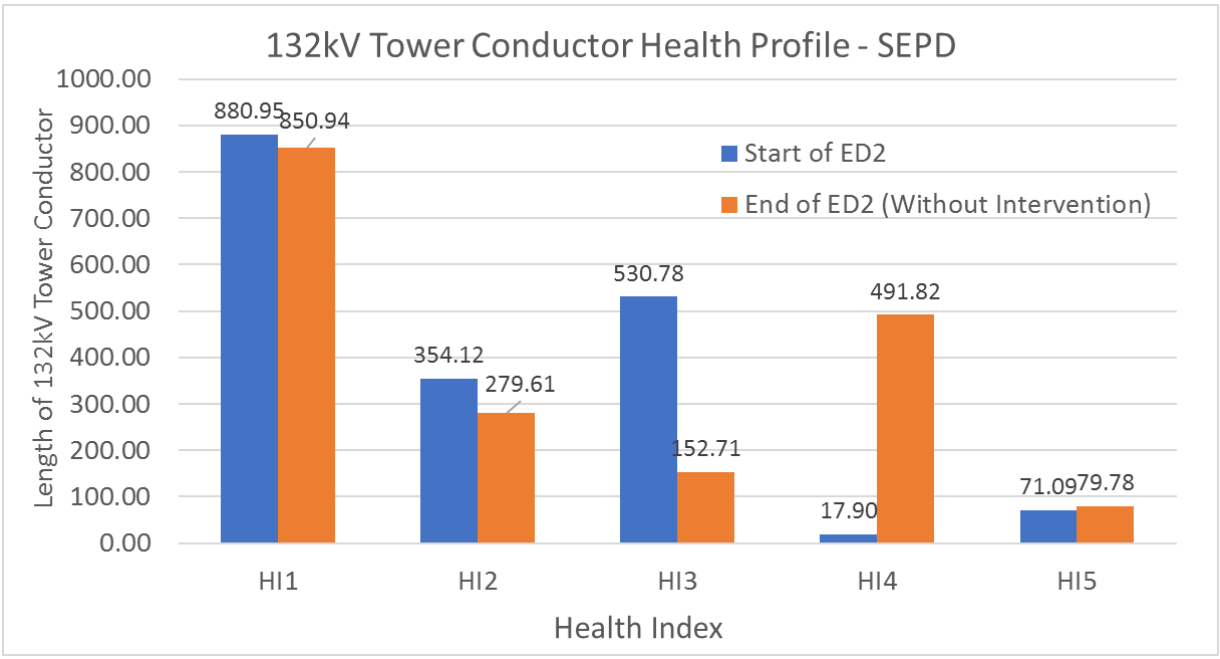
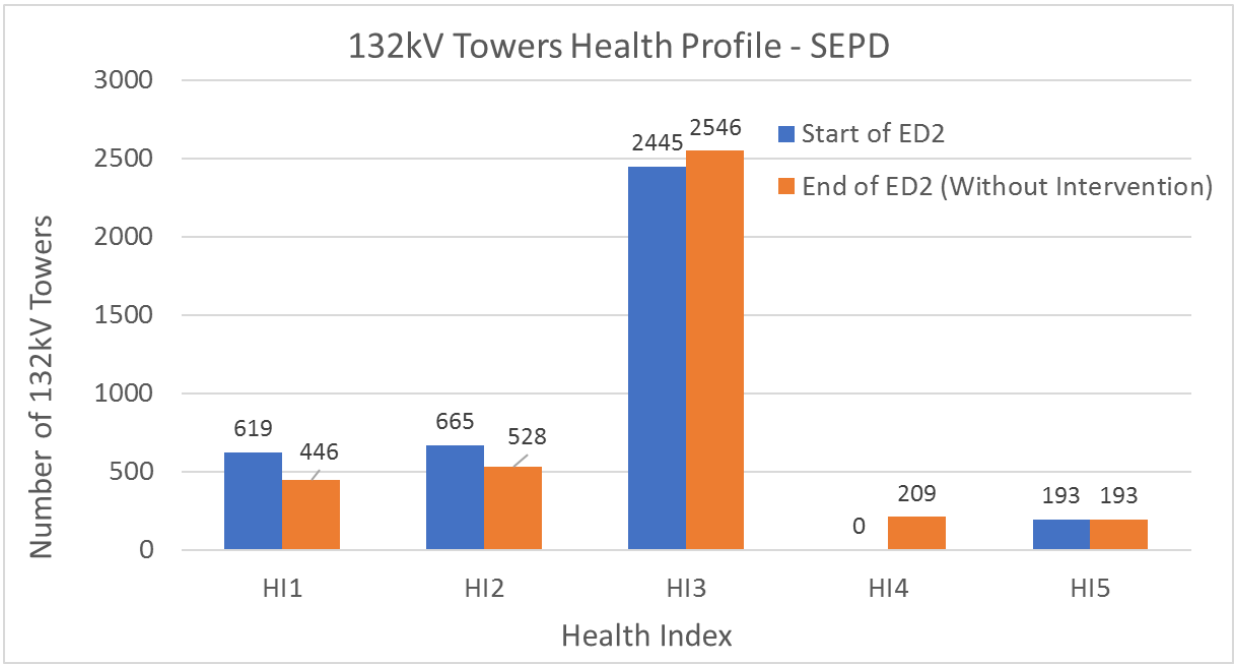


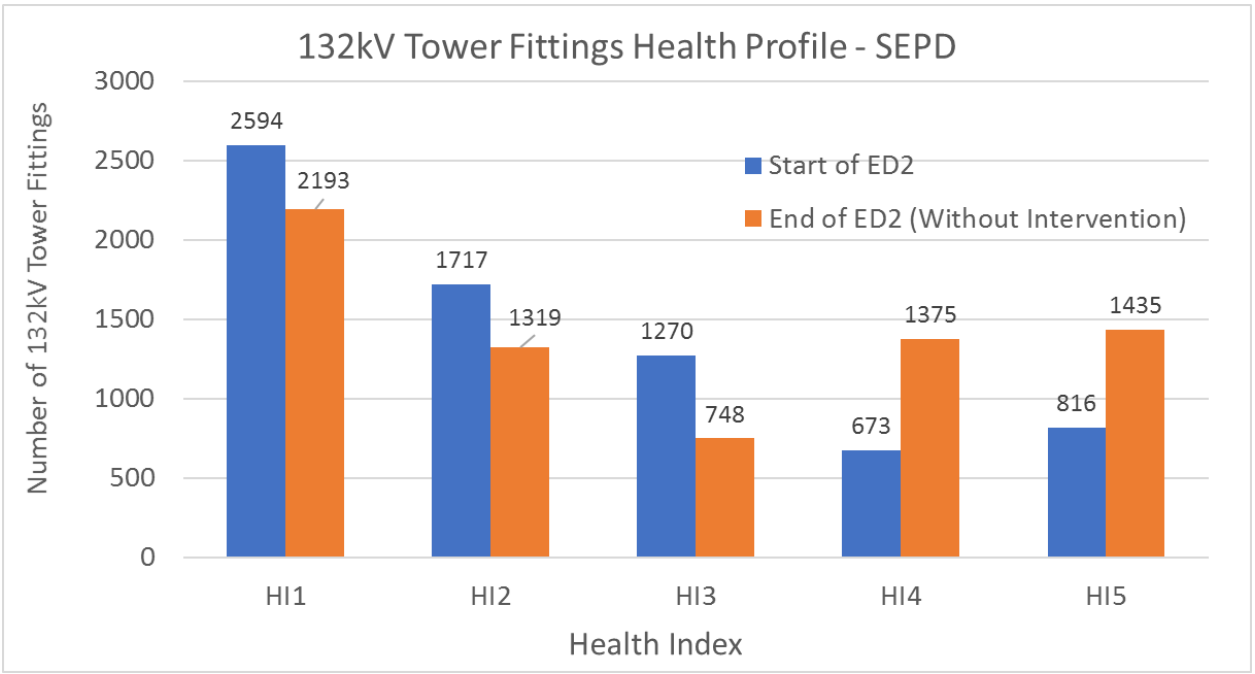
Figure 24 shows that there are already 193 towers (4.9 %) with a health index of HI5 at the start of ED2. Another 5.3 % move into HI4 by the end of ED2, indicating that there are over 10 % of towers with poorer condition (HI4 and HI5) by the end of ED2.

Figure 24: Health Profile for 132kV Towers SEPD



In Figure 25, both HI4 and HI5 bands show an increase in the volume of assets in these health bands: approximately 20 % in each band indicating that 40 % of tower fitting are in the HI4/HI5 categories.

Figure 25: Health Profile for 132kV Fittings SEPD



3.4.2 Criticality Index

Figure 26 to Figure 34 below show the current Criticality Profiles for 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor for SHEPD & SEPD. As illustrated, a vast majority of the assets are classified as C2. Even in Figure 32 for 132kV tower conductors, the percentage outside the C2 band, in C3, is just 6.5 %.

Each asset's criticality will likely remain constant from the beginning to the end of RIIO-ED2, as the consequence of failure is unlikely to change without a significant change in the network's characteristics (e.g. the number of customers connected to each asset etc.).

Figure 26: Criticality Profile for 33kV Tower Line Conductor SHEPD

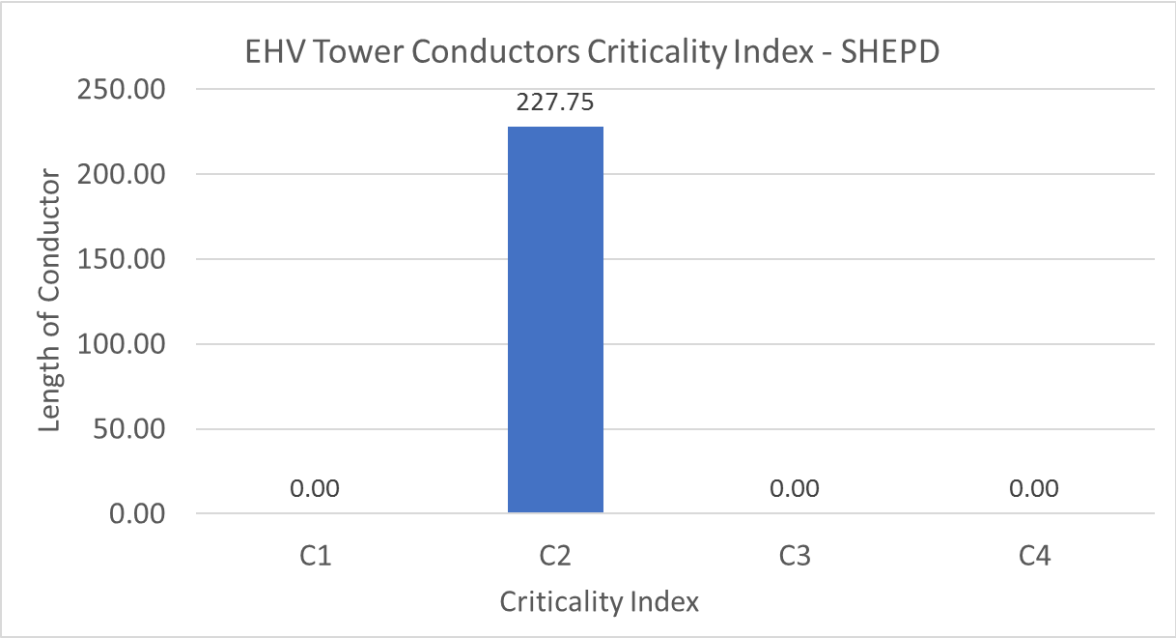


Figure 27: Criticality Profile for 33kV Towers SHEPD

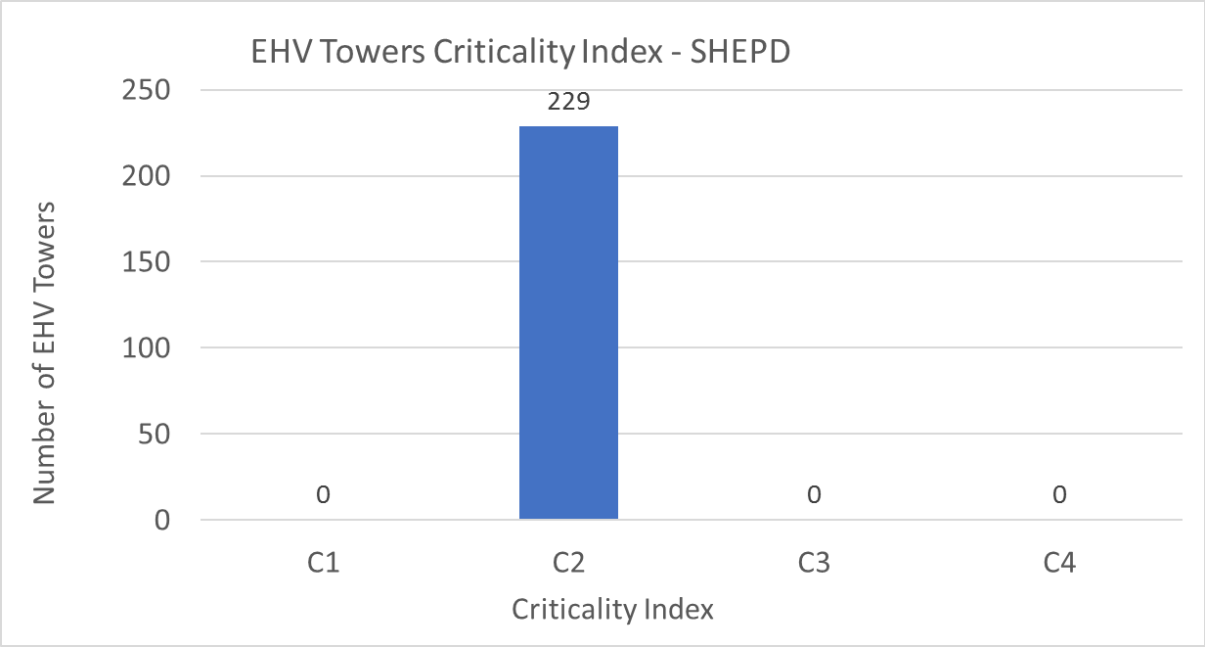


Figure 28: Criticality Profile for 33kV Fittings SHEPD

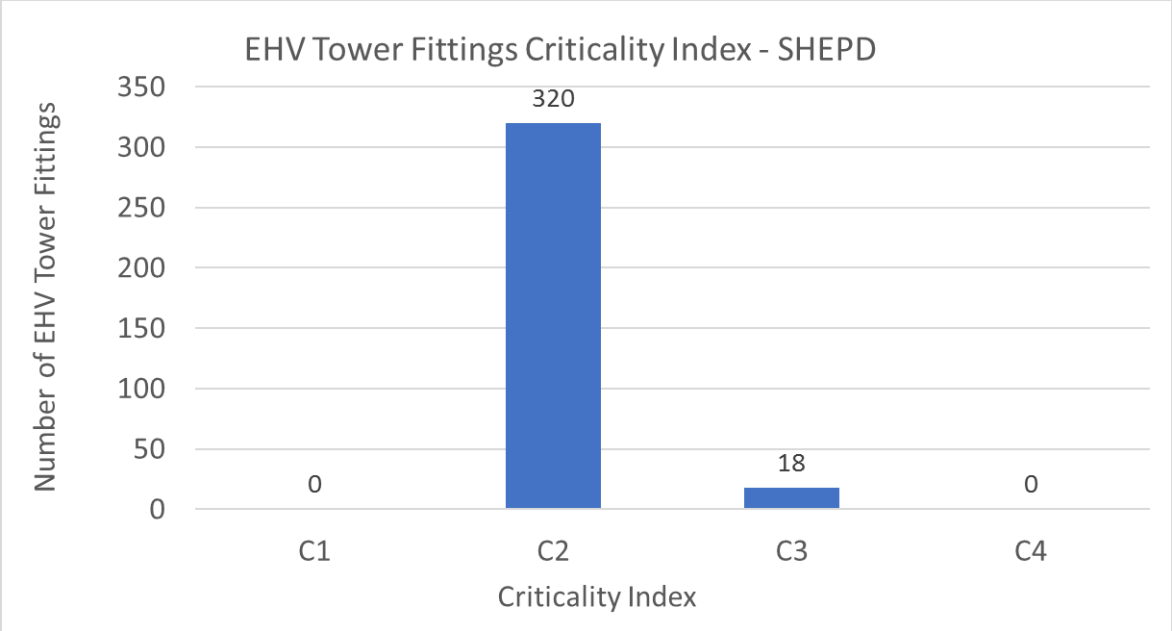


Figure 29: Criticality Profile for 33kV Tower Line Conductor SEPD

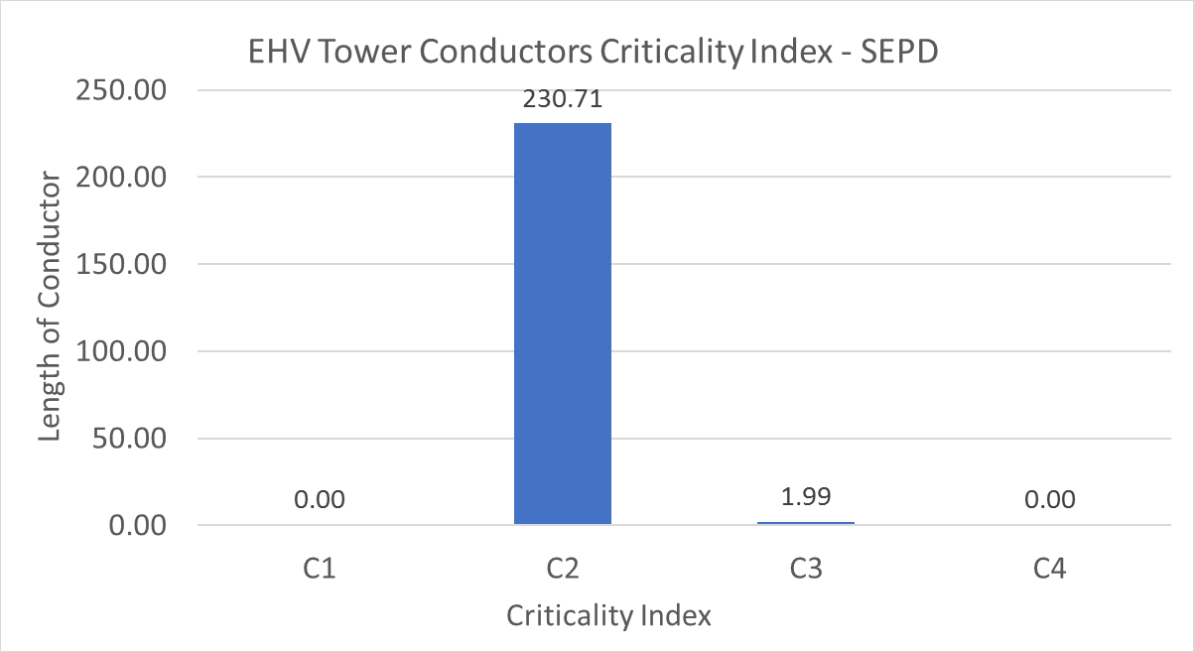


Figure 30: Criticality Profile for 33kV Towers SEPD

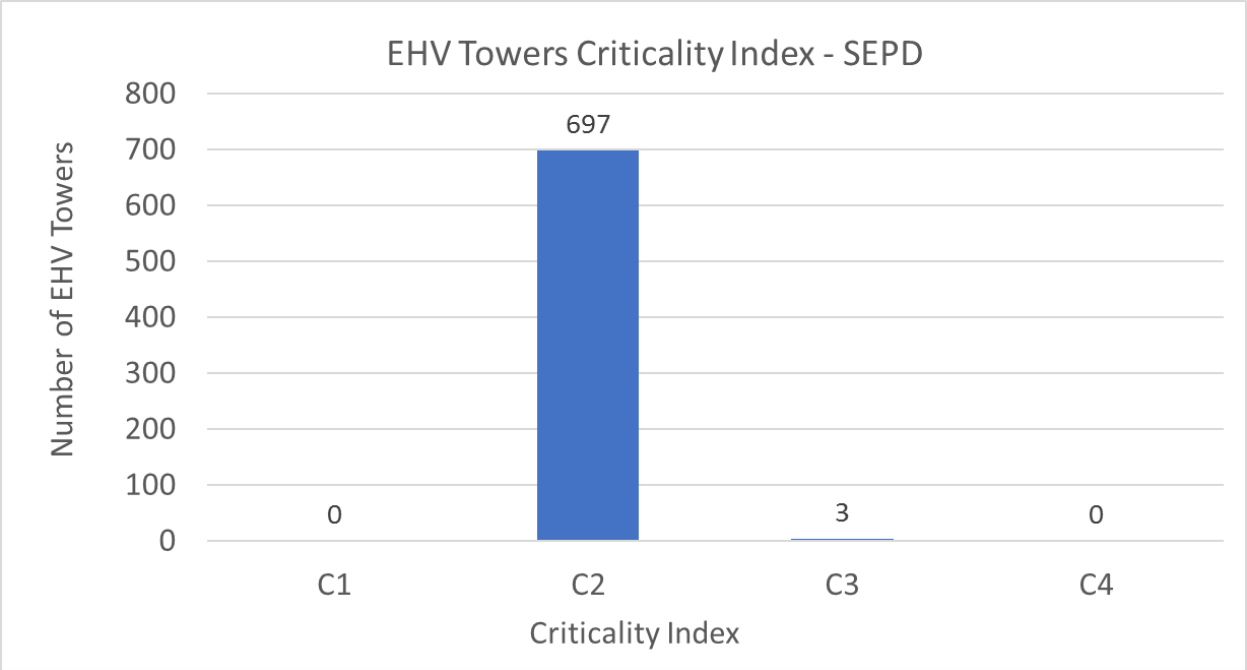


Figure 31: Criticality Profile for 33kV Fittings SEPD

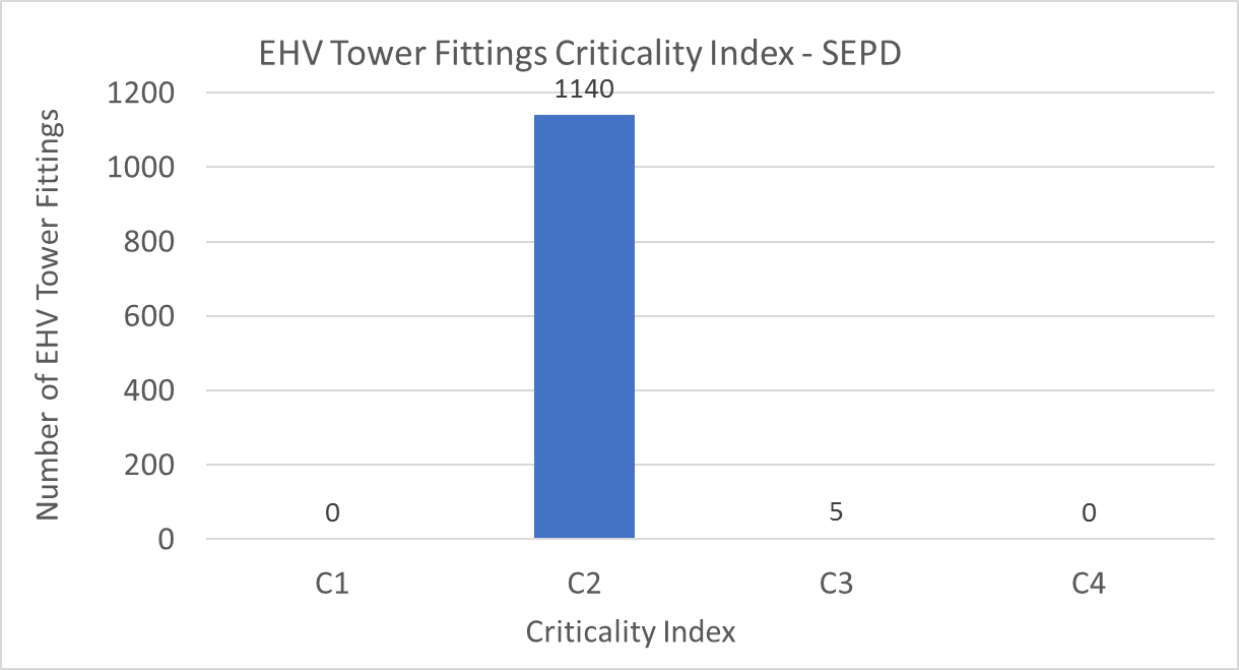


Figure 32: Criticality Profile for 132kV Tower Line Conductor SEPD

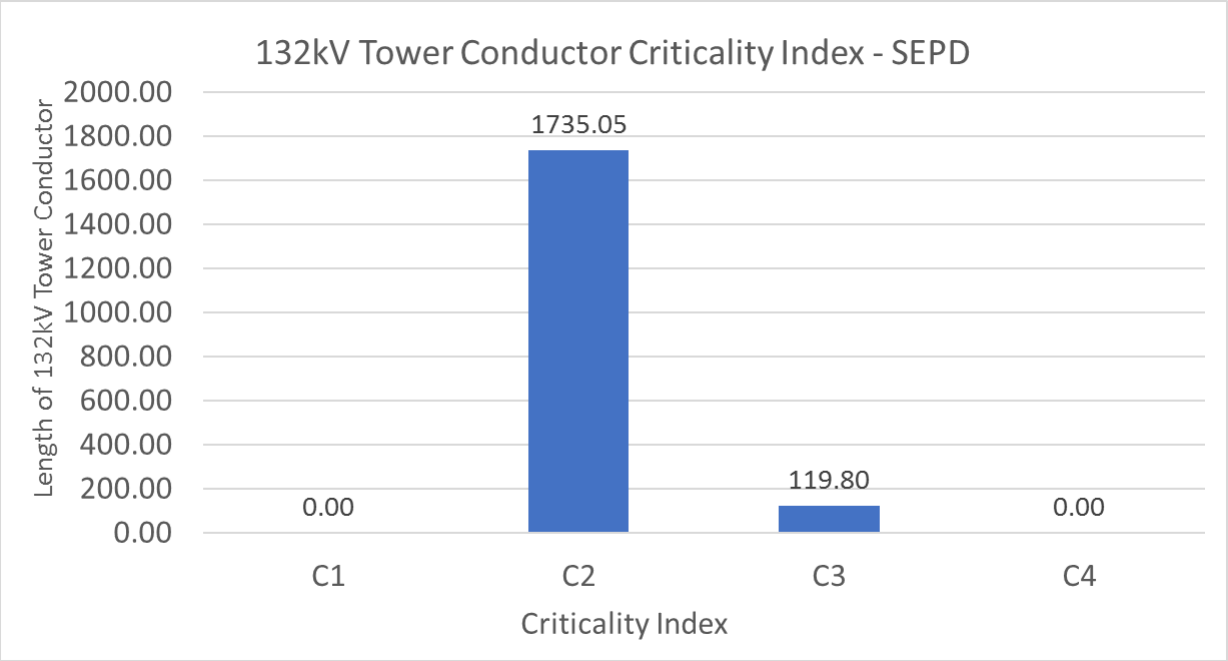


Figure 33: Criticality Profile for 132kV Towers SEPD

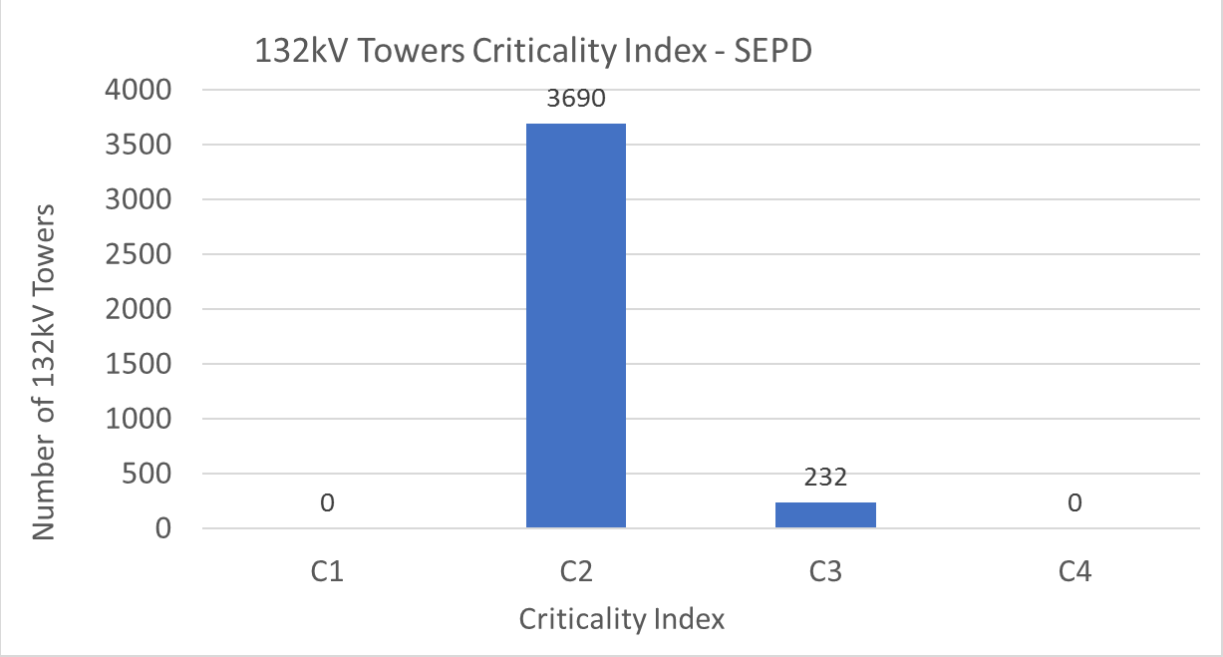
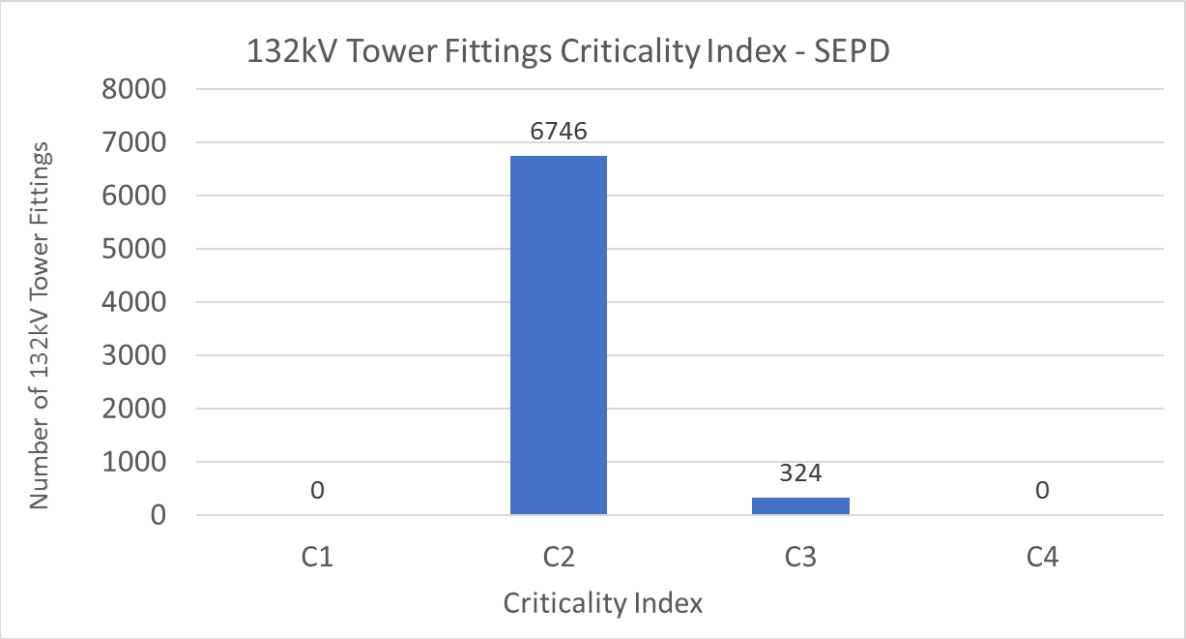


Figure 34: Criticality Profile for 132kV Fittings



3.4.3 Total Risk Score

Figure 35 to Figure 43 show the Risk Profile associated with Profiles for 33kV & 132kV Fittings within SEPD & SHEPD for the start of ED2 and the projection for the end of RIIO-ED2, without any additional network investment.

The risk profile for tower conductors (Figure 35) indicates that this asset category is in good condition with only low risk. However, it is noted that the risk profile is worse by the end of ED2 without intervention as there are assets moving into the HI3C2 banding.

Figure 35: Risk Profile for 33kV Tower Line Conductor SHEPD

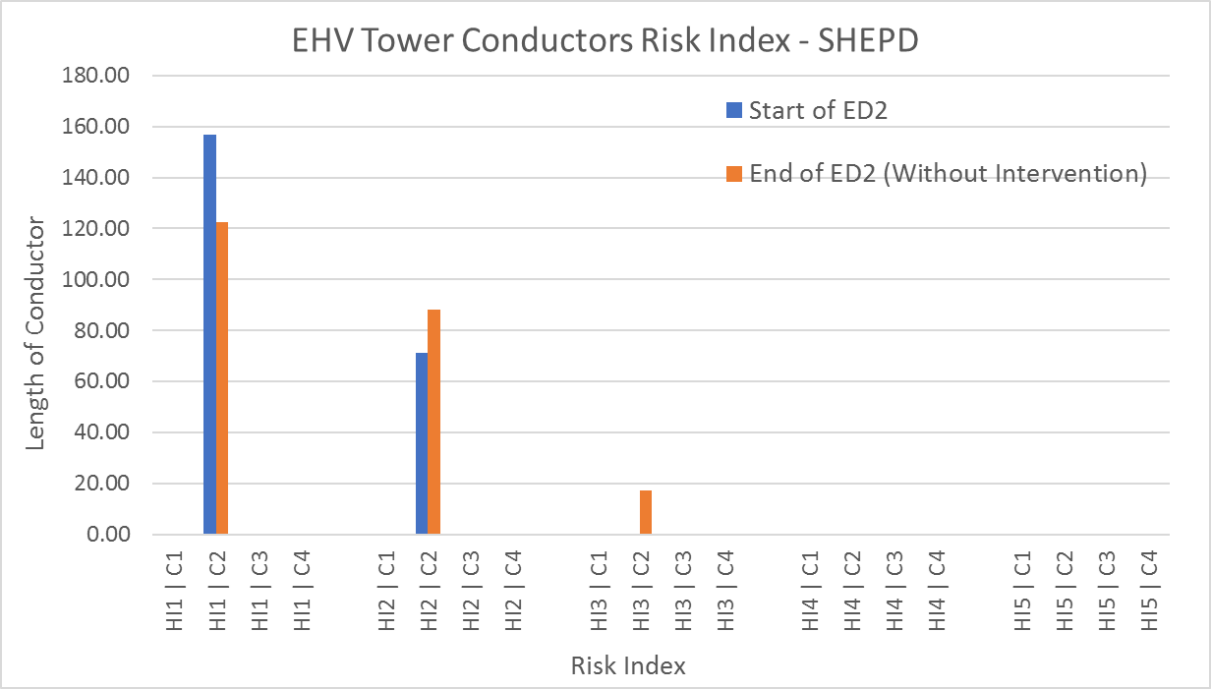


Figure 36 indicates that there are a large number of towers in SHEPD in poor health condition and with criticality C2 at the start of ED2. Their position will not improve without intervention and, if failing, could cause disruption on the network.

Figure 36: Risk Profile for 33kV Towers SHEPD

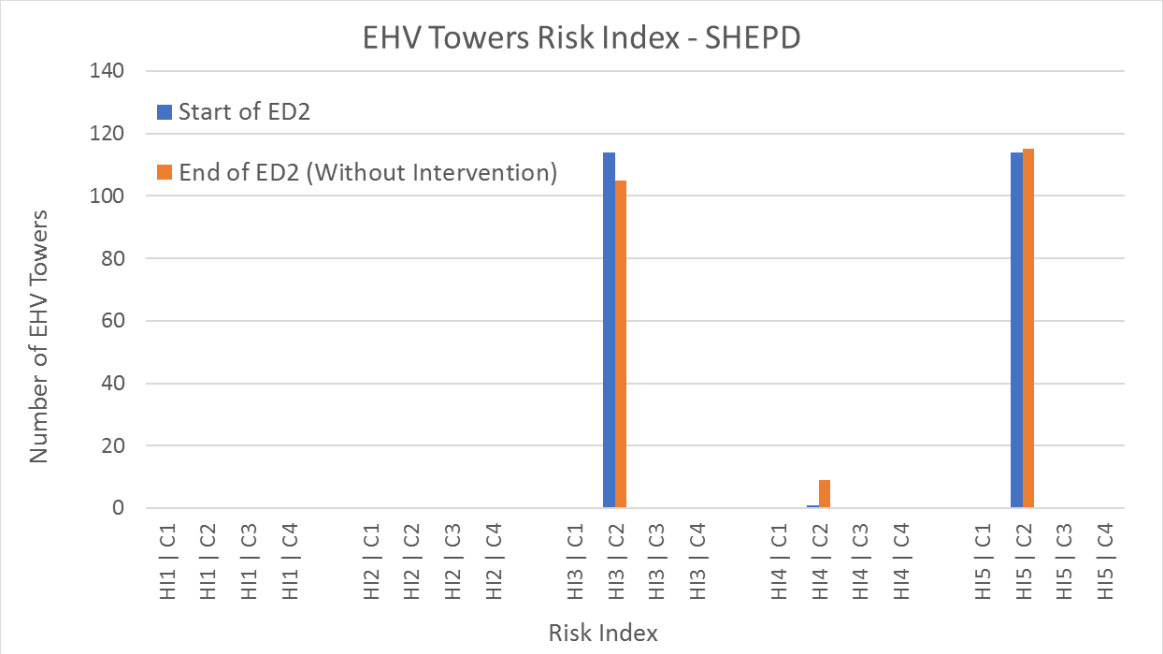
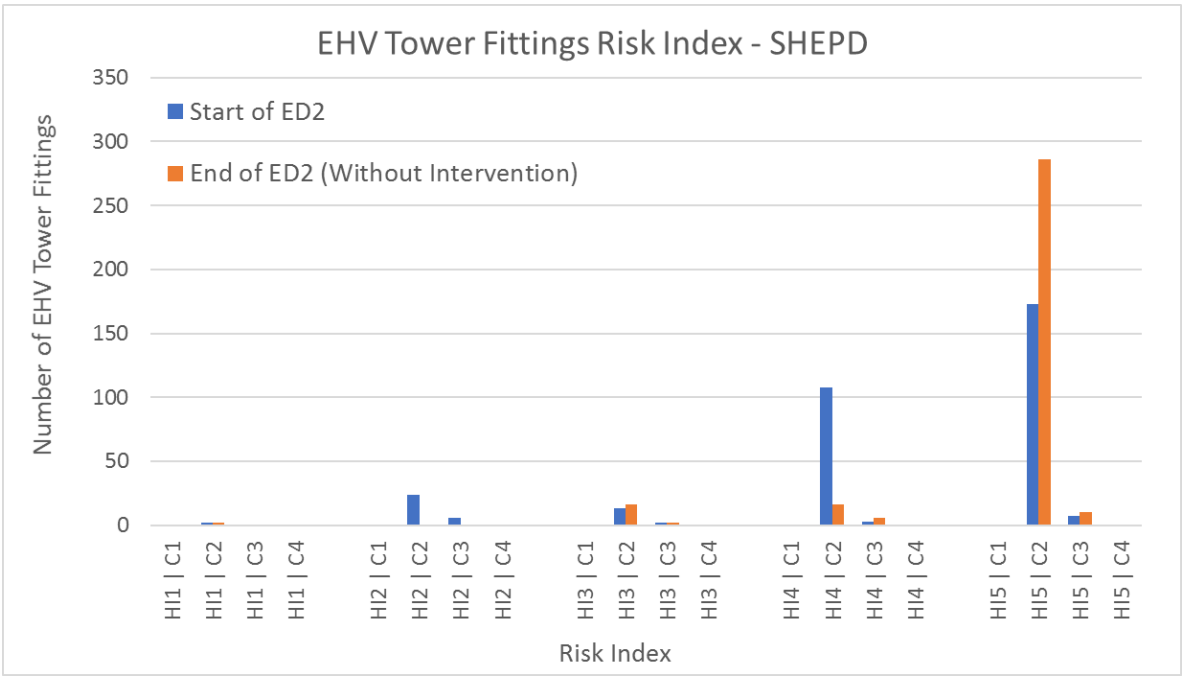


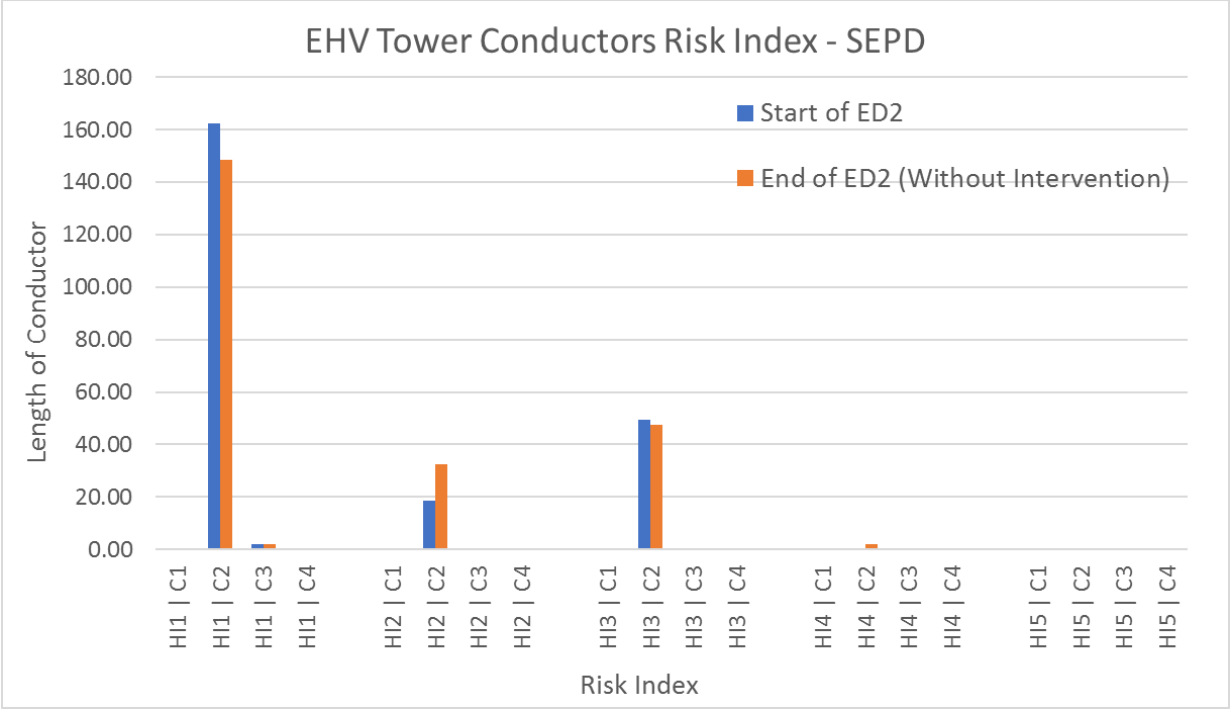
Figure 37 also indicates that a high proportion of tower fittings in SHEPD at H4 C2 move into the HI5 C2 band by the end of ED2, increasing their risk on the network. There are also a small number of this asset class at HI5 C3 at the end of ED2.

Figure 37: Risk Profile for 33kV Fittings SHEPD



The risk profile for EHV tower conductors in SEPD (Figure 38) shows the majority of this asset class is low risk, with the highest risk being a number of assets at HI3 C2 and a very small number becoming HI4 C2 by the end of ED2.

Figure 38: Risk Profile for 33kV Tower Line Conductor SEPD



The majority of EHV tower assets (SEPD) have a risk category of HI3 C2 (Figure 39). However, there are a small number of assets with a risk index of HI5 C2 at the start of ED2. These assets will not improve their health or risk to the network without intervention.

Figure 39: Risk Profile for 33kV Towers SEPD

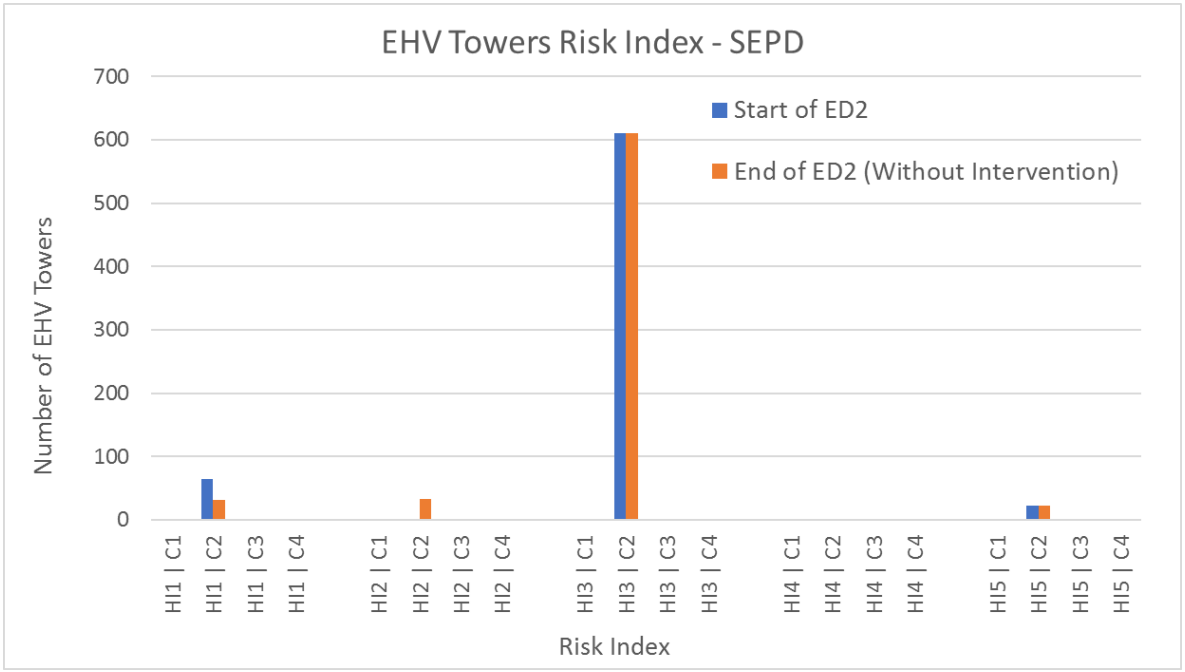
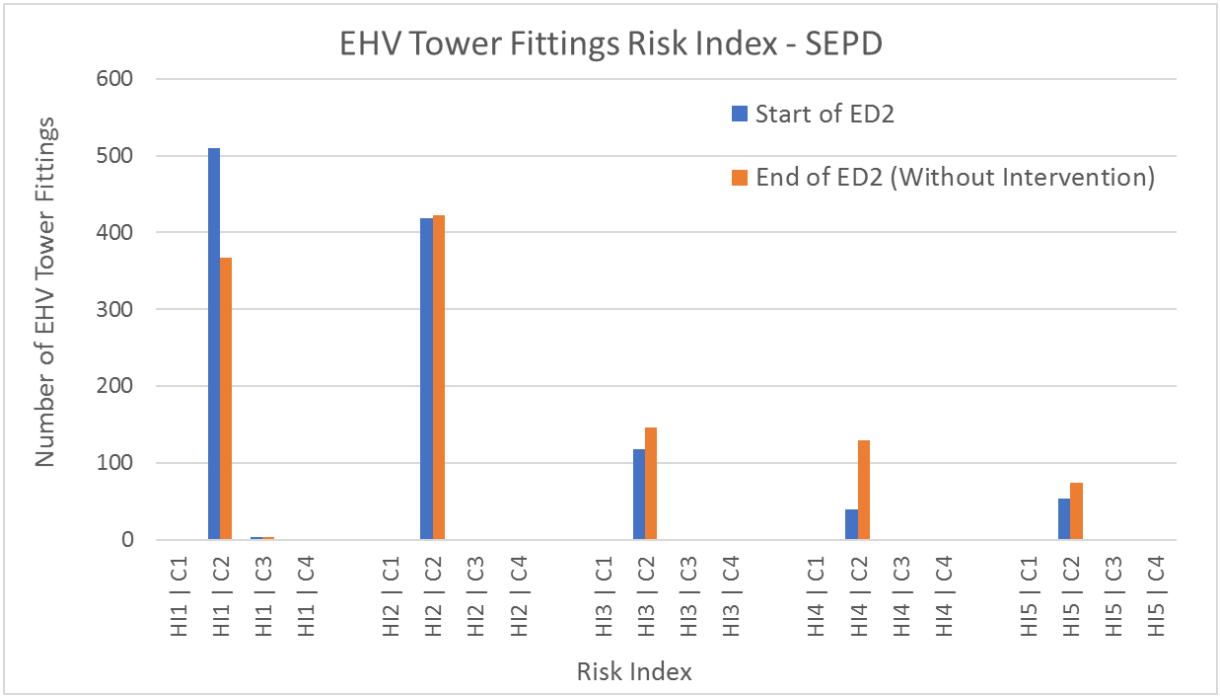


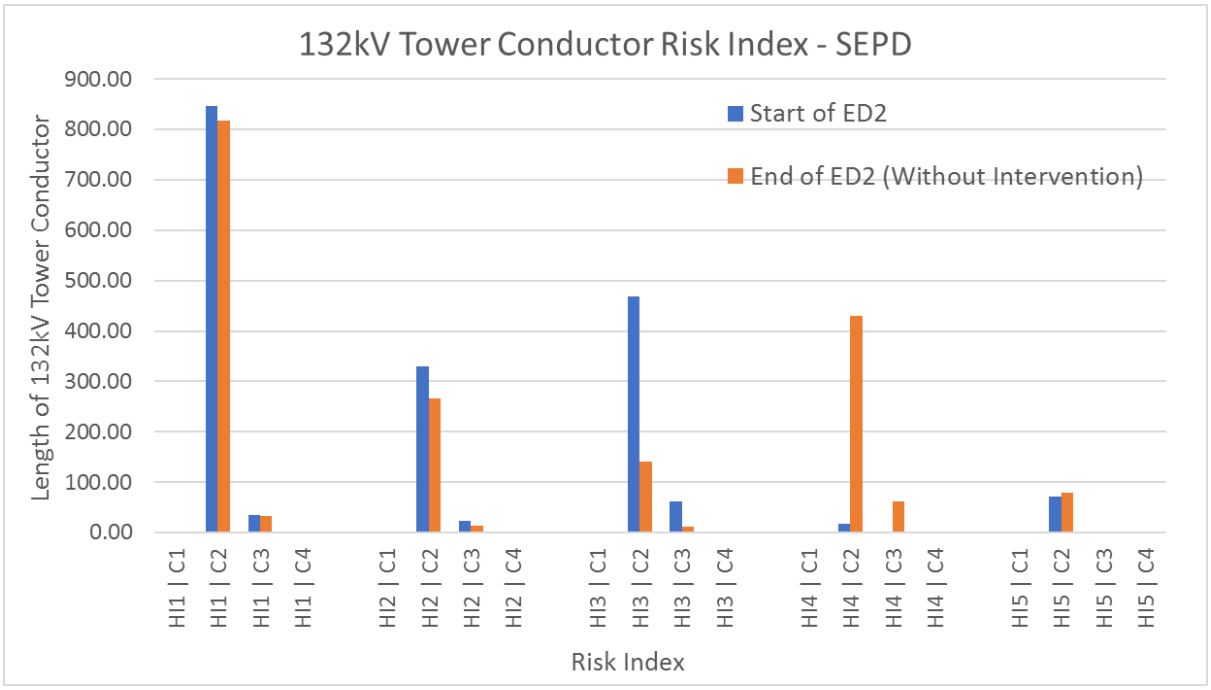
Figure 40 shows that the numbers of lower risk EHV tower fittings in SEPD decrease over ED2 as the asset move to higher risk categories. In particular, there is an increase in both the HI4 C2 and HI5 C2 numbers in ED2 which increases the risk on the network.

Figure 40: Risk Profile for 33kV Tower Fittings SEPD



Although there is a marginal increase during ED2 in the 132kV tower conductors in the HI5 C2 category (Figure 41), the more noticeable increase is in the numbers moving from the lower HI3 C2, HI3 C3 bands into the HI4 C2, HI4 C3 bands which increases the overall risk of asset failure.

Figure 41: Risk Profile for 132kV Tower Line Conductor SEPD



There is small movement in ED2 between risk categories for the 132kV towers (Figure 42) with the largest increase being the number of assets in the HI4 C2 band. However, there are a number of assets which start ED2 at HI5 C2 and which could pose a problem if their condition deteriorates.

Figure 42: Risk Profile for 132kV Towers SEPD

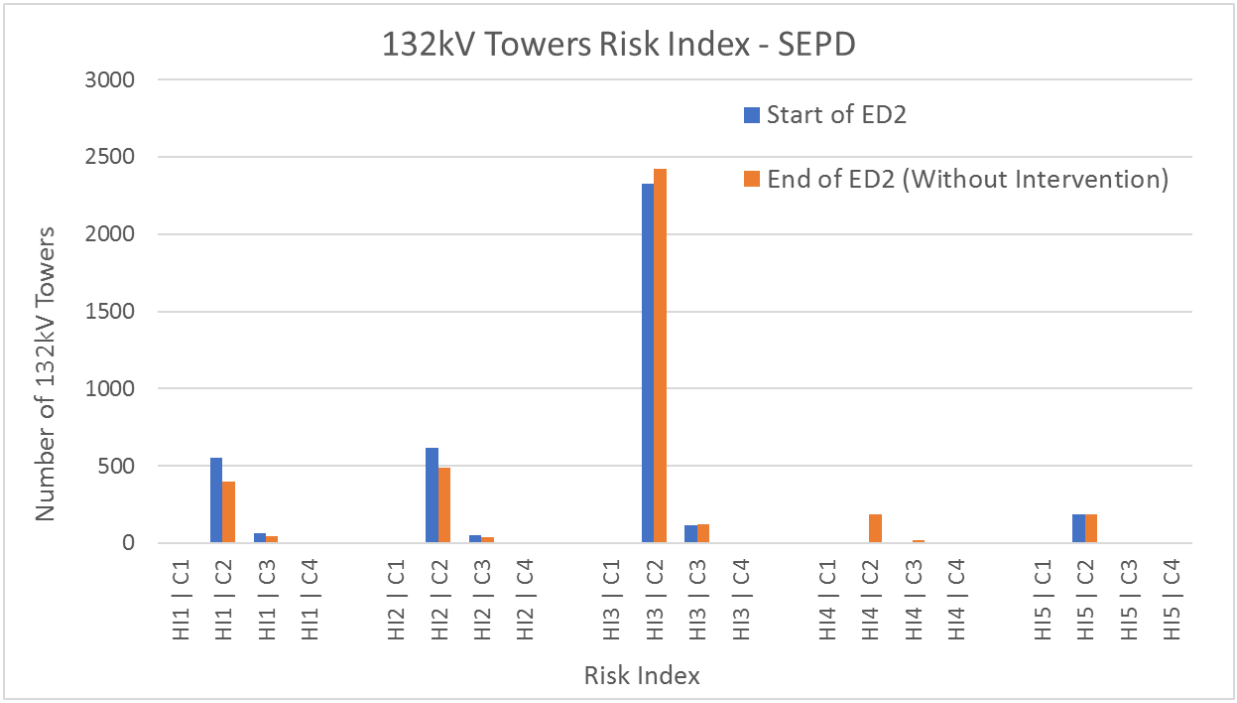
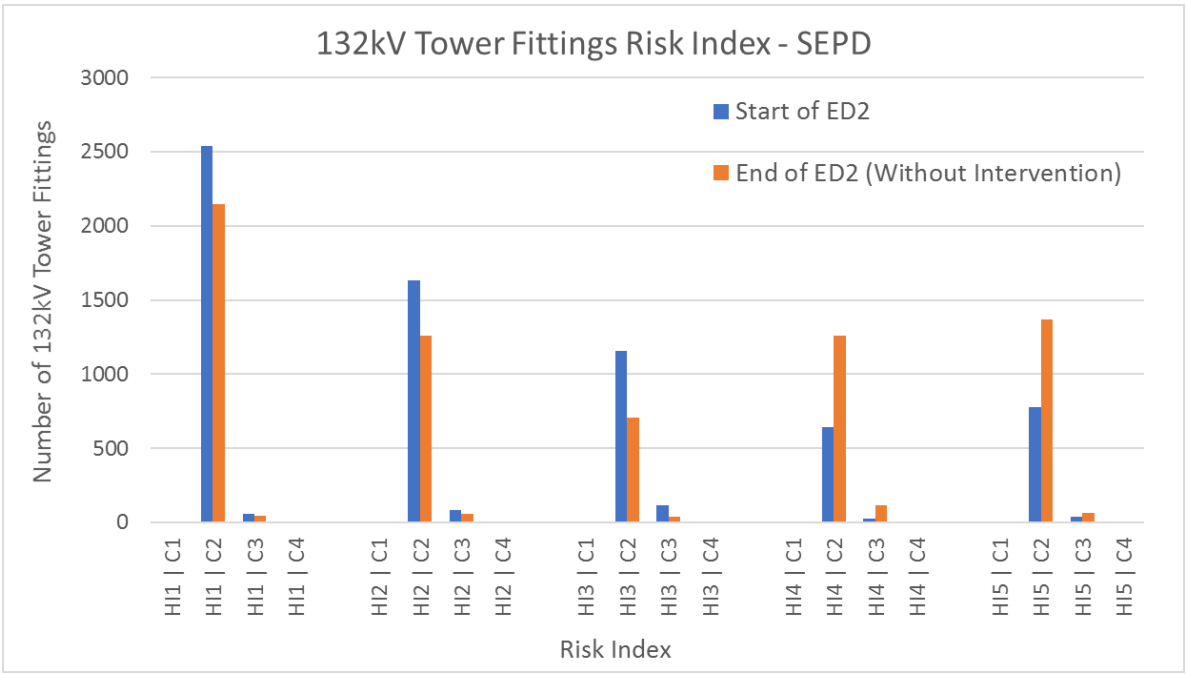


Figure 43 shows the increase in volumes of 132kV tower fittings in higher risk categories by the end of ED2. In particular, there are noticeable increases in the HI4 C2 and HI5 C2 categories but also smaller increases in the HI4 C3 and HI5 C3 bands. Therefore, the number of assets in the higher risk categories has increased over ED2 without any intervention.

Figure 43: Risk Profile for 132kV Tower Fittings SEPD



3.5 CyberHawk iHawk Data Management System

CyberHawk is an industry-leading, cloud-based visual asset management software; iHawk takes data captured from drones, helicopters or ground patrols and converts it into powerful and usable management information.

Using a map-driven interface and traffic light colour-coded reporting dashboard, iHawk allows easy access to inspection information and trends, with all inspection images and engineering commentary available. CyberHawk iHawk drone-based inspection ultra-hi-res, comprehensive, close visual inspection data, significantly improves safety by reducing 'at height' working and limiting our staff exposure to live power lines whilst decreasing inspection times with it being four times faster than traditional methods.

Through regular drone inspections and ensuring the data is efficiently processed and accessed on iHawk, our operational teams can identify issues early, focusing interventions on the highest priority items before they fail.

Figure 44 and Figure 45 below shows the ultra-high-res image and risk matrix dashboards of the iHawk tool.

Figure 44: Cyberhawk IHawk Dashboard

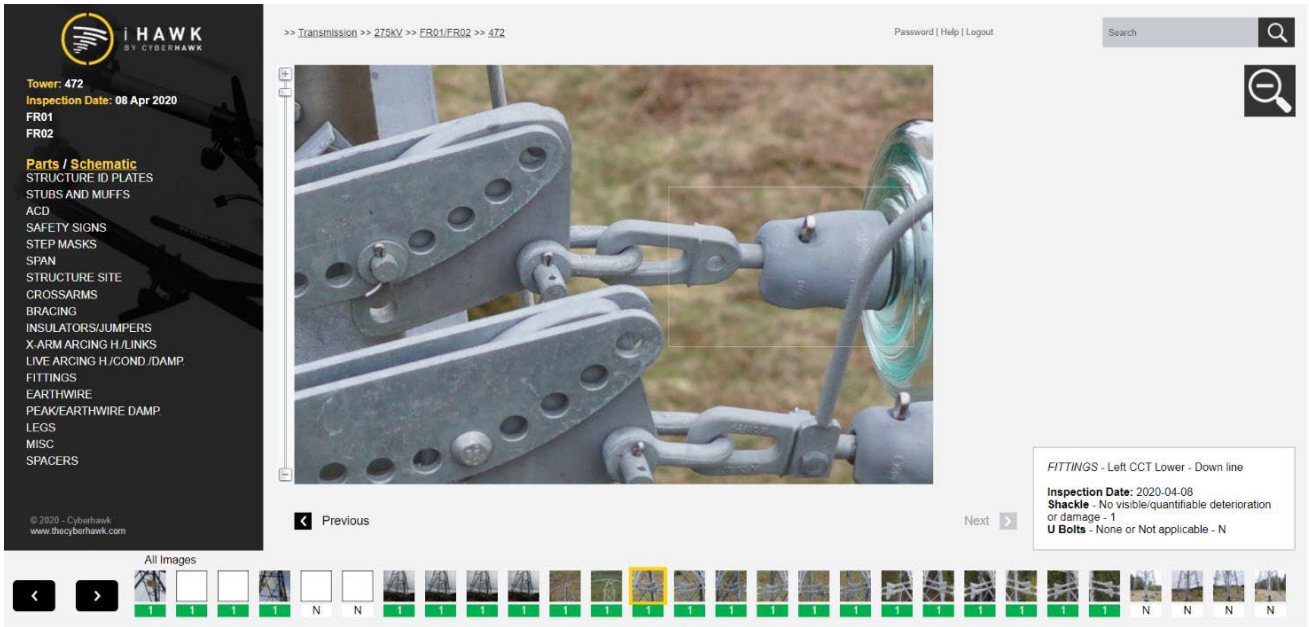
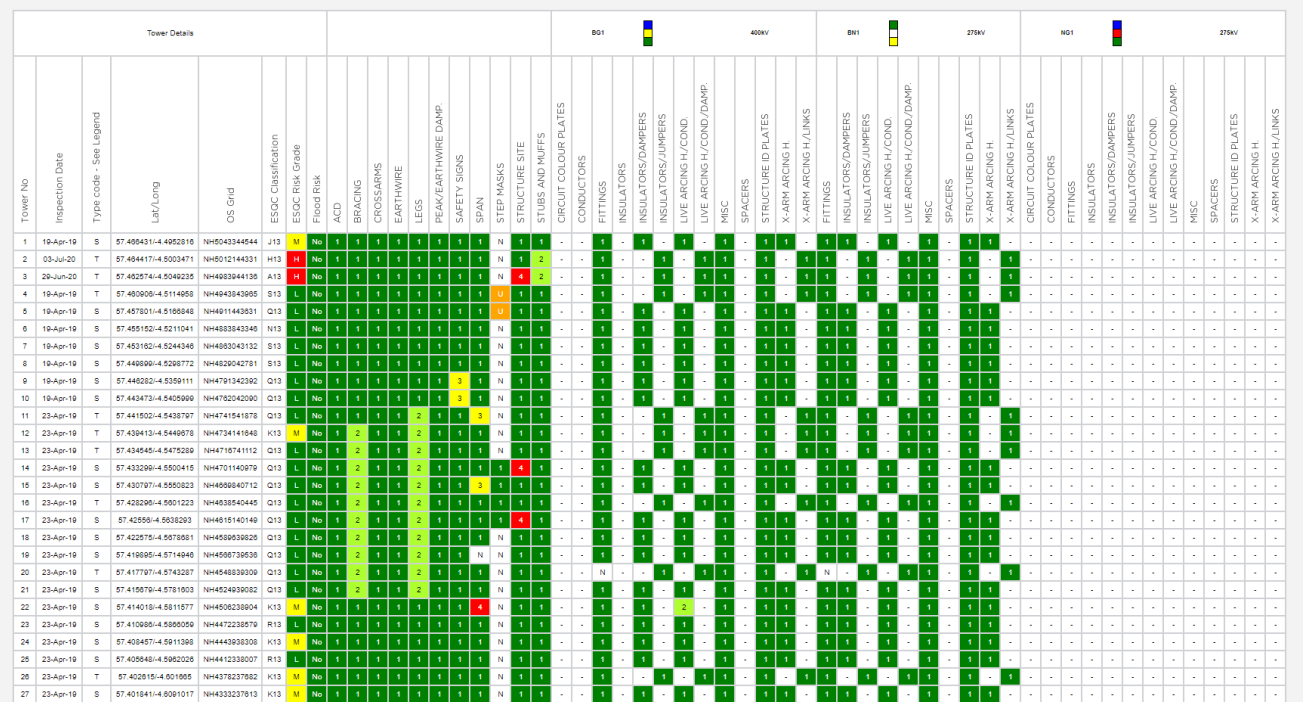


Figure 45: Cyberhawk iHawk Risk Matrix



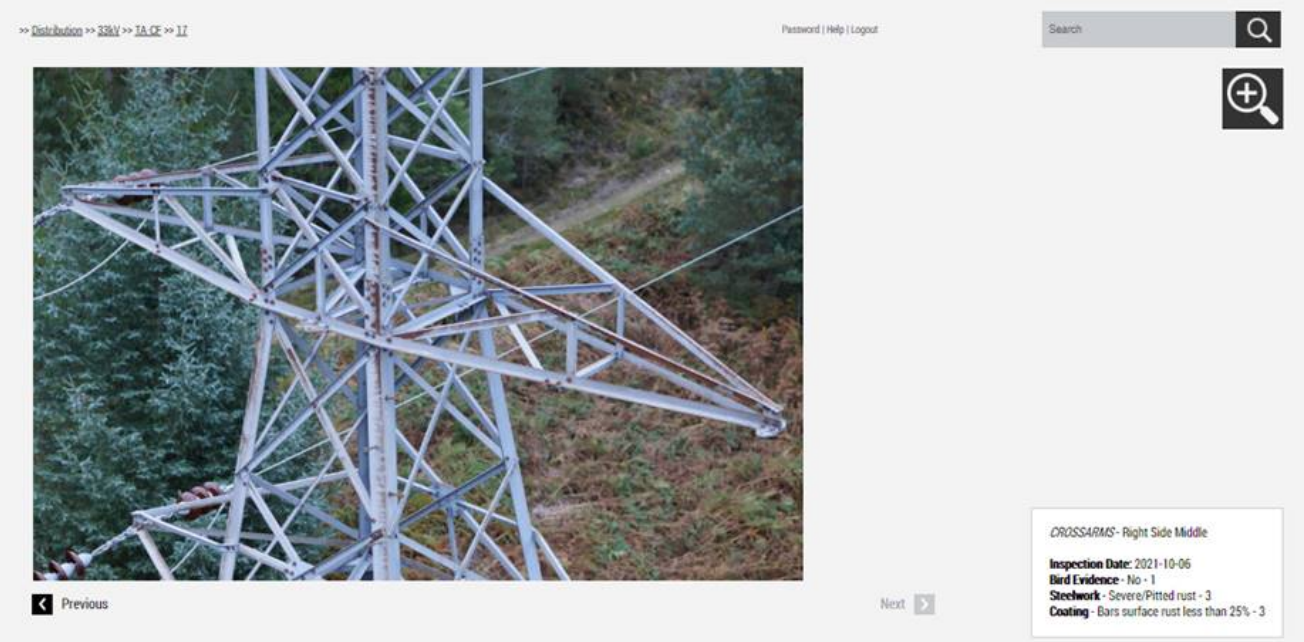
CyberHawk asset management software can also be used to determine asset intervention options. Table 10 and Figure 46 to Figure 48 show how several different 33kV Tower interventions were determined using CyberHawk.

Table 10: Different 33kV Towers and their intervention options

Tower ID	Route Name	Chosen Intervention (Refurbish, Paint, Replace, Paint & Refurbish)	Start of ED2 HI
SHEPD_TA-CF-17	Torr Achility to Conon Falls	Paint	HI5
SHEPD_LEC-B-22	Loch Etive Crossing / Bonawe	Paint & Refurbish	HI5
SHEPD_REC-35	River Earn Crossing (Abernethy to Perth Harbour)	Paint & Refurbish	HI5

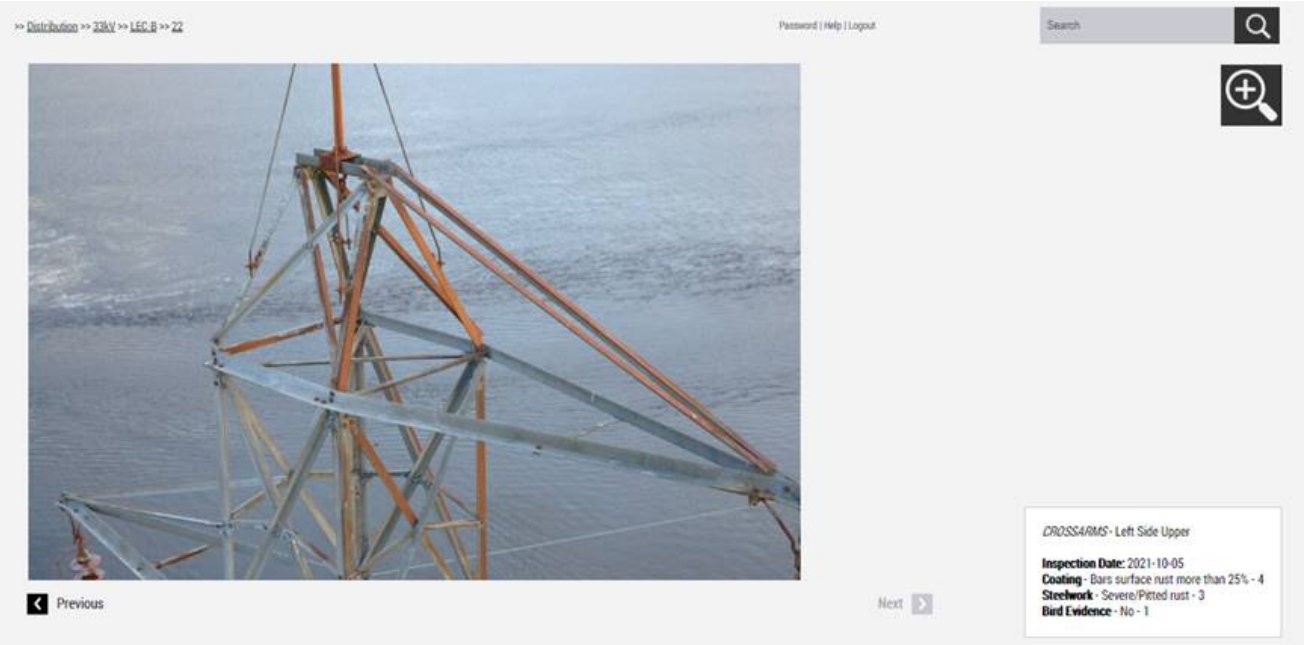
The 33kV Tower in Figure 46 is starting to show signs of corrosion and would benefit from being painted.

Figure 46: 33kV Tower - SHEPD_TA-CF-17, Torr Achility to Conon Falls, HI5



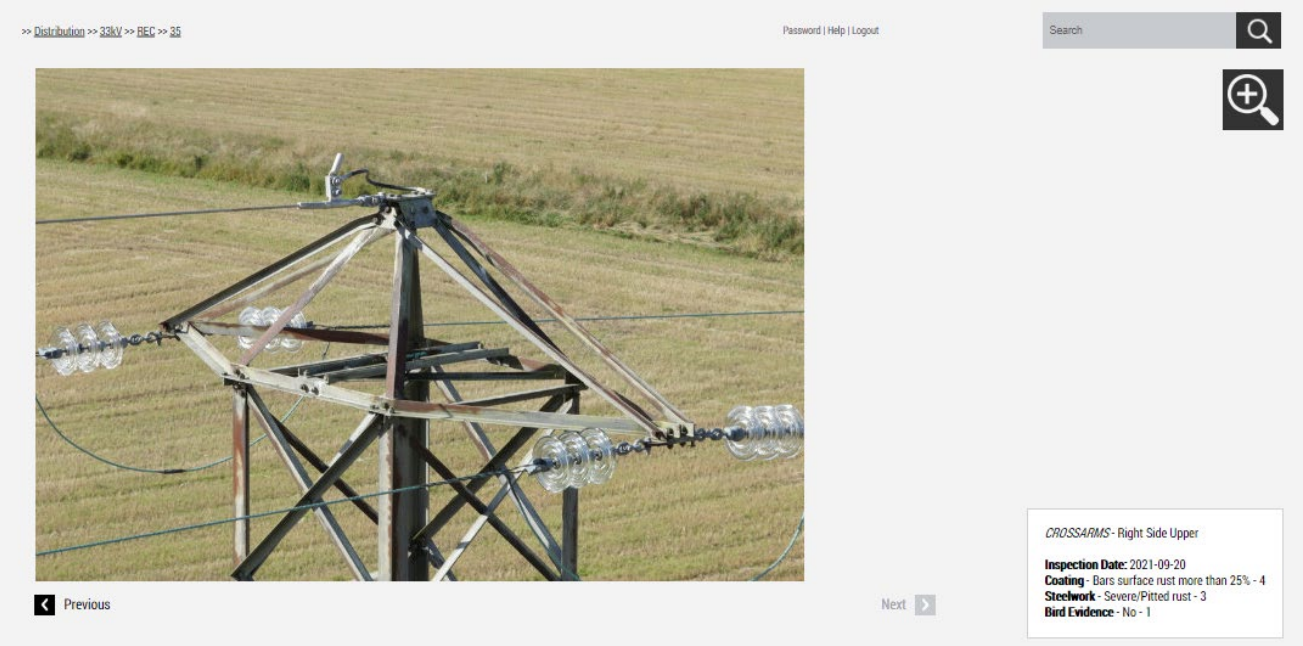
The 33kV Tower in Figure 47 has severe corrosion on the peak steelwork. It would benefit from being painted and refurbished by replacing steelwork.

Figure 47: 33kV Tower - SHEPD_LEC-B-22, Loch Etive Crossing / Bonawe, HI5



The 33kV Tower in Figure 48 has severe corrosion on the peak steelwork. It would benefit from being painted and refurbished by replacing steelwork.

Figure 48:33kV Tower - SHEPD_REC-35, River Earn Crossing (Abernethy to Perth Harbour), HI5



3.6 Rannoch Tower Circuit Replacement

Rannoch Tower circuit was originally built in 1936. It was last refurbished, by painting the towers in 1985. Conductor inspections were carried out in 2019, which determined that the conductor has 15-20 years of life remaining. Figures 49 and 50 shows that 65% and 63% of towers and fittings respectively are currently HI4 or HI5. If they were retained they would need considerable refurbishment carried out on them.

Figure 49: Rannoch Tower Condition in CBRM

CBRM Data at June 2021	Number of HI3	Number of HI4	Number of HI5	Total
Rannoch Power Station to Rannoch Station	24	4	11	39
Rannoch Station to Bridge of Orchy	23	27	47	97
% of HI4 and HI5 towers	**65%**			

Figure 50: Rannoch Fittings Condition in CBRM

	Number of Fittings			
CBRM Data at June 2021	**HI3**	**HI4**	**HI5**	**Total**
Rannoch Power Station to Rannoch Station	0	20	56	76
Rannoch Station to Bridge of Orchy	59	24	2	85
% of HI4 and HI5 towers	**63%**			**161**

There are significant benefits by removing all the towers on both Rannoch Circuits. There are considerable logistical challenges to carrying out inspections, maintenance and repair work particularly for the 80 towers which are not near a road. Staff, contractors and materials need to get to site safely.

It is not economic or desirable to refurbish the Rannoch tower circuits. It is proposed to replace the 39 towers from Rannoch Power Station to Rannoch Station with 10km of new wood pole line. Also, the 97 towers from Rannoch Station to Bridge of Orchy will be replaced with 15km of 33kV new wood pole line and 5.5km of 11kV new wood pole line.

4 Stakeholder Engagement

In preparation for our RIIO-ED2 business plans several stakeholder engagement exercises have been undertaken to understand more clearly 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 Strategy (Annex 3.1).***

The details from some of our critical stakeholders' feedback on our Asset Management Strategy and their views on the importance of improving network reliability is presented:

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 we 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

- In maintaining a reliable network, stakeholders strongly urged us to strike a balance between simply fixing older assets now and replacing assets (at a higher cost now) so that the network is ready for future use.
- We need 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.
- We need to think about current and future populations in areas now in order to plan its investments most effectively.

Summary of Findings

A wide range of stakeholders confirmed that they stakeholders strongly support our proposed approach of prioritising assets with a higher likelihood of failure as part of the asset management strategy. 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. This dependence on a reliable network 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.

5 Summary of Options Considered

This section of the report sets out the investment options that are considered for 33kV & 132kV Towers, Fittings and Overhead Line Tower Conductor and associated assets. A holistic approach is taken to ensure investment options which are both least regret and represent best value for money for network customers, are identified.

The investment options described below range from no investment at all to the full replacement of overhead tower line assets with modern equivalents with advanced capabilities. By analysing all the primary and secondary investment drivers in a coordinated manner for each individual project, we can arrive at the optimal investment decision which avoids unnecessary spend and risks the future stranding of network assets.

The use of the options described below are chosen with the aim to achieve an optimal balance between maintenance, refurbishment, and replacement throughout RIIO-ED2 to minimise the cost of managing this asset category.

5.1 Summary of Options

Table 11 below provides a high-level summary of the investment options under consideration along with the advantages and disadvantages associated with each. A more detailed description of each option is then provided within the proceeding sub-sections.

Table 11: Summary of 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor Options

Option	Description	Advantages	Disadvantages	Result
1. Do Minimum (Baseline)	No upfront action taken to improve condition of the Overhead Tower Lines under pre-defined Risk and Health scoring. Maintenance and Inspection activities continue as normal.	No additional CAPEX expenditure.	Risk of reduction in quality of supply, network safety, and environmental impact. Increased risk of complete asset failure.	Not Considered
2. Full Rebuild of Section/Span	Full rebuild of a section/span or number of sections/spans of Overhead Tower Lines.	Extends asset lifetime. Maintains operational flexibility.	Often costly when compared with other options.	Not Considered
3. Reconductor Overhead Tower Lines	Replacement of conductor.	Maintains operational flexibility. Targets specific issue where applicable.	Potential compatibility issues. No protection against ageing or defects on other assets. May be redundant if full span rebuild is required in the near future.	**Considered**
4. Insulators and Fittings Replacement	Replacement of insulators and fittings along a number of spans as required based upon the	Cost effective. Targets specific issue where applicable.	Potential compatibility issues.	**Considered**

	inspection and condition assessment results.		No protection against ageing or defects on other assets. May be redundant if full span replacement is required in the near future.	
5. Tower Painting & Steelwork Replacement	Repainting of tower steelwork depending on the outcome of the condition assessment. Replacement of tower steelwork depending on the outcome of the condition assessment.	Prevents the need to replace the majority of tower steelwork before it degrades to an unrecoverable level. Targets specific issue where applicable.	Requires frequent tower inspection. May require additional type testing	**Considered**

5.2 Option 1: Do-Nothing

The analysis of the Do-Nothing option depends upon the specific characteristics and challenges associated with the overhead Tower Line project in question. Under this option, a decision is made to accept the risk associated with each asset in its current condition and criticality without any further investment. If this option is selected, it is important to understand the impact on both the network, consumers and customers in terms of how much expenditure is saved versus the associated deterioration in network performance (safety, outages, environmental).

Ultimately, the feasibility of this Option depends upon the initial driver for investment.

5.3 Option 2: Full Rebuild of Section/Span

This option involves the full rebuild of an existing 33kV or 132kV overhead tower line section/span with an entirely new model. Replacing the entire span, including the conductor, tower, insulators, fittings and foundations avoids any compatibility issues and will extend the lifetime to the longest potential lifetime of all intervention options. However, depending on the exact solution chosen, full replacement can incur significant civil costs and outage costs if circuits need to be deenergised to facilitate replacement and customers lose supply.

Additionally, the span or spans of overhead line could be replaced with underground cable where there is rationale to do so and where this will be more cost effective e.g. in areas of high tree growth or where the local environment is not practical for overhead line assets.

5.4 Option 3: Reconductor Overhead Tower Line

Option 3 involves reconductoring the overhead tower line; input from the Engineering Design team would be required to confirm whether the existing overhead line can accommodate the proposed conductor or whether a complete re-build will be required.

This option may be particularly relevant where there are ACSR conductors, as ACSR conductors are gradually being phased out by suppliers and are unlikely to become standard products in the future. It is standard industry practice to replace these assets with AAAC conductors.

Depending on the type of conductor used, tower and foundation strengthening, and clearance infringement mitigations may be required where the strengthening and safety requirements of the new conductor differ from the original.

5.5 Option 4: Insulators and Fittings Replacement

This option involves replacing the insulators and fittings of an overhead line section/span where these components have been identified as having a defect, no longer operating optimally or being unsafe. This is a cost-effective approach if the overhead line fittings are the only assets with an issue, as these assets are relatively inexpensive compared to conductors and towers. The insulators and fittings would need to be compatible with the remaining assets, i.e. the conductors and towers.

5.6 Option 5: Tower Painting & Steelwork Replacement

This option is closely linked with tower steelwork replacement because a frequent painting programme significantly reduces the need to replace the majority of tower steelwork, as it prevents steel degradation due to weather. Tower steelwork is inspected annually by a helicopter fly by and inspected by walking the circuit every 6 years by taking high-definition visual images by a helicopter or drone flybys or foot patrol. These images then get recorded in the CyberHawk iHawk data system that feeds into our CBRM system. If it's found that the health of the steelwork is classified as unsuitable and there's a possibility of paint degradation, additional paint thickness measurements of the bars to confirm the visual grade classifications are carried out.

It is important to note that a consistent frequency of steelwork painting is not always possible to achieve because the rates of corrosion of paint and steel can vary across the overhead line tower circuit or the tower itself due to the different environmental conditions that towers are exposed to, due to their varying locations around the network. Repainting tower steelwork varies in difficulty. Some of the tower parts will require a network outage, which provides a problem in the timing of this activity. Painting towers is a complex and time-intensive activity. It involves preparing and cleaning steel surfaces to apply new layers while ensuring that the new paint coating is even throughout. As the paint layers of the tower steelwork degrade at different rates, imperfections will inevitably occur, meaning some degradation and corrosion of tower steelwork appear even after they get repainted.

Furthermore, this option also considers the replacement of the tower steelwork; leg sections, main crossarm pieces, large plan bracings, bars, wind bracings, and small tie bars, which have significant deterioration and are at high risk of failure. Helicopter flybys happen annually, where drone flybys or foot patrol visual inspection of tower steelwork happens a minimum of 1 in every 6 years. Similarly, to tower painting, steelwork condition is graded through CyberHawk iHawk surveys, where if it is found in an unsuitable condition for repainting, it is then replaced with new steel.

6 Detailed Analysis

This section of the report provides further detail on the investment strategy that we have designed for 33kV & 132kV Towers, Conductor and Fittings over RIIO-ED2 across the chosen investment options through consultation with stakeholders.

6.1 33kV & 132kV Towers, Conductor and Fittings Requiring Intervention

We have developed our own investment criteria for assets deemed end-of-life due to their condition. This criterion is applied against the Health and Criticality scores arising from our CBRM models to identify which assets require intervention during RIIO-ED2.

As defined by the Ofgem approved Common Network Asset Indices Methodology (CNAIM), the Health Score can be correlated to a Probability of Failure (PoF). The worse the asset Health, the higher the PoF will be. The total Risk for network customers increases as the PoF increases with the condition of the asset.

During ED2, we do not feel it is appropriate to replace all assets projected to become Health Index 5 by the end of ED2. This approach would shortlist many towers for complete tower replacement that still have multiple years of useful lifetime and only requires partial steelworks replacement before failing.

As such, specific Health Score criteria has been developed based upon the Criticality (consequence of failure) of each tower, conductor and fitting. This is reflected in the figures below which shows the minimum Health Score within the Health Index 5 and Health Index 4 bandings before an intervention is deemed necessary for towers, conductor or fittings. The higher the Criticality of the asset the lower the acceptable PoF should be to ensure the total Risk of Failure is tolerable for network customers. As such, the minimum Health score varies based on the Criticality of each fitting C1-C4).

Figure 50: Health Score Criteria for 33kV & 132kV Towers & Fittings

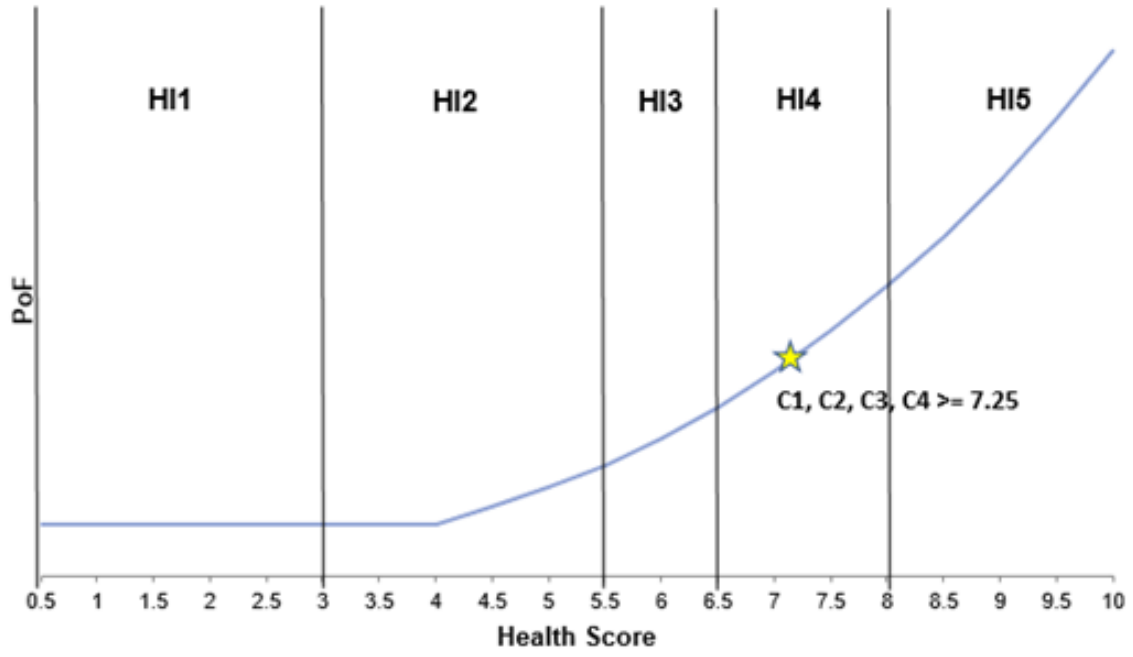
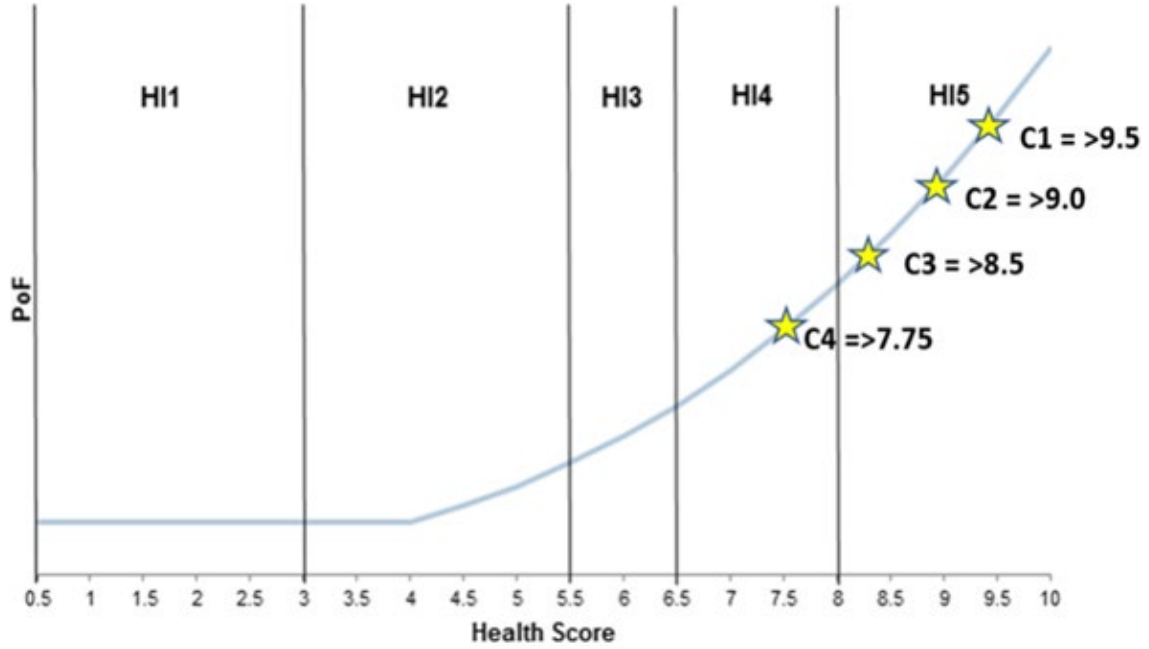


Figure 51: Health Score Criteria for 33kV & 132kV Tower Line Conductor



This approach ensures that only 33kV & 132kV Towers, Conductor and Fittings which are truly in need of additional condition related investment are shortlisted for RIIO-ED2, where the risk associated with any deferment in that investment would be intolerable for network customers.

6.2 Cost Benefit Analysis (CBA)

The investment options described in this EJP have not been assessed within a Cost Benefit Analysis (CBA). This is based on the information contained in the CBA guidance document published by Ofgem.

6.3 Proposed RIIO-ED2 Investment

As previously described, the primary investment driver detailed within this EJP is the management of 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor for non-load related purposes, specifically asset Health and Criticality. This correlates to the CV7 (Asset Replacement) and CV9 (Refurbishment) tables within Ofgem's BPDTs. The following subsections show both the costs and volumes that are proposed for RIIO-ED2 for each of these CV tables.

6.3.1 CV7 - Asset Replacement

Table 12 to Table 15 show the volumes and costs associated with the replacement of the 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor asset categories for SHEPD & SEPD. These costs and volumes have been determined by our asset management strategy for this asset category and the feedback we have gathered from the RIIO-ED2 stakeholder engagement activities.

Table 12: CV7 33kV Overhead Towers, Conductor and Fittings volumes for RIIO-ED2 for SHEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Overhead Tower Line Conductor	km	3.0	4.0	4.0	4.0	4.2	**19.2**
33kV Towers	#	-	-	-	-	-	**-**
33kV Overhead Line Fittings	#	24	26	29	29	28	**136**

Table 13:CV7 33kV & 132kV Towers, Conductor and Fittings volumes for RIIO-ED2 for SEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Overhead Tower Line Conductor	km	-	-	-	-	-	**-**
33kV Towers	#	-	-	-	-	-	**-**
33kV Overhead Line Fittings	#	20	21	24	24	24	**113**
132kV Overhead Tower Line Conductor	km	13.0	14.0	15.0	15.0	14.6	**71.6**
132kV Towers	#	-	-	-	-	-	**-**
132kV Overhead Line Fittings	#	312	339	374	383	374	**1,782**

Table 14: CV7 33kV Towers, Conductor and Fittings Costs for RIIO-ED2 for SHEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Overhead Tower Line Conductor	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
33kV Towers	£m	-	-	-	-	-	**-**
33kV Overhead Line Fittings	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 15: CV7 33kV & 132kV Towers, Conductor and Fittings Costs for RIIO-ED2 for SEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Overhead Tower Line Conductor	£m	-	-	-	-	-	**-**
33kV Towers	£m	-	-	-	-	-	**-**
33kV Overhead Line Fittings	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
132kV Overhead Tower Line Conductor	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
132kV Towers	£m	-	-	-	-	-	**-**
132kV Overhead Line Fittings	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

6.3.2 CV9 - Asset Refurbishment

Table 16 to Table 19 show the volumes and costs associated with the refurbishment of the 33kV & 132kV Towers, Fittings, and Overhead Line Tower Line Conductor asset categories for SHEPD & SEPD. These costs and volumes have been determined by our asset management strategy for this asset category and the feedback we have gathered from the RIIO-ED2 stakeholder engagement activities.

Table 16: CV9 33kV Towers Volumes for RIIO-ED2 for SHEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Towers	#	-	-	-	34	33	**67**

Table 17: CV9 33kV & 132kV Towers Volumes for RIIO-ED2 for SEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Towers	#	4	5	5	5	5	**24**
132kV Towers	#	70	76	84	86	86	**402**

Table 18: CV9 33kV Towers Cost for RIIO-ED2 for SHEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Towers	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 19: CV9 33kV & 132kV Towers Cost for RIIO-ED2 for SEPD

Asset Category	Unit	2023	2024	2025	2026	2027	Total
33kV Towers	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
132kV Towers	£m	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

6.4 Unit Costs

We have undertaken a thorough review of our 33kV & 132kV Towers, Fittings and Overhead Line Tower Line Conductor unit costs to ensure they represent best value for money for GB electricity network consumers. A unit cost has been developed benchmarking past and contrasting against targeted future unit costs based on expert views for SHEPD & SEPD.

This includes analysis of the following:

- Historical unit costs in each licence area
- Expert cost analysis
- Consideration of benchmark targets set by Ofgem.

This analysis has produced a RIIO-ED2 unit costs as follows:

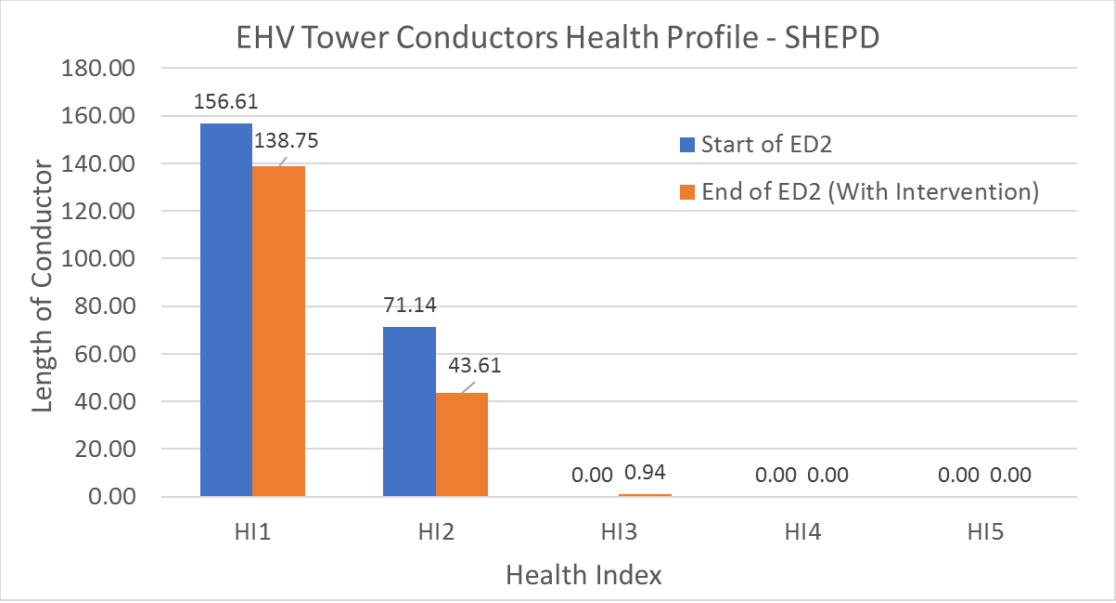
- Replacement (CV7) 33kV Overhead Tower Line Conductor SHEPD – [redacted]
- Replacement (CV7) 33kV Tower Fittings SHEPD – [redacted]
- Replacement (CV7) 33kV Overhead Tower Line Conductor SEPD – [redacted]
- Replacement (CV7) 33kV Tower Fittings SEPD – [redacted]
- Replacement (CV7) 132kV Overhead Tower Line Conductor SEPD – [redacted]
- Replacement (CV7) 132kV Tower Fittings SEPD – [redacted]
- Refurbishment (CV9 – SDI): 33kV Towers SHEPD - [redacted]
- Refurbishment (CV9 – SDI): 33kV Towers SEPD - [redacted]
- Refurbishment (CV9 – SDI): 132kV Towers SEPD - [redacted]

6.5 Change in Network Health & Risk Scores

Given the investment proposed for the chosen investment strategy in CV7 and CV9, Figure 52 to Figure 60 below show the change in the Health and Risk Profiles for 33kV & 132kV towers, conductor and fittings over the course of RIIO-ED2 with the proposed investment set out in the tables above.

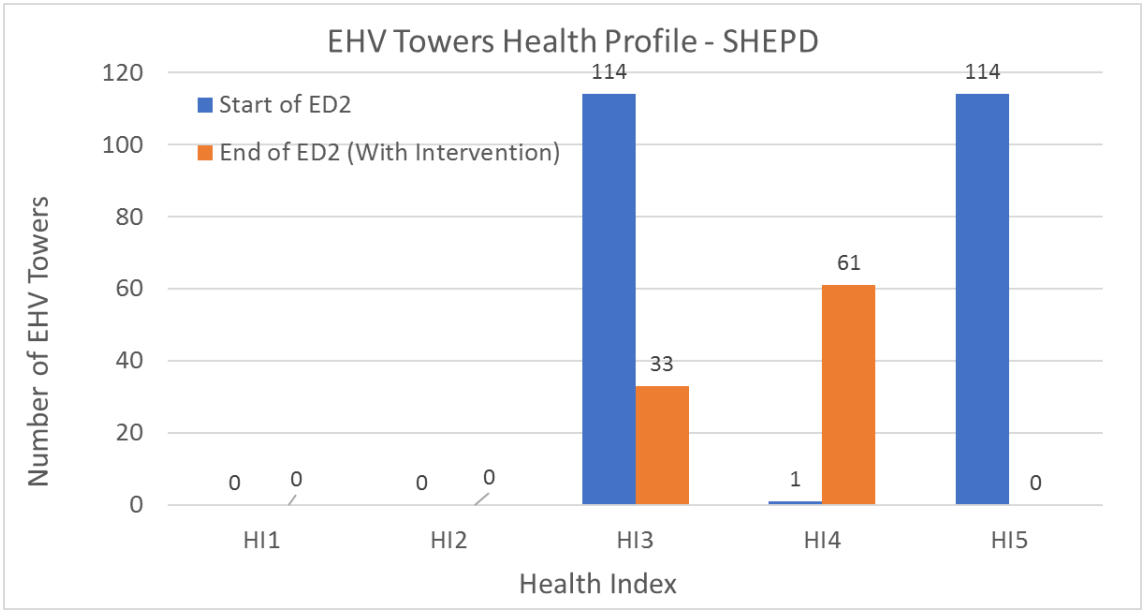
Comparing Figure 52 with Figure 17, it is seen that the length of HI3 and HI2 tower conductors (SHEPD) at the end of ED2 has reduced from 17.36 km to 0.94 km and from 88.07 to 43.61 km, respectively, improving the health of this asset class on the network.

Figure 52: Health Profile after investment of 33kV Tower Line Conductor SHEPD



Whereas there were 115 towers predicted to be in poor health (HI5) by the end of ED2 without intervention (from Figure 18), Figure 53 shows that this number has dropped to zero. There is however a rise in the number of C4 assets which will require future intervention in later years.

Figure 53: Health Profile after investment of 33kV Towers SHEPD



Likewise, in Figure 54, the number of HI5 tower fittings (296, from Figure 19) has dropped to zero under the intervention policy. In this asset class there is also minimal change in HI3 and HI4 at the end of ED2 with the intervention applied.

Figure 54: Health Profile after investment of 33kV Fittings SHEPD

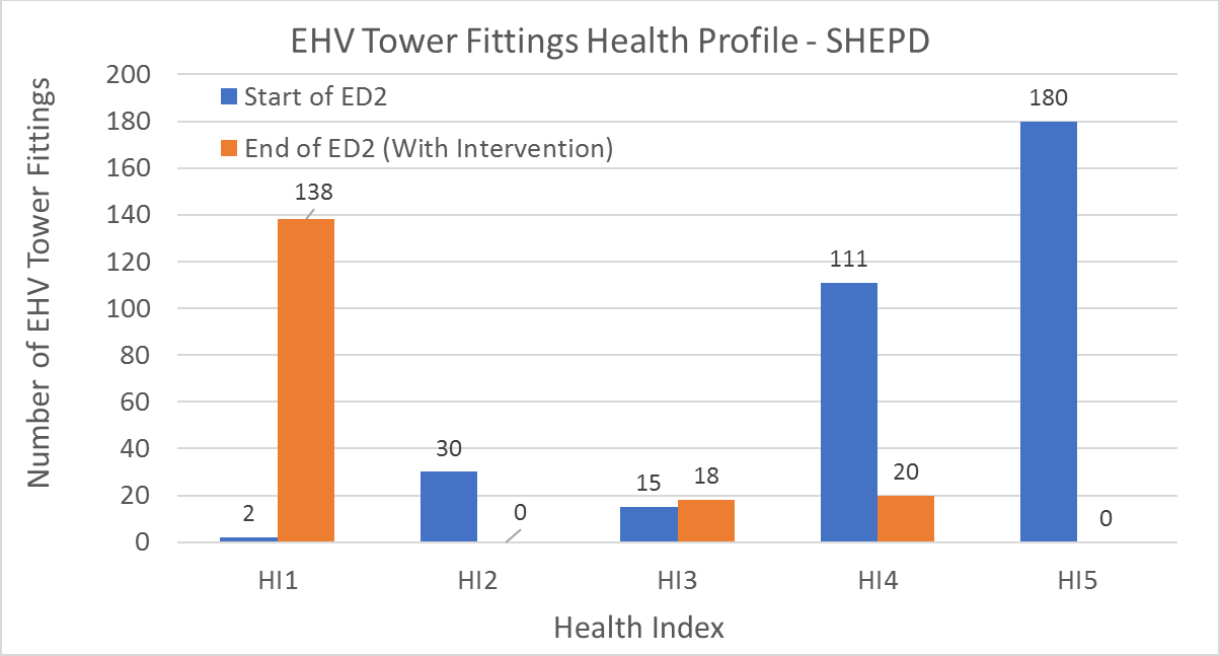


Figure 55 shows that there is no change in the SEPD EHV Tower health profile, due to no investment required in this asset type in ED2.

Figure 55: Health Profile after investment of 33kV Tower Line Conductor SEPD

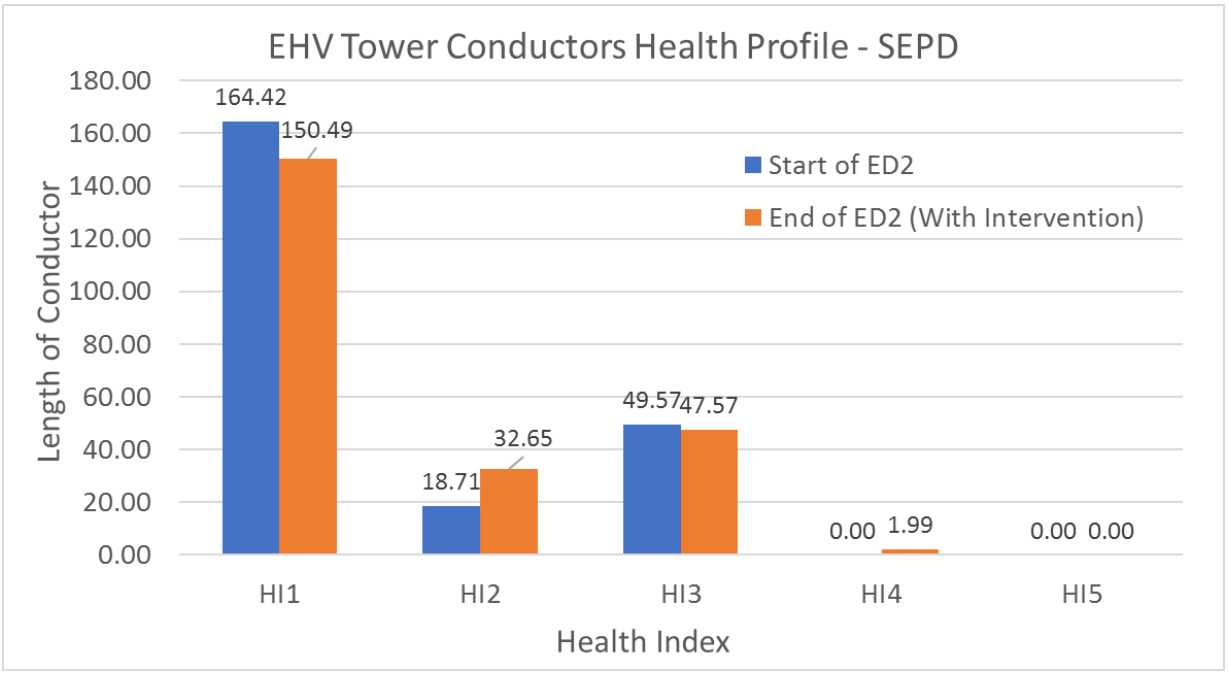


Figure 56 shows the effect of intervention on the EHV towers health profile. The 24 assets that were proposed for intervention are now listed at HI3, increasing the HI3 profile whilst reducing the HI5 profile to zero at the end of ED2. This improves the overall network health.

Figure 56. Health Profile after investment of 33kV Towers SEPD

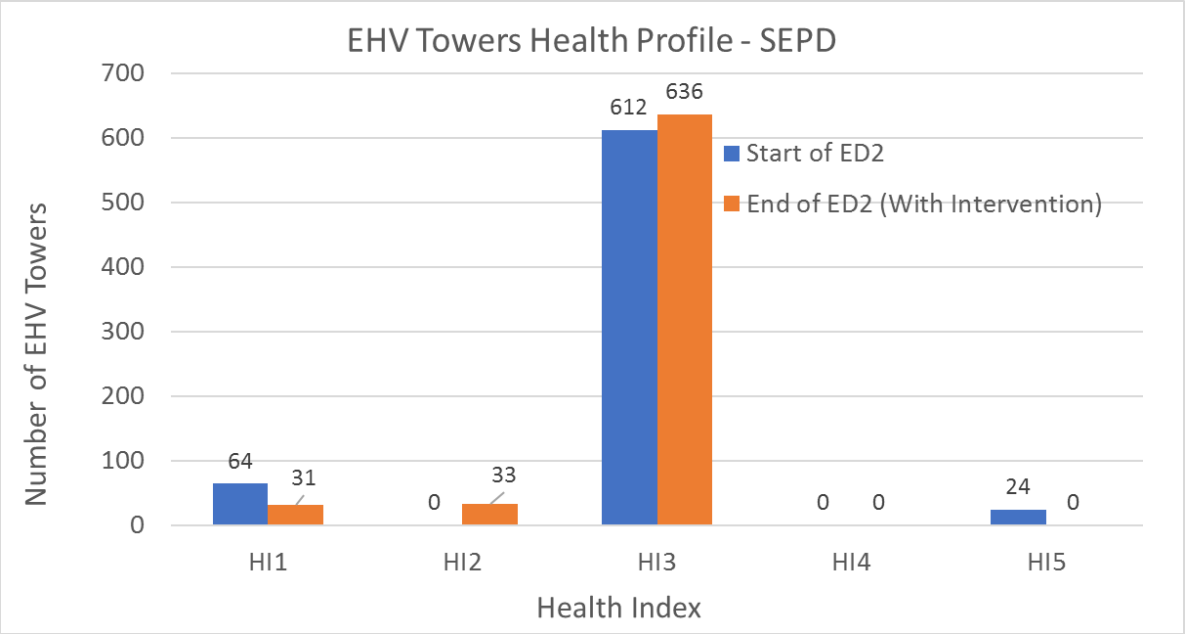


Figure 57 shows that with intervention the 74 tower fittings that would have been HI5 at end of ED2 (from Figure 22) have moved to HI1 banding along with 39 of the assets which would have been HI4 at the end of ED2. This has improved the health profile, although there are still 91 assets remaining at HI4 on the network.

Figure 57: Health Profile after investment of 33kV Fittings SEPD

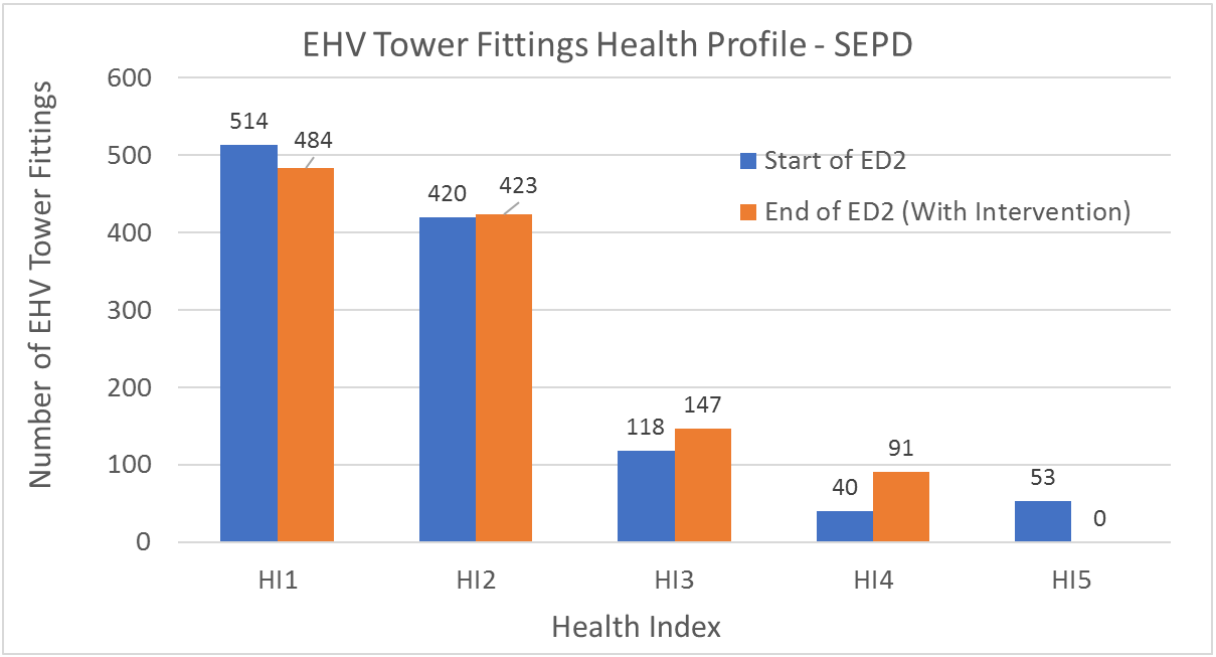
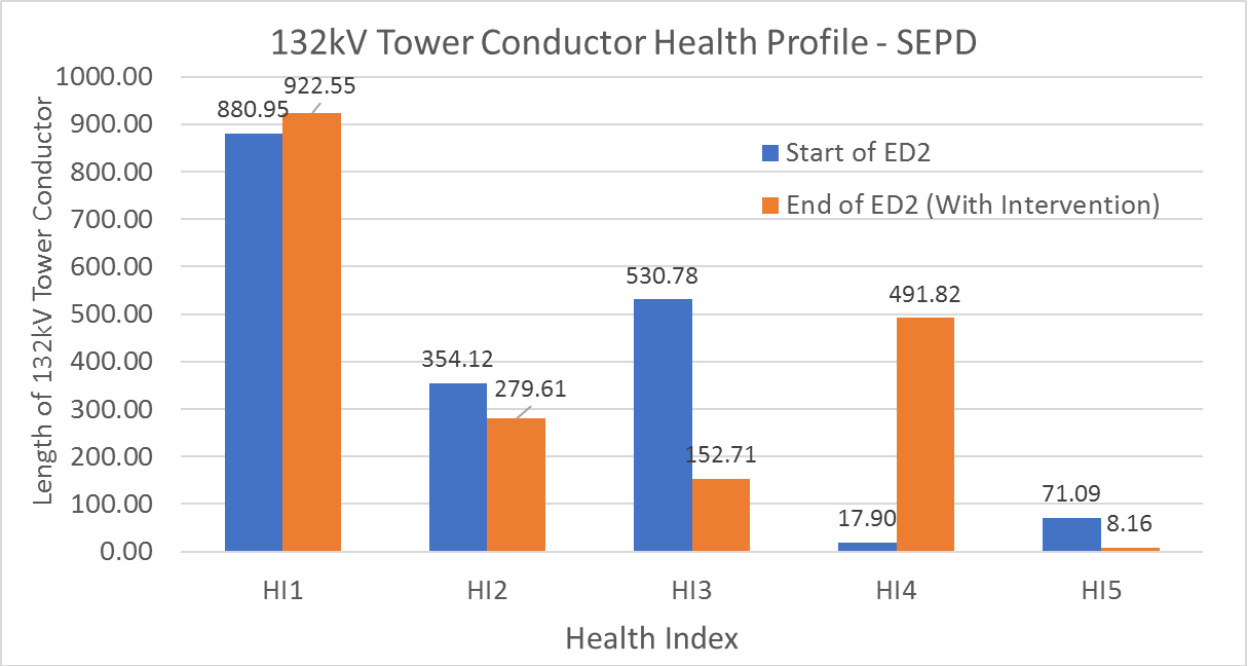


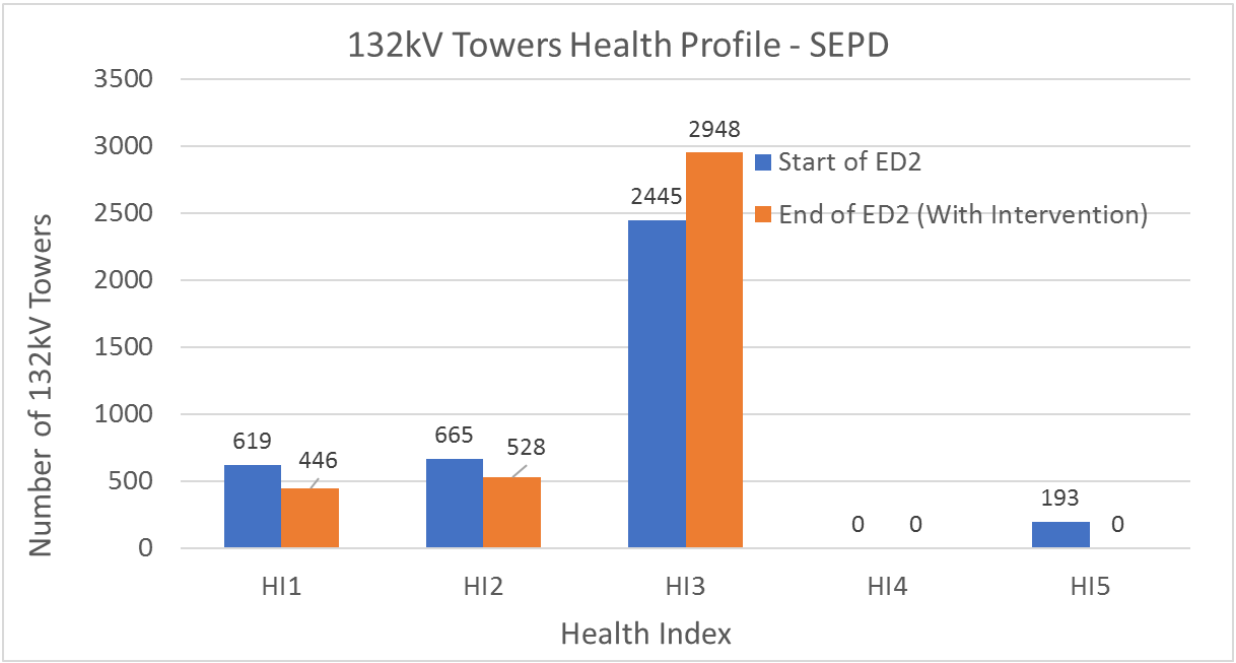
Figure 58 indicates the 132kV tower conductor health profile with the planned intervention. The 79.78 km of tower conductor at HI5 (from Figure 23) has been reduced to 8.16km. Although this will improve the network health, there is still a risk due to the length of conductor at HI4 remaining on the network.

Figure 58: Health Profile after investment of 132kV Tower Line Conductor SEPD



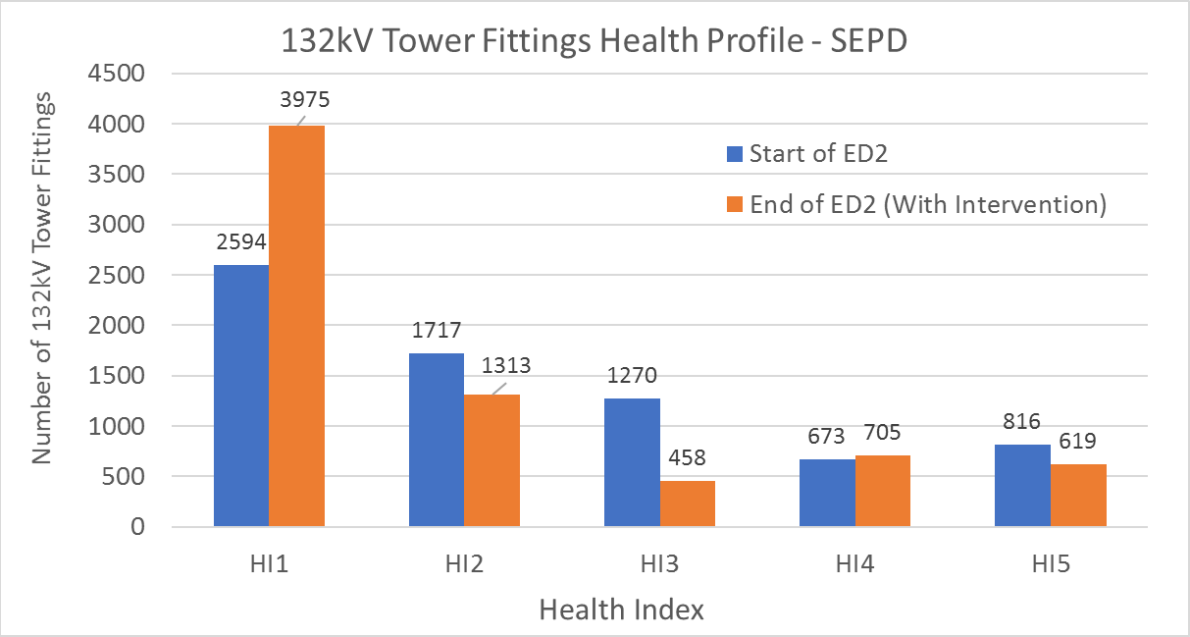
With intervention all the assets predicted to be HI4 and HI5 by end of ED2 are now at HI3, providing considerable improvement to the overall Towers' health profile with no assets remaining at HI4 or HI5.

Figure 59: Health Profile after investment of 132kV Towers SEPD



Although Figure 60 shows a significant number of tower fittings remaining on the network after intervention, there is a considerable reduction in the numbers at HI3,HI4 and HI5 compared to the situation with no intervention (Figure 25): the numbers in each band reduce from 748 to 458, from 1375 to 705 and from 1435 to 619, respectively, thereby improving the health profile of the 132kV Tower Fittings.

Figure 60: Health Profile after investment of 132kV Fittings



As per our asset management strategy for RIIO-ED2, we have only shortlisted 33kV & 132kV Towers, Conductor and Fittings for replacement when the Health Score within the Health Index 5 and Health Index 4 banding becomes so severe that the continued risk for network customers becomes intolerable and the asset must be intervened upon.

Any reduction against these volumes will risk the reliability, safety and environmental impact of the network to the detriment of our network customers.

6.6 RIIO-ED2 Deployment of Investment Options

Table 20 below shows the final volumes associated with each investment option concluded from our strategic review of each scenario for 33kV & 132kV overhead tower line assets and feedback from our stakeholder engagement exercises.

Table 20: SSEN Final RIIO-ED2 volumes for each investment Option

Option	Options Name	No. of Deployments (#)	RIIO-ED2 TOTEX Spend (£m)
1	Do Minimum (Baseline)	-	-
2	Full Rebuild of Span/Section	-	-
3	Reconductor Overhead Tower Line	90.9km	[redacted]
4	Insulators and Fittings Replacement	2,031	[redacted]
5	Tower Painting & Steel Tower Steelwork Replacement	493	[redacted]

6.7 Deliverability and Risk 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 and Efficiency (Annex 15).***

- 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 (Annex16.2))*** 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 21 below shows a comparison of the 33kV & 132kV Overhead Tower Line assets replaced within the first 5 years of RIIO-ED1 compared to our proposal for RIIO-ED2.

Table 21: SSEN change in volume comparison for deliverability

SSEN Licenced Area	Asset Category	ED1 (first 5 years)	ED2 Proposed Volumes	Percentage Change
SHEPD	CV7 - 33kV Overhead Tower Line Conductor	0km	19.2km	**-**
SHEPD	CV7 - 33kV Fittings	1	136	**13600.0%**
SHEPD	CV9 – 33kV Towers	0	67	**-**
SEPD	CV7 - 33kV Fittings	176.518	71.613792	**40.6%**
SEPD	CV7 - 132kV Overhead Tower Line Conductor	128km	136km	**106.3%**
SEPD	CV7 - 132kV Fittings	743	1782	**239.8%**
SEPD	CV9 – 33kV Towers	164	24	**14.6%**
SEPD	CV9 – 132kV Towers	934	402	**43.0%**

7 Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that we intend to take during RIIO-ED2 for the non-load related management of 33kV & 132kV overhead tower line assets.

A background into the asset category under consideration has been provided including the Age Profiles for SEPD and SHEPD as well as the Health, Criticality, and Risk profiles prior to the start of ED2 and at the end of ED2 without investment.

Section 6 outlined five investment option categories for the issue of dealing with poor condition assets. A holistic approach was taken when selecting the most viable option for 33kV & 132kV towers, conductor and fittings project. This Includes future network trend analysis and careful consideration of the financial, safety, and environmental implications of each investment option. In relation to 33kV & 132kV towers, conductor and fittings only the option in bold has been considered:

- Option 1: Do Minimum
- Option 2: Full Rebuild of Span/Section
- **Option 3: Reconductor Overhead Lines**
- **Option 4: Insulators and Fittings Replacement**
- **Option 5: Tower Painting & Steelwork Replacement**

In total, an equivalent of 493 33kV & 132kV towers, 2031 tower line fittings and 90.9km of tower line conductor have been identified for intervention during RIIO-ED2 based on the asset's health. This investment represents a total spend of **£25.05m** throughout ED2.

8 Appendix 1: Acronym Table

Acronym	Description
AAAC	All Aluminium Alloy Conductors
ACB	Air Circuit Breaker
ACSR	Aluminium Conductor Steel Reinforced
AIB	Air Insulated Busbar connected
AVC	Auto Voltage Control
BaU	Business as Usual
BPDT	Business Plan Data Table
Cad Cu	Cadmium Copper
CapEx	Capital Expenditure
CB	Circuit Breaker
CBRM	Condition Based Risk Methodology
CBA	Cost Benefit Analysis
CCA	Chromated Copper Arsenate
CEG	Customer Engagement Group
CI	Customer Interruption
CML	Customer Minutes Lost
CMR	Continuous Maximum Rating
CMZ	Constraint Management Zone
CNAIM	(DNO) Common Network Asset Indices Methodology
CO_2e	Carbon Dioxide equivalent (can be suffixed by t (tonnes))
CoF	Consequence of Failure
Consac	Underground Cable type, Paper insulation with Aluminium Sheath
CRC	Charge Restriction Condition
CV	Cost and Volume
DFES	SSEN's Distribution Future Energy Scenarios
DGA	Dissolved Gas Analysis
DIN	Dangerous Incident Notification
DNO	Distribution Network Operator
DP	Degree of Polymerisation
DPCR5	Distribution Price Control Review for five years from 1 April 2010 to 31 March 2015
DSI	Death or Serious Injury
DSO	Distribution System Operator
DTI	Department of Trade and Industry

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
EQ	Equation
ESQCR	Electricity, Safety, Quality and Continuity Regulations
EU	European Union
FFA	Furfuraldehyde
FFC	Fluid Filled Cable
GB	Great Britain
GIB	Gas Insulated Busbar connected
GM	Ground Mounted
GRP	Glass Reinforced Plastic
HI	Health Index
HSE	Health and Safety Executive or Health, Safety and Environment
HM	Her Majesty or His Majesty
HV	High Voltage, Voltages > 1kV and < 22kV , in SSEN these assest are usually 6.6kV and 11kV.
ID	Indoor
IIS	Interruption Incentive Scheme
IR	Insulation Resistance
kV	Kilovolt
LCT	Low Carbon Technology
LV	Low Voltage, Voltages < 1kV, in SSEN these assest are usually ~400V.
LV UGB	Low Voltage Underground Board (Link Box)
LTA	Lost Time Accident
MEAV	Modern Equivalent Asset Value
MMI	Maximum and Multiple Increment
MR	Monetised Risk
MVA	Megavolt Ampere
NaFIRS	National Fault and Interruption Reporting Scheme
NAIM	Network Asset Intervention Methodology
NARA	Network Asset Risk Annex
NARM	Network Asset Risk Metric
NAW	Network Assets Workbook
NEDeRs	National Equipment Defect Reporting Scheme
NPV	Net Present Value

OD	Outdoor
OEM	Original Equipment Manufacturer
Ofgem	Office of Gas and Electricity Markets
OHL	Overhead Line
OpEx	Operational Expenditure
PCB	Polychlorinated Biphenyls
PESC	Postsecondary Electronic Standards Council
PILC	Paper Insulated Lead Covered
PM	Pole Mounted
PoF	Probability of Failure
PVC	Polyvinyl Chloride
RIG	Regulatory Instructions and Guidance
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
RMU	Ring Main Unit
SDI	Secondary Deliverable Intervention
SEPD	Southern Electric Power Distribution PLC
SF6	Sulphur Hexafluoride
SHEPD	Scottish Hydro Electric Power Distribution PLC
SLC	Standard Licence Condition
SOP	Suspension of Operational Practice
UGC	Under Ground Cable
VoLL	Value of Lost Load
VSL	Value of Statistical Life
WM	Wall Mounted

9 Appendix 2: Relevant Policy, Standards, and Operational Restrictions

The policies, manuals and standards and operational restrictions which govern the management of 33kV & 132kV Overhead Tower Line assets are listed below in Table 22

Table 22: 33kV & 132kV Overhead Tower Line relevant documents

Policy Number	Policy Name / Description
MA-NET-OHL-003	Painting of Lattice Steel Distribution Towers Technical Manual
SP-NET-OHL-516	Safety Signs, Information Plates and Anti Climbing Devices for Steel Lattice Towers