Scottish and Southern Energy
Power Distribution

# Technical Appendix 03a

# Secondary Deliverables

This Technical Appendix is part of the RIIO-ED1 Business Plan of Southern Electric Power Distribution plc ("SEPD") and Scottish Hydro Electric Power Distribution plc ("SHEPD"), together Scottish and Southern Energy Power Distribution ("SSEPD").

A map of the full Business Plan can be found at www.yourfutureenergynetwork.co.uk/map.pdf

All costs shown are in 2012/13 prices unless indicated otherwise.

# Summary

This section of our Business Plan provides further detail on our proposals for maintaining and improving the reliability of both of our distribution network areas, Scottish Hydro Electric Power Distribution (SHEPD) and Southern Electric Power Distribution (SEPD). It is intended to bridge the gap between the high level commentary in Technical Appendix 03 – A Reliable Supply of Electricity and the data presented in the Ofgem Business Plan Data Tables

In addition to our primary output measures, we have developed a set of metrics which allow us to monitor the health, loading and resilience of our network assets. This data enables us to:

Make targeted and efficient decisions on our network investment strategy,

Ensure we maintain an acceptable level of risk on the network,

Manage our assets effectively and efficiently.

Our proposals for these secondary deliverables over the 2015-2023 period are described in detail in this paper. It also lays out the consequences of not making investments and the resultant increase in operational risk. This provides part of the justification that our proposed investment is necessary to maintain existing levels of risk.

While this information cannot perfectly predict the future performance of our network assets, it can be used as part of a wider suite of information available to assess whether or not we are maintaining an acceptable level of risk. These primary metrics measure the reliability and the availability of the network and, as such, the overall experience of our customers.

There are three related areas of activity which are defined as Secondary Deliverables:

- Health, Criticality and Risk.
- Load Index, a measure of the loading on our networks.
- Resilience, managing risk in the areas of flooding, Black Start and Overhead Lines.

## Summary of our Plans….

Our objective is to improve the reliability of supply to our customers through targeted investment, the efficient use of resources and the use of innovative solutions.

| | |
|---|---|
| Managing Demand and Distributed Generation risks | We will invest £456.93M to maintain or improve the overall capacity of our networks<br>Of this total £177.55M will be invested in our SHEPD licence area and £279.38M in our SEPD licence area. |
| Managing our network condition | We will invest £1,696.71M to avoid any deterioration in our existing level of network condition<br>Of this total £527.16M will be invested in our SHEPD licence area and £1,169.55M in our SEPD licence area. |
| Improving network performance | We will reduce the number of customer interruptions from our current level by an average of more than 5% across our SHEPD and SEPD licence areas by the end of RIIO ED1 in 2023<br>We will reduce the duration of customer interruptions from our current level by more than 25% on average across our SHEPD license and SEPD license areas by the end of RIIO ED1 in 2023.<br>We will make compensation payments automatically to customers on our Priority Services Register. |
| Improving reliability in the Highlands and Islands | We plan to invest £25.2M to improve the network reliability of around 4000 customers on the west coast of Scotland. |
| Investing for Resilience | We will invest a further £57.43M to reduce the risk of disruption from exceptional events such as flooding, major network failure and extreme weather.<br>Of this total £5.2M will be invested in our SHEPD licence area and £52.23M in our SEPD licence area. |

# Contents

# Health, Criticality and Risk

## Introduction

Throughout DPCR5 Ofgem has used the Health Index (HI) to track changes in our asset health and to confirm that we are maintaining the health of our assets at the level we agreed to at the start of DPCR5. For RIIO-ED1, we have been working closely with Ofgem to develop changes to the existing HI methodology.

In DPCR5 we have included elements of Criticality within our overall Health Assessments of many of our asset types. For RIIO-ED1, Ofgem has mandated that we separate out these criticality elements to produce a Composite Risk Index (CR).

Many of the details around the Criticality and Risk indices have yet to be finalised but, while we work alongside Ofgem to develop these, we have decided to use the draft methodology determined by the Ofgem Criticality and Health Index Working group.

Our investment proposals reflect our actual Health Index and Criticality assessments of our assets, including projected deterioration during the period to 2023. Our investment strategy is to maintain a level network risk over the RIIO ED1 period, and the volumes proposed are reflective of this position.

## Health Index

The Health Index (HI) is a measure of the overall Health of the asset and is made up of a combination of data. This includes asset age, condition assessments, historical performance and known operational defects. We are also able to anticipate the likely future change in condition, or the degradation, of that asset. Ofgem has defined HI categories and assets measured against these categories to effectively classify their condition. The HI scale is 1-5, where “1” corresponds to the best condition and “5” indicates the worst condition on a “1-5” basis. The table below defines these health index categories.

| | |
|---|---|
| HI1 | New or as new |
| HI2 | Good or serviceable condition |
| HI3 | Deterioration, require assessment or monitoring |
| HI4 | Material deterioration, intervention requires consideration |
| HI5 | End of serviceable life, intervention required |

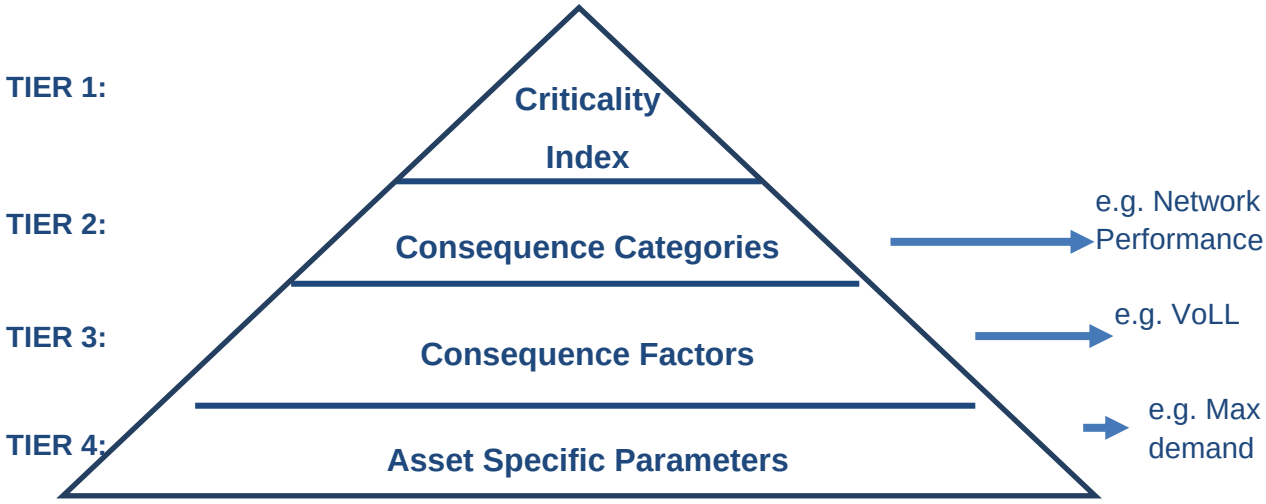
We always seek the appropriate balance between minimising the level of this expenditure whilst ensuring that there is no risk to the safety of our staff and the public, or risk to security of supply to our customers. In DPCR5 we are on target to deliver all of our forecast outputs for less cost than we predicted. This is as a result of new policies, procedures and innovative processes that have reduced unit rates across the broad range of asset types.

In DPCR5 we developed our methodology to include the refurbishment as well as the replacement of our assets. Most of our more complex equipment is made up of many component parts. Traditionally we would have replaced these assets at greater cost. Our current methodology looks at each equipment type and assesses whether component replacement is a better whole life solution to complete replacement. We do this for both overhead lines and ground mounted equipment.

We are also working closely with the University of Strathclyde to enhance our methodology and increase the robustness of our condition data using Multiple Criteria Decision Making (MCDM), specifically a combination of Analytical Hierarchy Process (AHP) and Pairwise Comparison. We will continue this development prior to the commencement of RIIO-ED1, and will expand it to include the development of a Criticality Index.

## Criticality Index

The Criticality Index (CI) is a measure of the impact of asset failure, based on a combination of safety, environmental, network performance and financial factors. We continue to with Ofgem and other DNOs to produce a common methodology for assigning criticality to assets. Whilst this is being finalised, we have based our Criticality Index on the draft principles recommended by the Criticality and Health Index Working Group. These recommendations consist of a common high level set of definitions, principles and framework for the Criticality Index. The working group has sought to determine the appropriate level of commonality at each of the subsequent layers of detail below the Criticality Index. These different layers are illustrated below




The Criticality Index is intended to provide a comparison of the relative Consequences of Failure for assets of the same type, as well as between different asset types.

Each asset is assigned a Criticality Index Band, based upon the relative magnitude of the Overall Consequence Of Failure of the asset, compared to the Average Overall Consequence Of Failure for all assets in the same Health Index Asset Category. There are four Criticality Index Bands as shown in the table below:

| | |
|---|---|
| CI1 | Low Criticality; less than 75% of the Average Overall Consequence Of Failure |
| CI2 | Average Criticality; greater than, or equal to, 75% and less than 125% of the Average Overall Consequence Of Failure |
| CI3 | High Criticality; greater than, or equal to, 125% and less than 200% of the Average Overall Consequence Of Failure |
| CI4 | Very high criticality; greater than, or equal to, 200% of average consequence of the Average Overall Consequence Of Failure |

The Consequence of Failure of an asset is comprised of four parts;

- Network Performance consequence

- Safety consequence
- Environmental consequence
- Financial consequence of repair/ replacement

For each asset, the Overall Consequence Of Failure is the sum of the individual Consequences in the four Consequence Categories and can be shown as follows:


## Composite Risk Index

The Composite Risk of an asset is derived from a combination of the health and criticality indices. The methodology for producing the Composite Risk is still to be finalised with Ofgem but, in the interim, we will utilise the principles recommended by the Ofgem-led 'Criticality and Health Index Working Group'.

The table below shows how Health and Criticality will be combined to determine the risk index of an asset.

| | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
|---|---|---|---|---|---|
| CI 1 | RI 1 | RI 1 | RI 1 | RI 2 | RI 3 |
| CI 2 | RI 1 | RI 1 | RI 2 | RI 2 | RI 3 |
| CI 3 | RI 1 | RI 1 | RI 2 | RI 3 | RI 4 |
| CI 4 | RI 1 | RI 1 | RI 2 | RI 4 | RI 5 |

We have analysed our asset base for both of our licence areas for four scenarios: 2019 with investment, 2019 without investment, 2023 with investment and 2023 without investment.

## Further Development

The production of a separate Criticality Index is a relatively new development within Distribution Networks and we are aware that further work is required to refine and mature the concept of Criticality and Composite Risk Indices. We will continue to work closely with other DNOs and with Ofgem to develop commonality, and with experts from the University of Strathclyde to develop our internal processes and procedures. We are also working with EA Technology Ltd on the utilisation of their Condition Based Risk Management tool to assist with our Criticality Indices and we anticipate this will be in place prior to the commencement of RIIO-ED1.

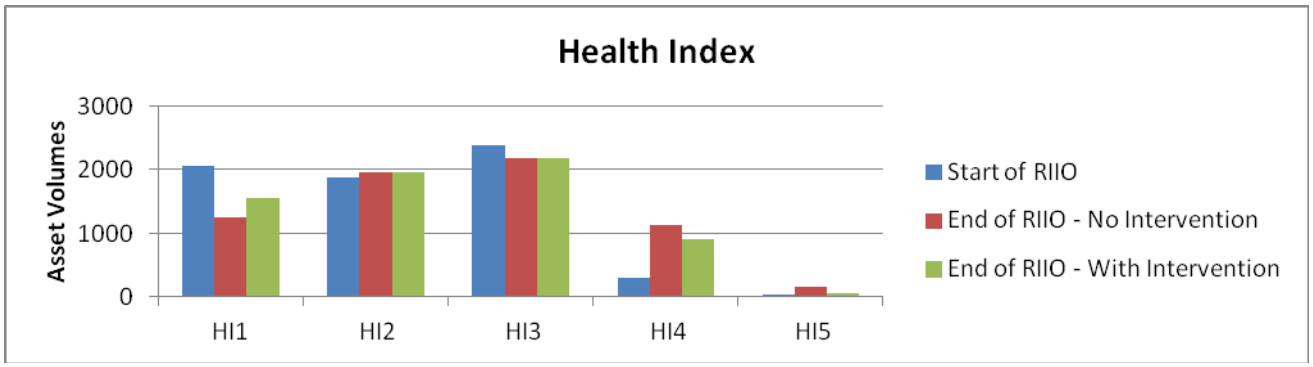
## LV Switchgear

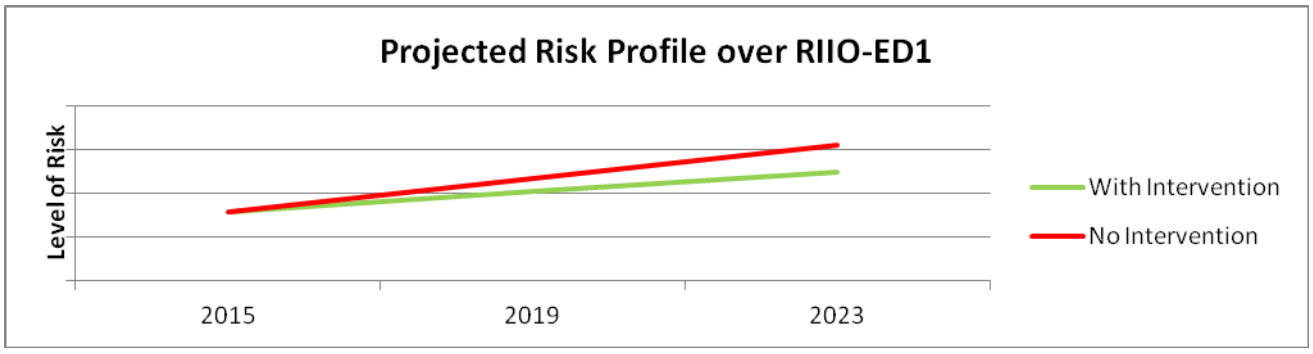
SSEPD needs to know the condition of its Low Voltage plant so that we can responsibly manage our assets. We inspect our LV Switchgear assets and maintain them as soon as possible after any defects are reported. The condition of the switchgear can be gauged by assessing against a number of criteria. Deterioration of the internal components is a factor but experience of how switchgear deteriorates has led us to conclude that the external condition of the plant and its supporting structure are a primary driver in determining the plant condition.

Our replacement programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 3% realised from the investment of £6.86m in replacement and refurbishment.

### SHEPD

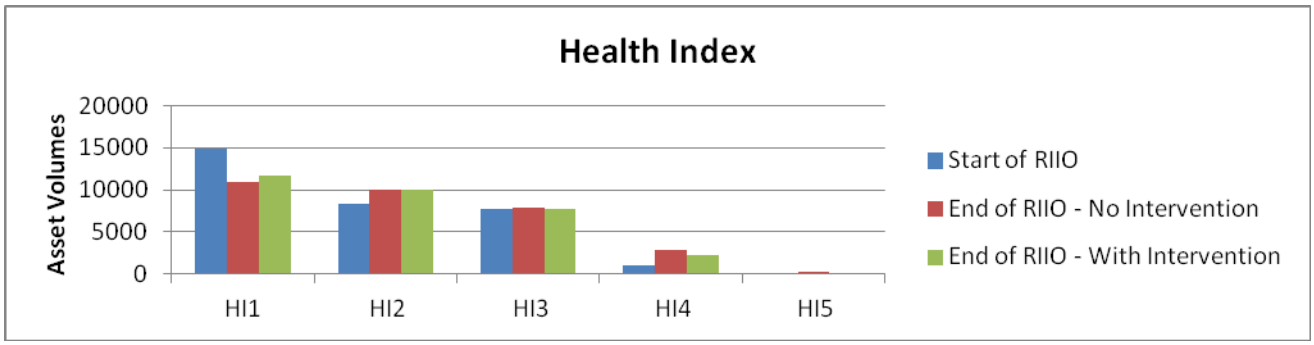


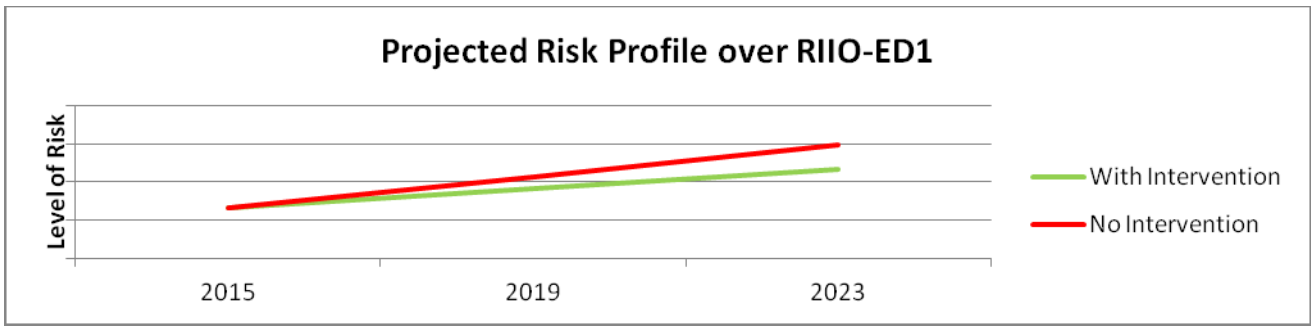



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 5% | 5% | 3% | 0% |
| | CI 2 | 5% | 9% | 10% | 5% | 1% |
| | CI 3 | 5% | 9% | 10% | 5% | 1% |
| | CI 4 | 5% | 8% | 8% | 4% | 1% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 4% | 5% | 5% | 2% | 0% |
| | CI 2 | 7% | 9% | 9% | 4% | 0% |
| | CI 3 | 7% | 9% | 9% | 4% | 0% |
| | CI 4 | 6% | 8% | 8% | 3% | 0% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 1% | 0% | 0% | 0% | 0% |
| | CI 2 | 13% | 12% | 9% | 3% | 0% |
| | CI 3 | 10% | 10% | 7% | 3% | 0% |
| | CI 4 | 10% | 10% | 7% | 3% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 1% | 0% | 0% | 0% | 0% |
| | CI 2 | 14% | 12% | 9% | 3% | 0% |
| | CI 3 | 11% | 10% | 7% | 2% | 0% |
| | CI 4 | 11% | 10% | 7% | 2% | 0% |

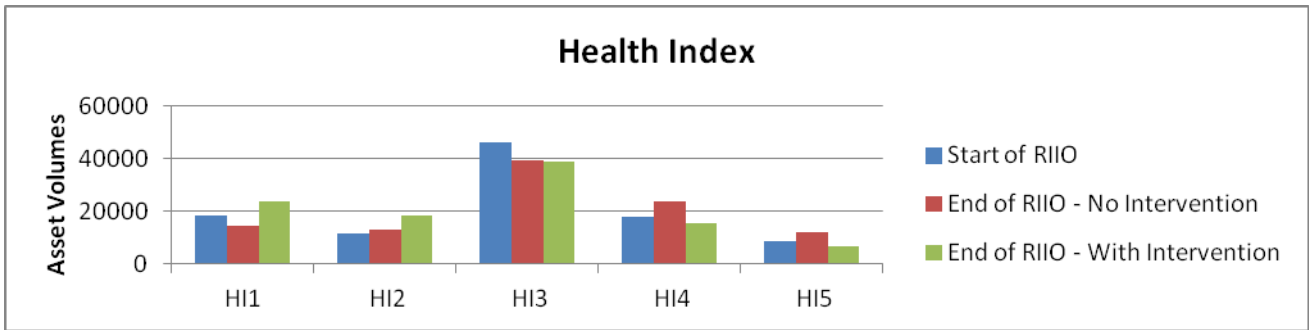
## LV OHL Supports

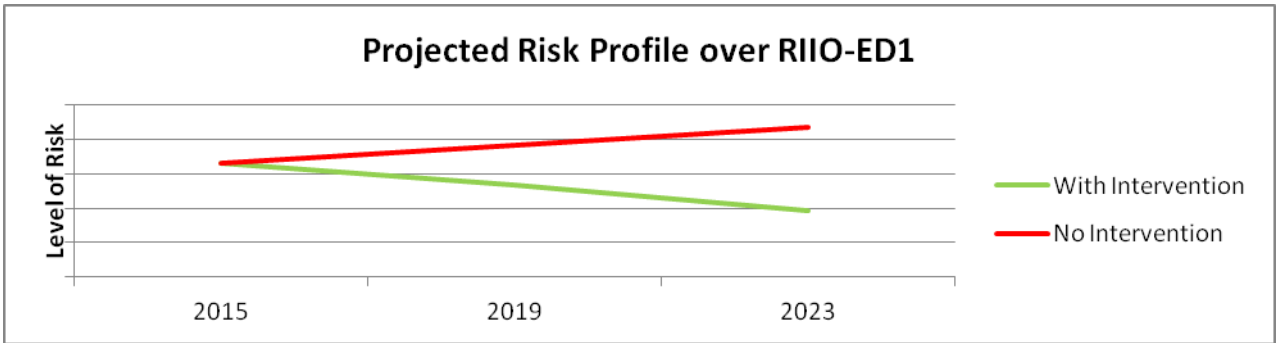
We inspect, maintain and refurbish our overhead line assets on the basis of a 12 year cyclical approach. This includes an inspection and maintenance 4 yearly foot patrol with refurbishment or replacement of assets in the 12th year. Additional inspections and intervention is provided for parts of our network which are considered High Risk, such as at recreational sites.

Our overhead line programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 13% realised from the investment of £50.4m in the replacement and refurbishment.

### SHEPD

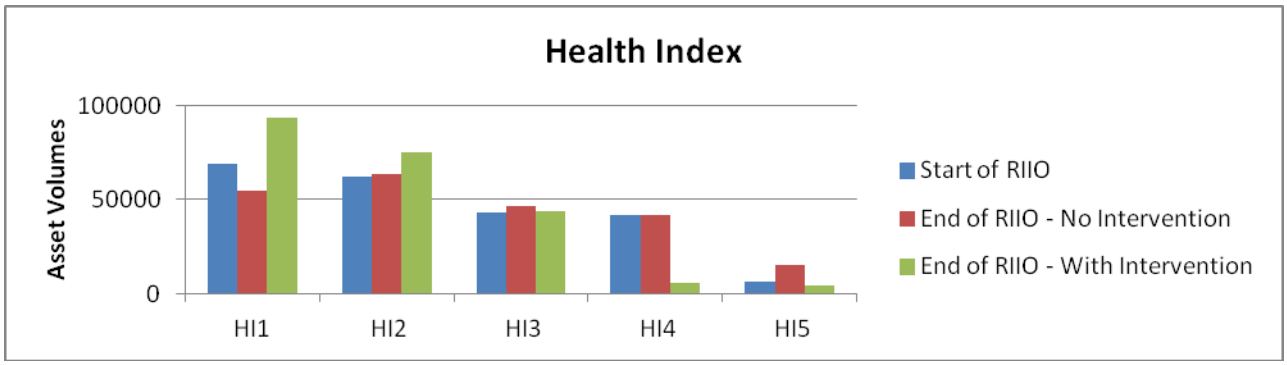


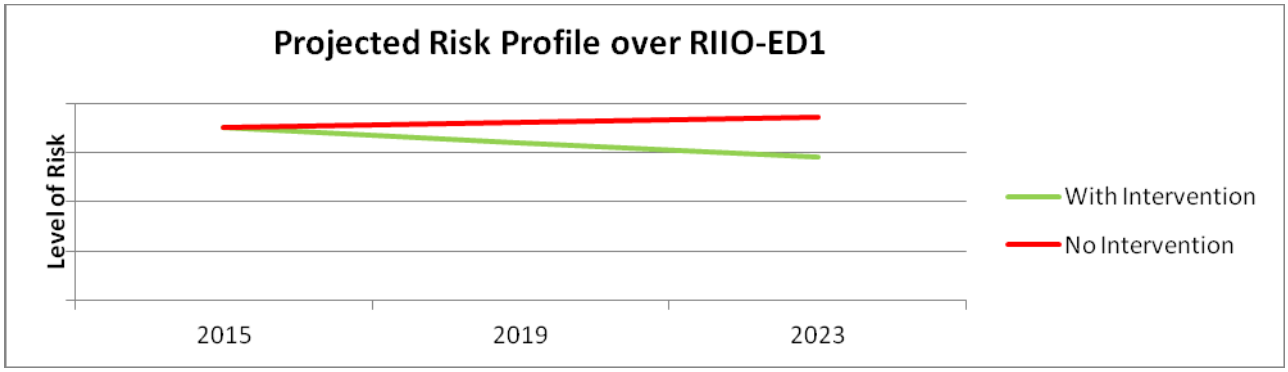




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 13% | 11% | 34% | 20% | 11% |
| | CI 3 | 1% | 1% | 4% | 2% | 1% |
| | CI 4 | 0% | 0% | 1% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 21% | 16% | 33% | 13% | 6% |
| | CI 3 | 2% | 2% | 4% | 1% | 1% |
| | CI 4 | 0% | 0% | 1% | 0% | 0% |

## SEPD




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 23% | 27% | 20% | 18% | 6% |
| | CI 3 | 1% | 1% | 1% | 1% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 40% | 32% | 19% | 2% | 2% |
| | CI 3 | 2% | 1% | 1% | 0% | 0% |
| | CI 4 | 1% | 0% | 0% | 0% | 0% |

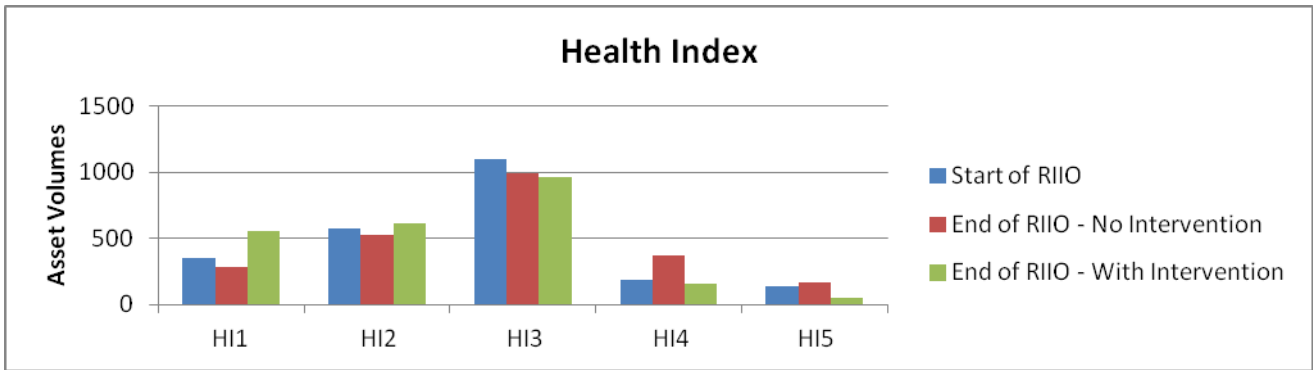
## HV Primary Switchgear

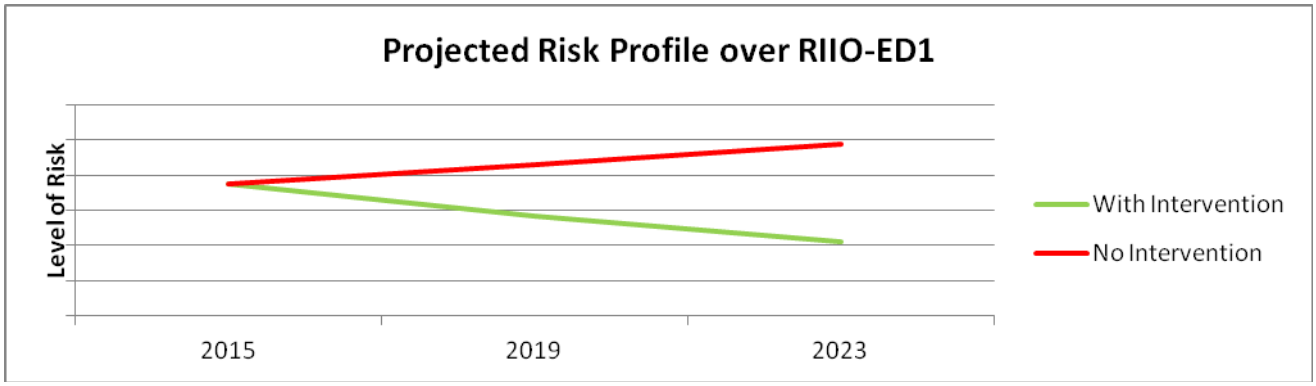
Our asset management practices for substation equipment includes regular inspections to confirm the safety and condition of these assets. These inspections ensure that equipment remains in good operational condition and does not create a risk to staff or the public, or to reliability of supply. These inspections inform the Health Index of the assets and we use information such as the cost to replace the asset, safety, the environmental impact of any leak and the customers dependant on that asset to determine its criticality.

The majority of our expenditure in our capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where cost-benefit analysis has determined it is a lower cost alternative over the life of the asset.

We forecast a reduction in risk of 12% realised from the investment of £34.4m in the replacement and refurbishment.

### SHEPD

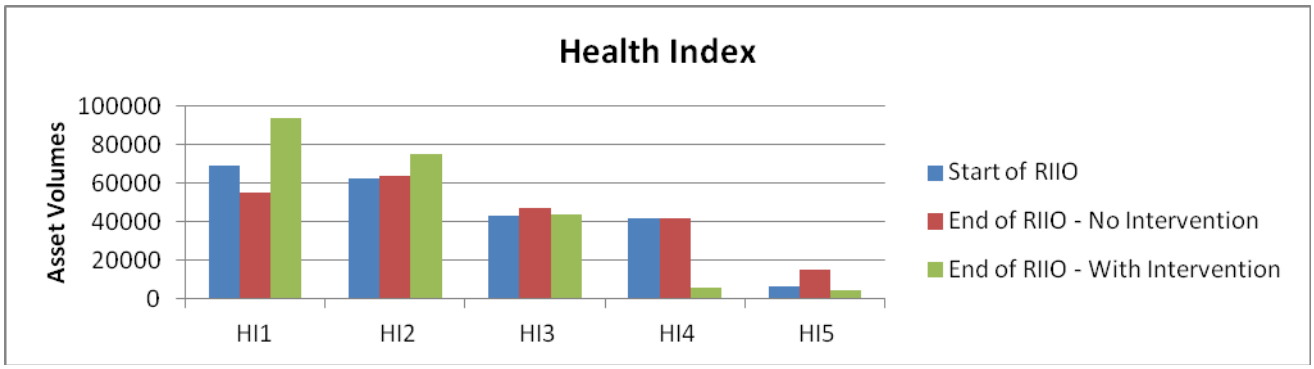


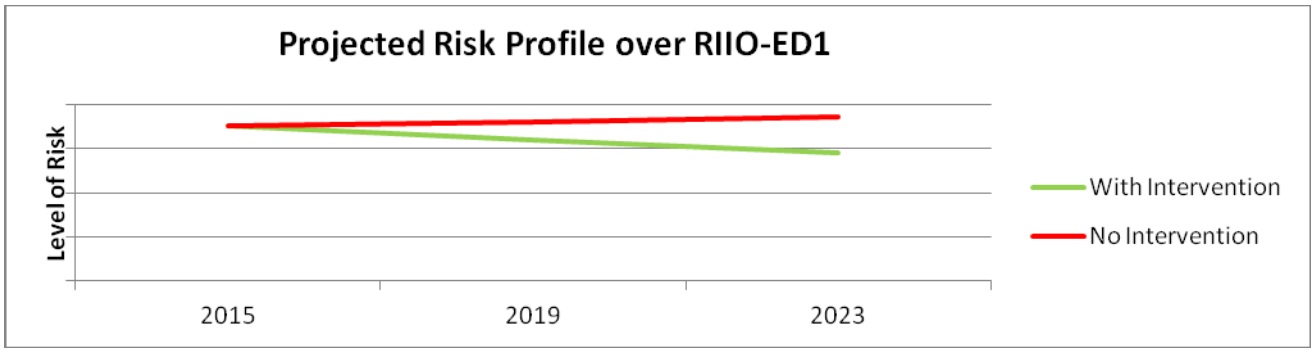



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 4% | 8% | 15% | 6% | 3% |
| | CI 3 | 8% | 14% | 27% | 10% | 5% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 8% | 9% | 14% | 2% | 1% |
| | CI 3 | 15% | 17% | 26% | 4% | 1% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 12% | 10% | 12% | 3% | 1% |
| | CI 3 | 10% | 8% | 9% | 2% | 1% |
| | CI 4 | 10% | 8% | 9% | 2% | 1% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 1% | 0% | 0% | 0% | 0% |
| | CI 2 | 17% | 11% | 8% | 1% | 1% |
| | CI 3 | 14% | 9% | 7% | 0% | 1% |
| | CI 4 | 14% | 9% | 7% | 0% | 1% |

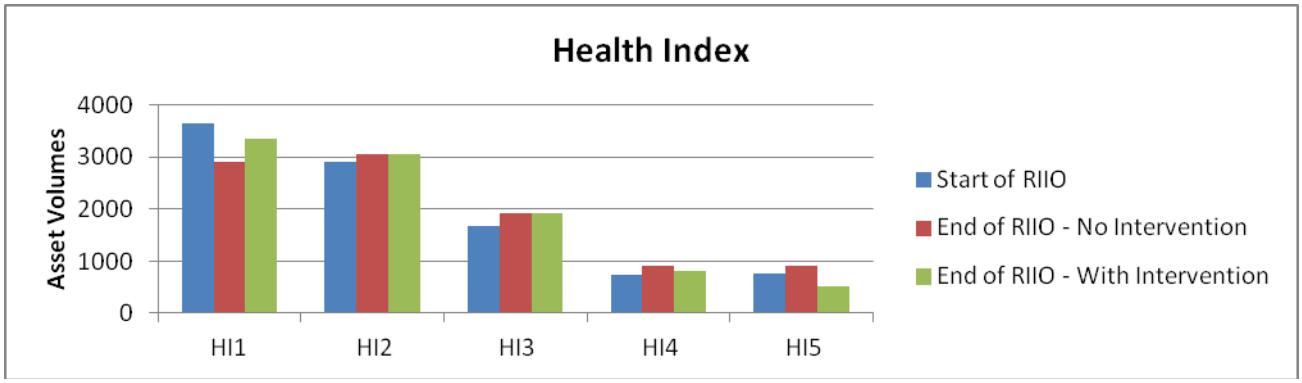
## HV Distribution Switchgear

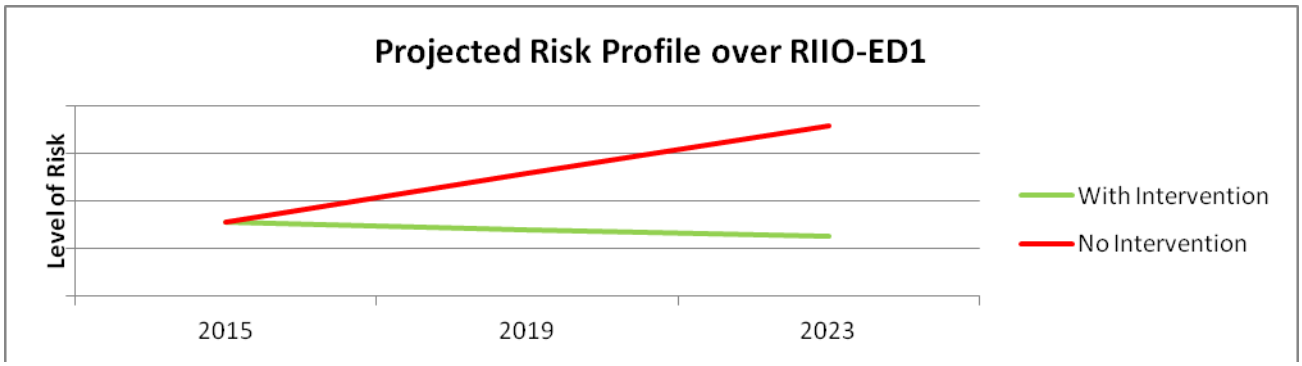
Our asset management practices for substation equipment includes regular inspections to confirm the safety and condition of these assets. These inspections ensure that equipment remains in good operational condition and does not create a risk to staff or the public, or to reliability of supply. These inspections inform the Health Index of the assets and we use information such as the cost to replace the asset, safety, the environmental impact of any leak and the customers dependant on that asset to determine its criticality.

The majority of our expenditure in our capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where cost-benefit analysis has determined it is a lower cost alternative over the life of the asset.

We forecast a reduction in risk of 6% realised from the investment of £43.4m in the replacement and refurbishment.

### SHEPD

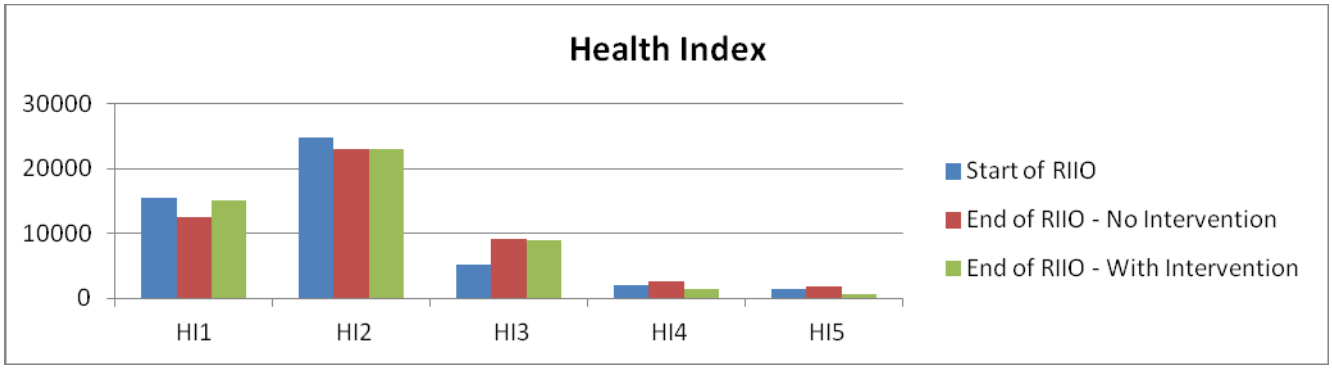


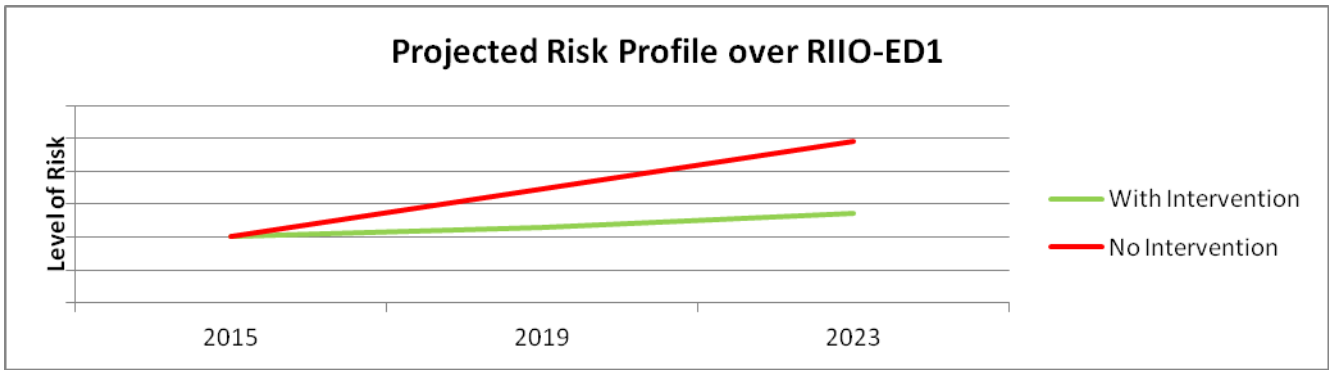



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 5% | 5% | 3% | 2% | 2% |
| | CI 2 | 9% | 9% | 6% | 3% | 3% |
| | CI 3 | 9% | 9% | 6% | 3% | 3% |
| | CI 4 | 8% | 8% | 5% | 2% | 2% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 6% | 5% | 3% | 1% | 1% |
| | CI 2 | 10% | 9% | 6% | 2% | 2% |
| | CI 3 | 10% | 9% | 6% | 2% | 2% |
| | CI 4 | 9% | 8% | 5% | 2% | 1% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 1% | 0% | 0% | 0% |
| | CI 2 | 10% | 18% | 7% | 2% | 1% |
| | CI 3 | 8% | 14% | 6% | 2% | 1% |
| | CI 4 | 8% | 14% | 6% | 2% | 1% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 1% | 0% | 0% | 0% |
| | CI 2 | 12% | 18% | 7% | 1% | 1% |
| | CI 3 | 9% | 14% | 6% | 1% | 0% |
| | CI 4 | 9% | 14% | 6% | 1% | 0% |

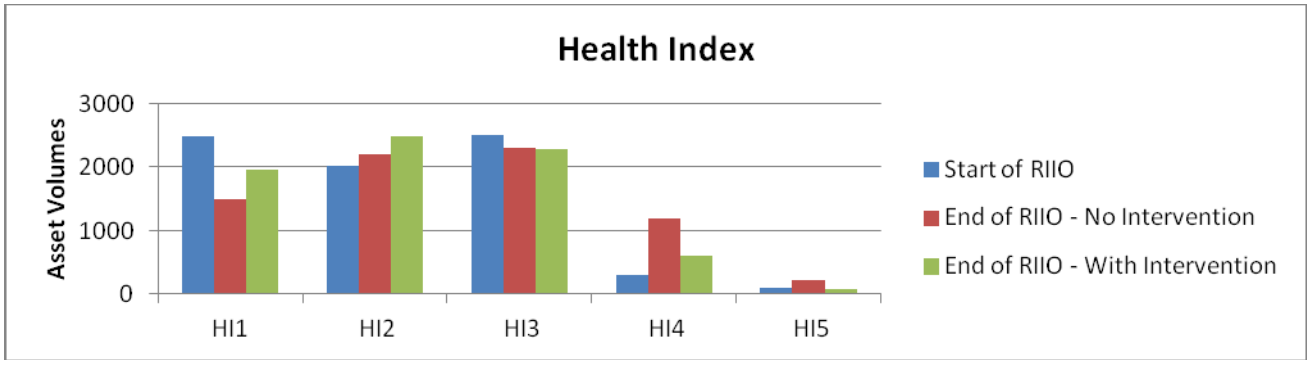
## HV Transformers

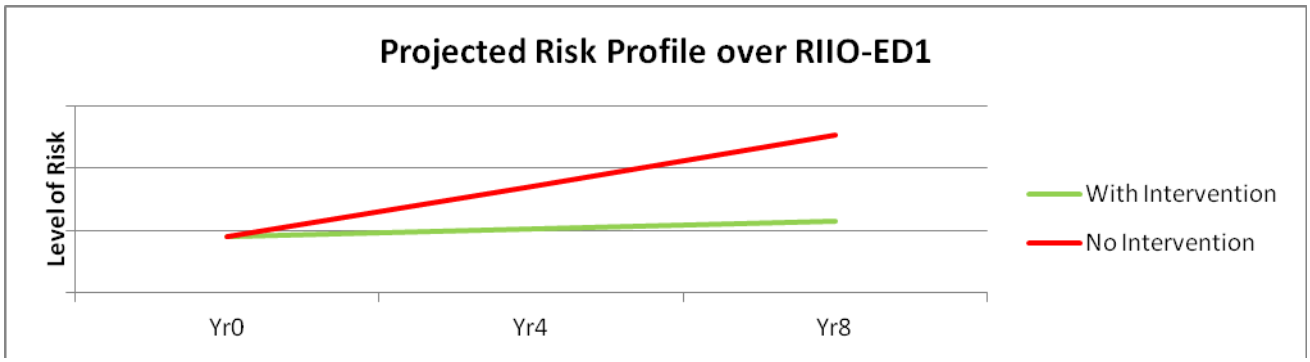
Our asset management practices for substation equipment includes regular inspections to confirm the safety and condition of these assets. These inspections ensure that equipment remains in good operational condition and does not create a risk to staff or the public, or to reliability of supply. These inspections inform the Health Index of the assets and we use information such as the cost to replace the asset, safety, the environmental impact of any leak and the customers dependant on that asset to determine its criticality.

The majority of our expenditure in our capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where cost-benefit analysis has determined it is a lower cost alternative over the life of the asset.

We forecast a reduction in risk of 3% realised from the investment of £11.6m in the replacement and refurbishment.

### SHEPD

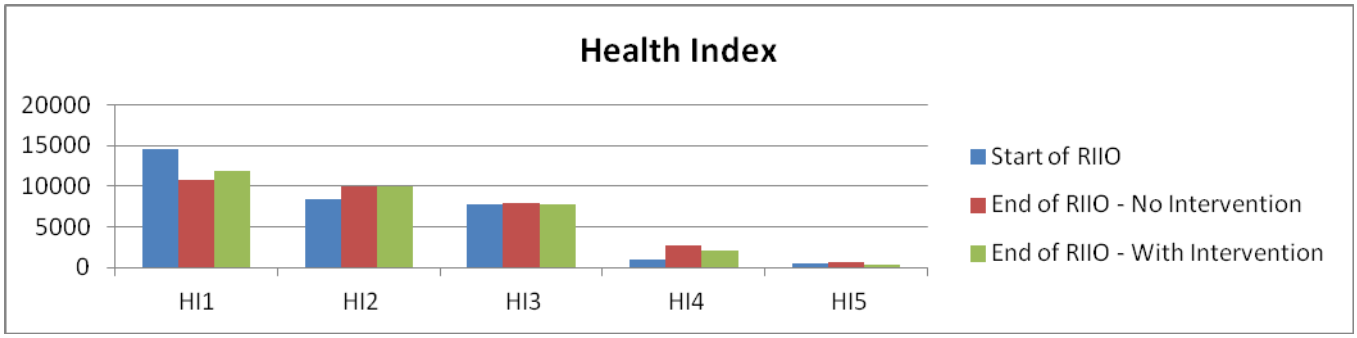


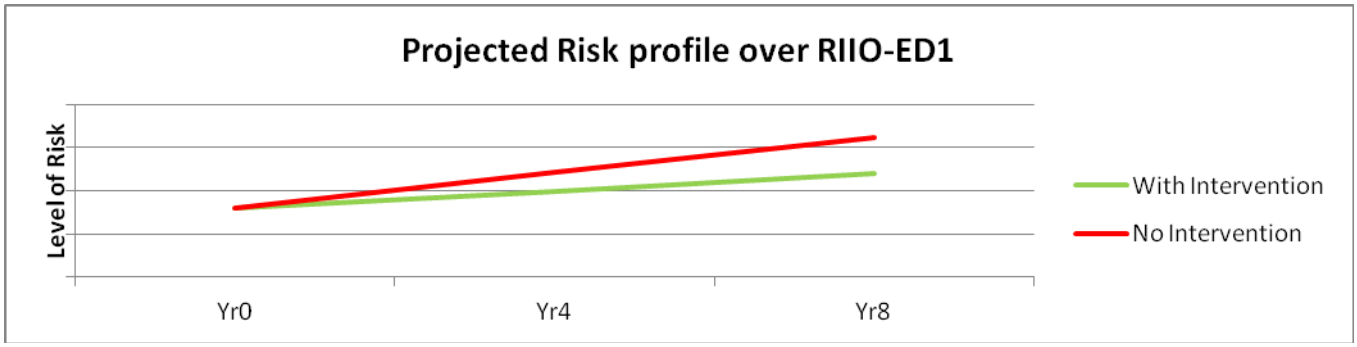



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 5% | 5% | 3% | 0% |
| | CI 2 | 6% | 9% | 9% | 5% | 1% |
| | CI 3 | 6% | 9% | 9% | 5% | 1% |
| | CI 4 | 5% | 8% | 8% | 4% | 1% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 4% | 5% | 5% | 1% | 0% |
| | CI 2 | 8% | 10% | 9% | 2% | 0% |
| | CI 3 | 8% | 10% | 9% | 2% | 0% |
| | CI 4 | 7% | 9% | 8% | 2% | 0% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 1% | 0% | 0% | 0% | 0% |
| | CI 2 | 13% | 12% | 9% | 3% | 1% |
| | CI 3 | 10% | 10% | 8% | 3% | 1% |
| | CI 4 | 10% | 9% | 7% | 3% | 1% |

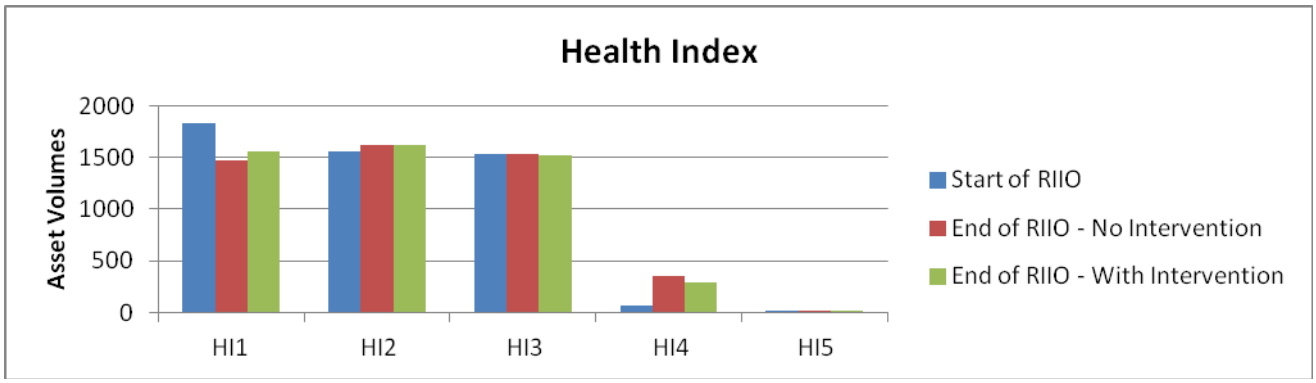
| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 1% | 0% | 0% | 0% | 0% |
| | CI 2 | 14% | 12% | 9% | 2% | 0% |
| | CI 3 | 11% | 10% | 7% | 2% | 0% |
| | CI 4 | 11% | 9% | 7% | 2% | 0% |

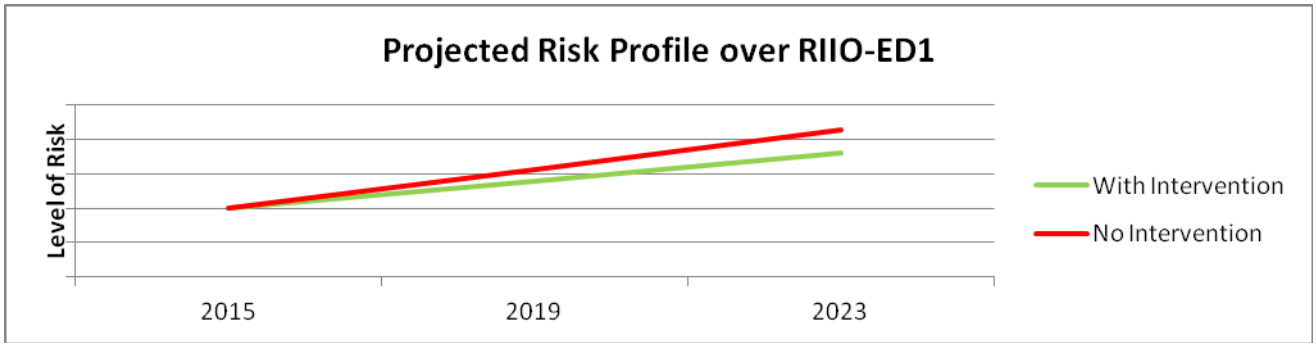
## HV Cable

As a solid underground cable has no inspectable components, it is impossible to determine the health of the asset. As such we have historically used the fault rate as a proxy for health. We use information such as the cost to replace the asset, safety, environment and the customers dependant on that asset to determine its criticality.

We forecast a small increase in risk of 0.2% realised from the investment of £64.5m in the replacement and refurbishment, due to an increase in our asset volume.

### SHEPD

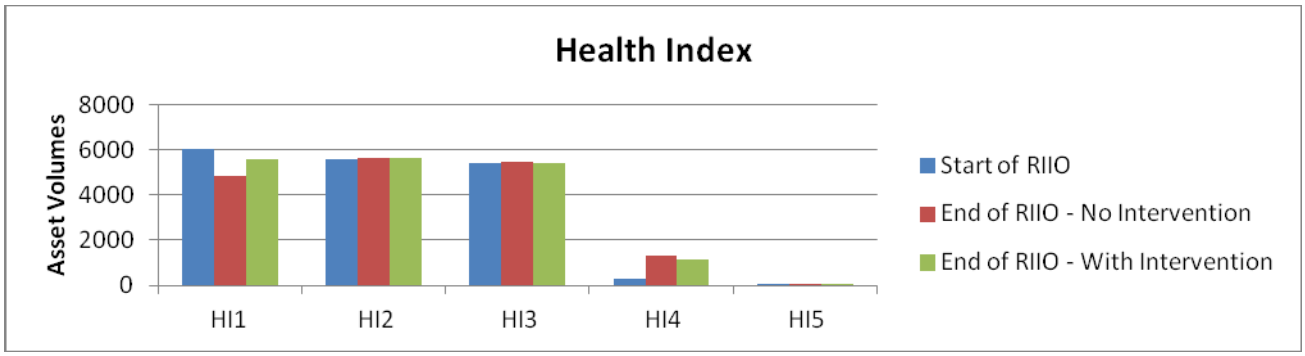


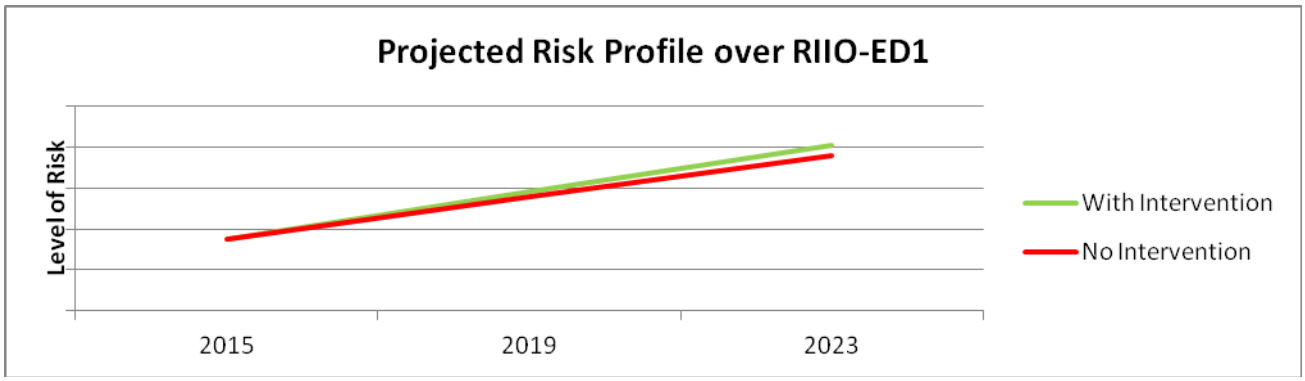



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 10% | 11% | 11% | 3% | 0% |
| | CI 3 | 19% | 21% | 20% | 5% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 11% | 11% | 11% | 2% | 0% |
| | CI 3 | 20% | 21% | 20% | 4% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

## SEPD






| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 11% | 12% | 12% | 3% | 0% |
| | CI 3 | 8% | 10% | 10% | 2% | 0% |
| | CI 4 | 8% | 10% | 10% | 2% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 12% | 12% | 11% | 2% | 0% |
| | CI 3 | 10% | 10% | 9% | 2% | 0% |
| | CI 4 | 9% | 10% | 9% | 2% | 0% |

## HV OHL Support – Poles

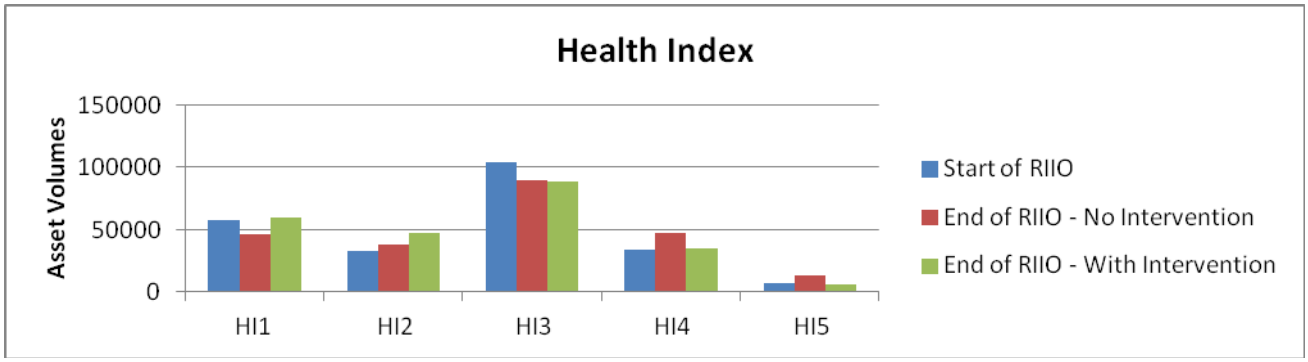
We inspect, maintain and refurbish our overhead line assets on the basis of a 12 year cyclical approach. This includes a 4 yearly foot patrol inspection and maintenance with refurbishment or replacement of assets in the 12th year. Additional inspections and intervention is provided for parts of our network which are considered High Risk, such as at recreational sites.

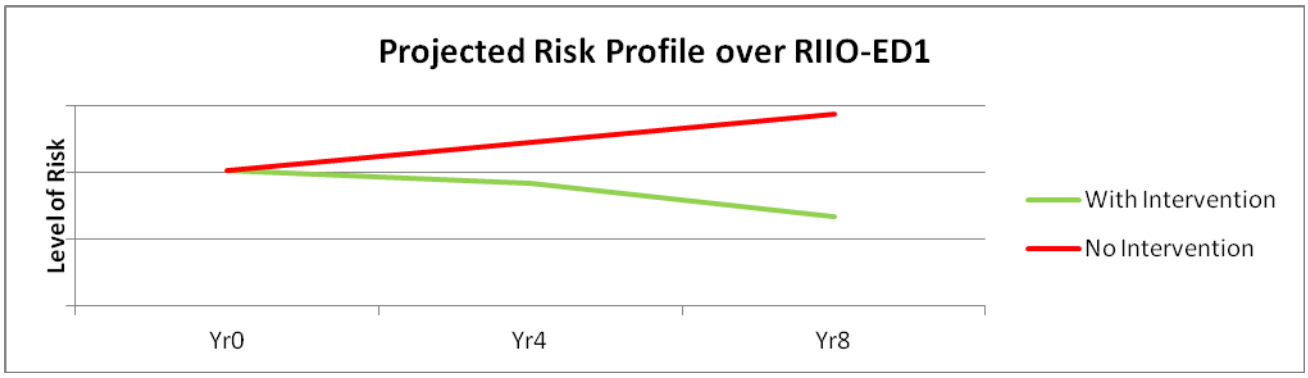
We consider the condition of our equipment, their safety in the surrounding environment, and the reliability of the network. We review the adequacy of the design of the overhead line to withstand the weather conditions and the local environment. In establishing the scope of our works we consider options for investment that achieve best value, taking into account all the information available. For example, in many cases the majority of the overhead line will be in good condition and it will only be necessary to replace individual components. In other cases it may be necessary to completely rebuild the circuit or to replace it with underground cable, in whole or in part, which can be more cost effective.

Our overhead line programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 9% realised from the investment of £56m in the replacement and refurbishment

### SHEPD

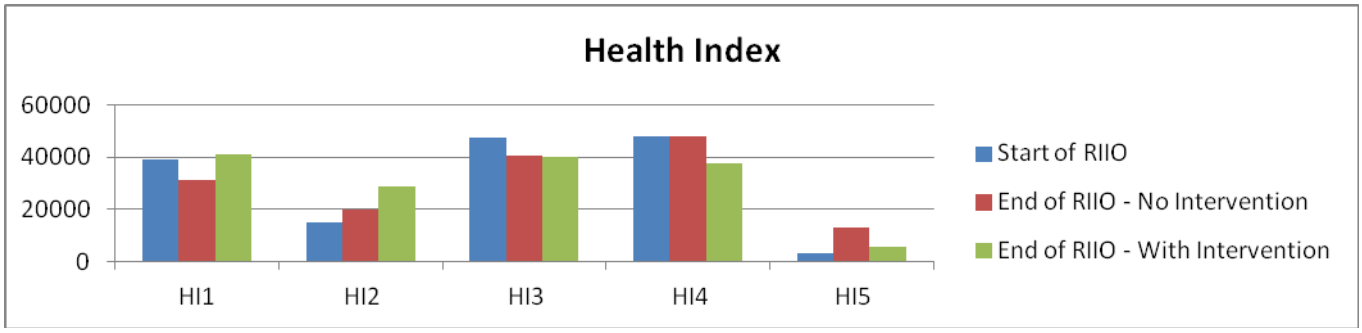


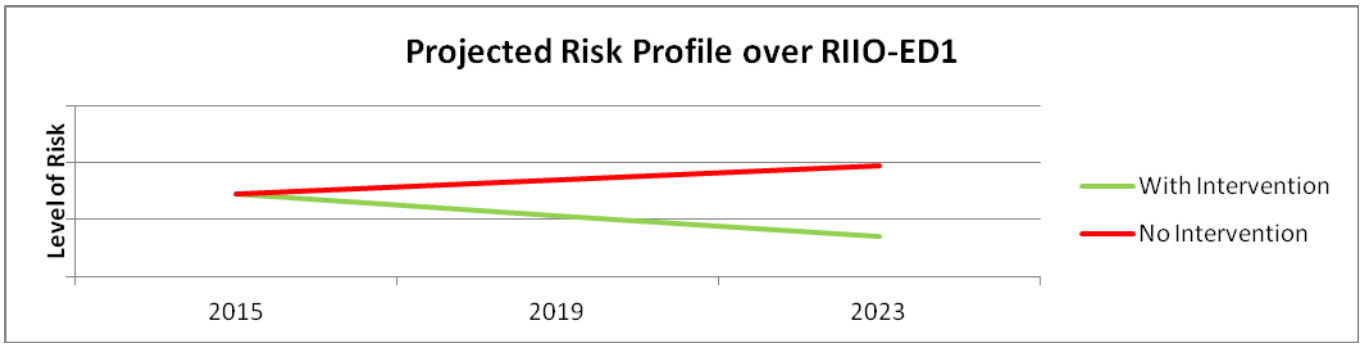



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 17% | 14% | 34% | 18% | 5% |
| | CI 3 | 2% | 2% | 4% | 2% | 1% |
| | CI 4 | 0% | 0% | 1% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 22% | 18% | 33% | 13% | 2% |
| | CI 3 | 2% | 2% | 4% | 1% | 0% |
| | CI 4 | 0% | 0% | 1% | 0% | 0% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 19% | 12% | 25% | 30% | 8% |
| | CI 3 | 1% | 0% | 1% | 1% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 25% | 18% | 25% | 23% | 3% |
| | CI 3 | 1% | 1% | 1% | 1% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

## EHV Switchgear

Our asset management practices for EHV Switchgear includes regular inspections to confirm the safety and condition of these assets. This ensures that equipment remains in good operational condition and does not create a risk to staff or the public, or to reliability of supply. Our Asset Risk Management (ARM) Manual has a section that specifically details time scales for inspections and how these should be carried out.

Alongside shared information from other DNOs, these inspections inform decisions on repairs and maintenance, asset replacement and refurbishment, or other necessary interventions such as to improve safety, address environmental risks, or to protect the equipment from the environment.

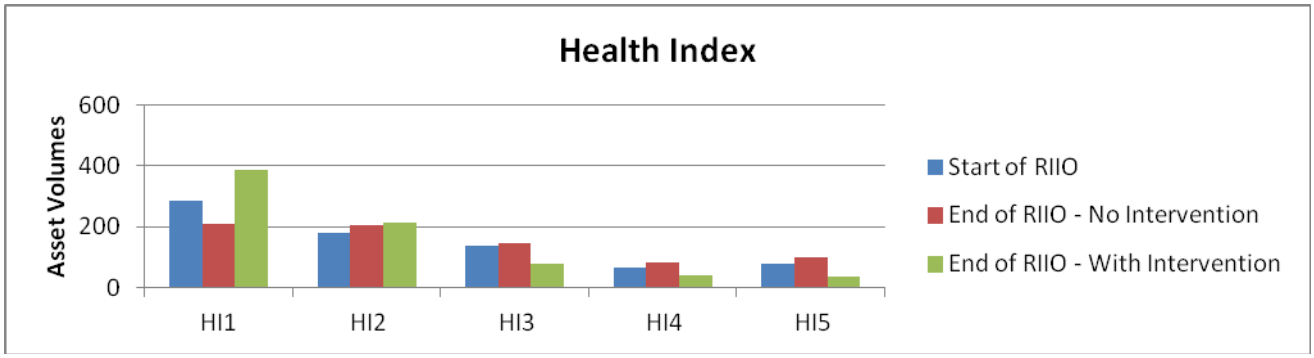
The majority of our expenditure in our DPCR5 capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where it is a lower cost alternative to complete replacement.

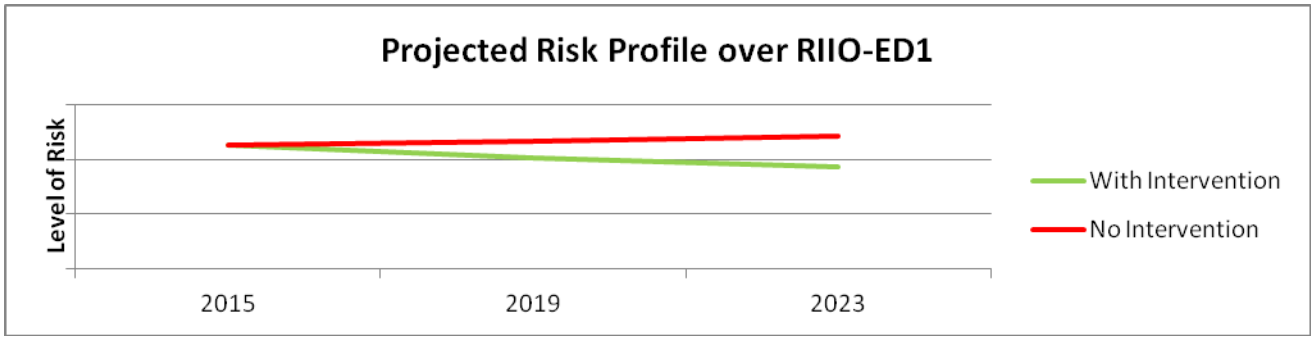
We use a large number of diagnostic tools to monitor and manage our switchgear. These are documented in our ARM Manual which is at the heart of our approach to the good stewardship of these assets. Over the period of DPCR5 we have improved our understanding of these assets by using techniques such as:

- Innovative SF6 leak detection devices
- Use of devices such as EA Technology's Ultra TEV device to monitor electrical discharges from our switchgear
- Measurement of voltage and current waveforms to identify potential faults in equipment

We forecast a reduction in risk of 15% realised from the investment of £30.3m in the replacement and refurbishment.

## SHEPD

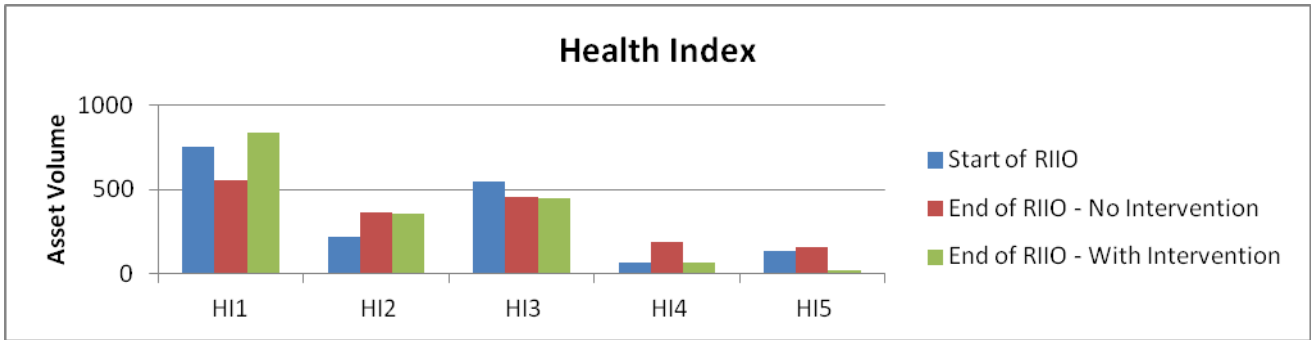


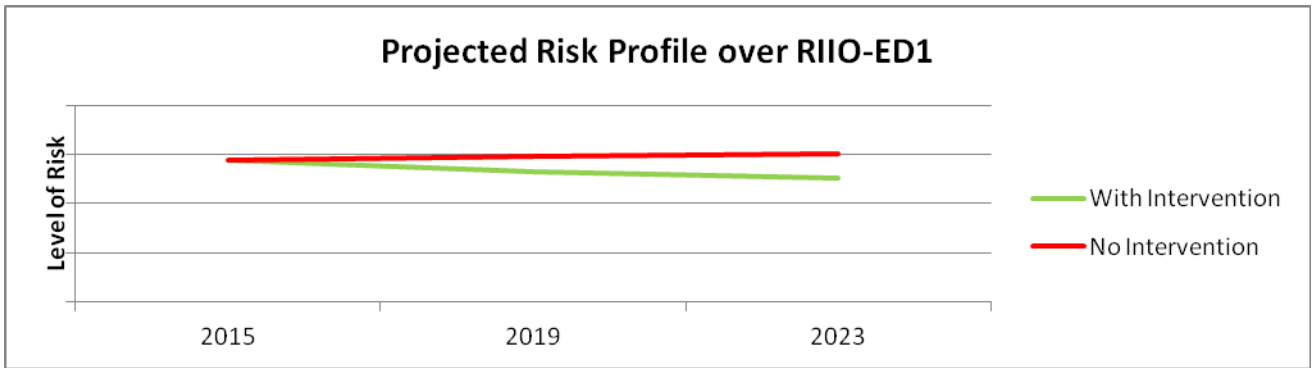




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 13% | 13% | 9% | 5% | 6% |
| | CI 2 | 10% | 10% | 7% | 4% | 5% |
| | CI 3 | 5% | 5% | 4% | 2% | 3% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 23% | 13% | 5% | 2% | 2% |
| | CI 2 | 18% | 10% | 4% | 2% | 2% |
| | CI 3 | 10% | 5% | 2% | 1% | 1% |
| | CI 4 | 1% | 0% | 0% | 0% | 0% |

## SEPD




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 2% | 1% | 2% | 1% | 1% |
| | CI 2 | 23% | 15% | 19% | 8% | 6% |
| | CI 3 | 7% | 4% | 5% | 2% | 2% |
| | CI 4 | 1% | 0% | 1% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 1% | 2% | 0% | 0% |
| | CI 2 | 34% | 15% | 18% | 3% | 1% |
| | CI 3 | 10% | 4% | 5% | 1% | 0% |
| | CI 4 | 1% | 0% | 0% | 0% | 0% |

## EHV Transformers

EHV transformers are managed on an individual basis due to the site specific nature of the asset and its criticality. We target investment in transformers based on internal and external condition, operational feedback, location, information on known operational safety issues and consideration of the consequences of asset failure, including the number of customers reliant on the asset.

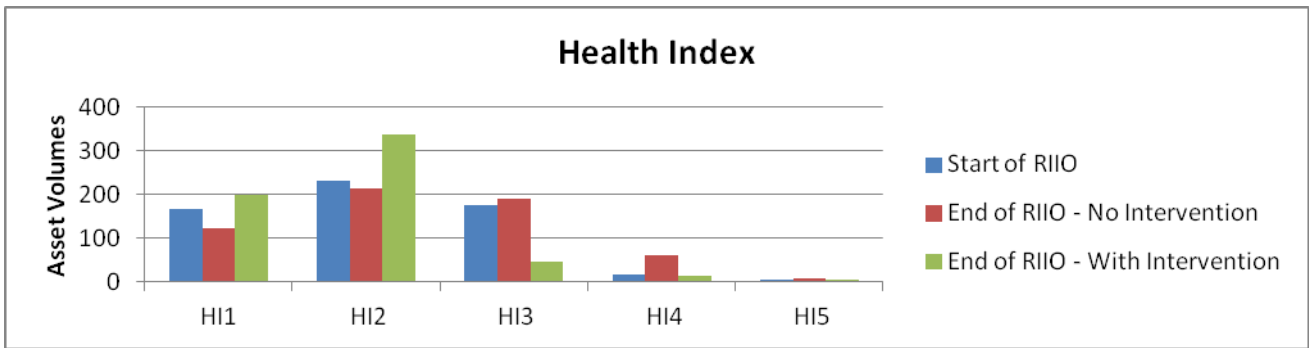
The majority of our expenditure in our DPCR5 capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where it is a lower cost alternative to complete replacement.

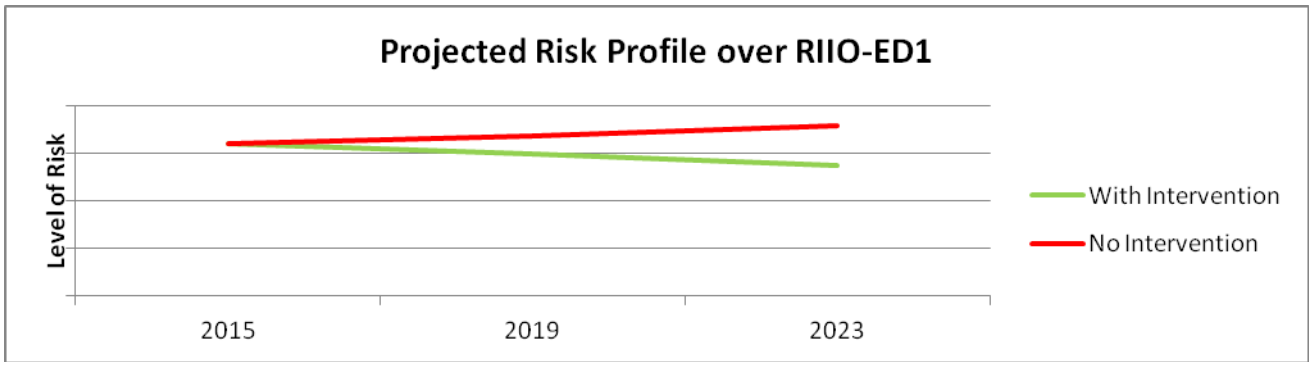
We use a large number of diagnostic tools to monitor and manage our substation equipment. These are documented in our ARM Manual which is at the heart of our approach to the good stewardship of these assets. Over the period of DPCR5 we have improved our understanding of these assets by using techniques such as:

- Dissolved gas analysis of transformer oil to predict incipient faults and potential plant failures
- Furfuraldehyde Analysis - Another oil based analysis which is used to determine the rate of deterioration of the paper components.
- Measurement of voltage and current waveforms to identify potential faults in equipment

Over the period of DPCR5 we have reduced our unit costs from our original forecast and delivered more for less by using innovative techniques and strong cost management. In RIIO-ED1, we forecast a reduction in risk of 17% realised from the investment of £67.9m.

## SHEPD

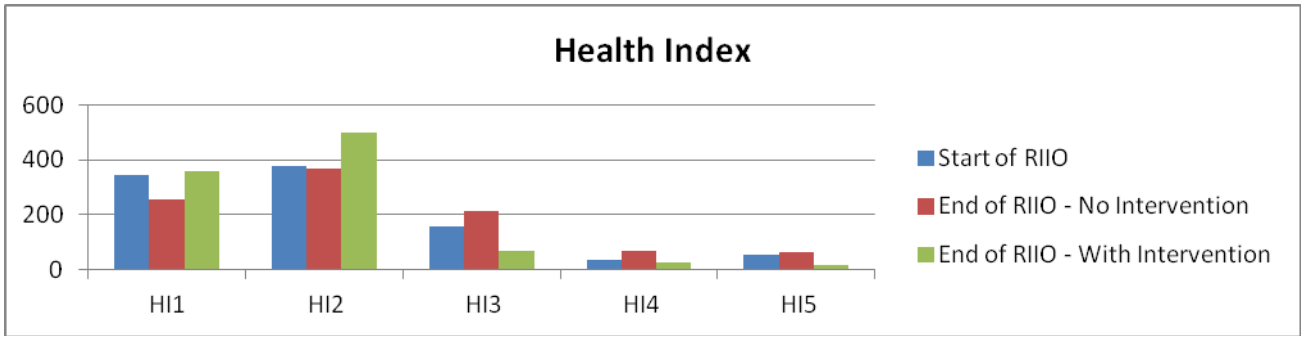


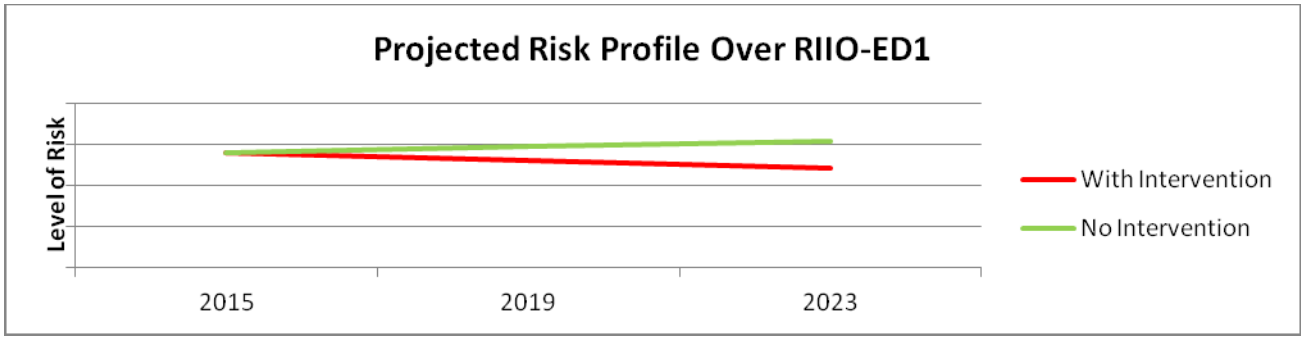




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 9% | 16% | 14% | 4% | 1% |
| | CI 2 | 7% | 13% | 11% | 4% | 1% |
| | CI 3 | 4% | 7% | 6% | 2% | 0% |
| | CI 4 | 0% | 1% | 1% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 15% | 26% | 4% | 1% | 0% |
| | CI 2 | 12% | 20% | 3% | 1% | 0% |
| | CI 3 | 6% | 11% | 1% | 1% | 0% |
| | CI 4 | 1% | 1% | 0% | 0% | 0% |

## SEPD




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 2% | 3% | 2% | 1% | 0% |
| | CI 2 | 19% | 27% | 16% | 5% | 5% |
| | CI 3 | 5% | 8% | 5% | 1% | 1% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

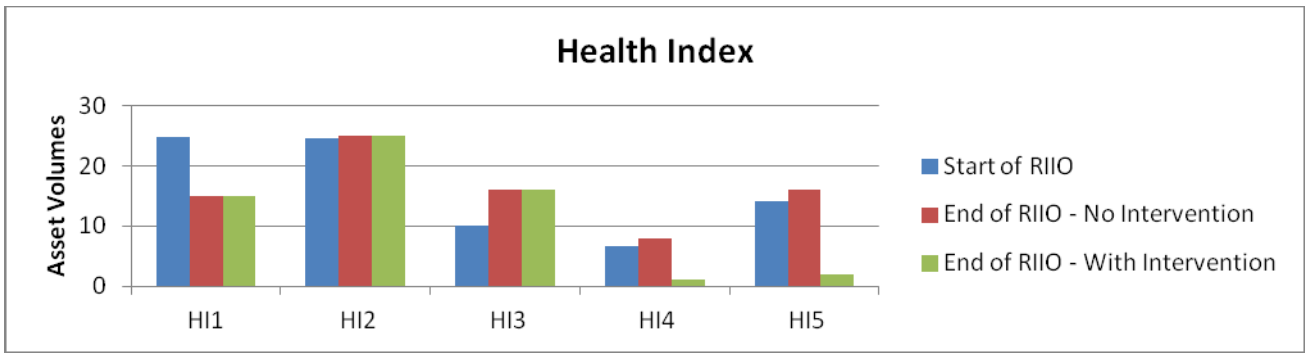
| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 4% | 1% | 0% | 0% |
| | CI 2 | 27% | 37% | 5% | 2% | 1% |
| | CI 3 | 8% | 11% | 1% | 1% | 0% |
| | CI 4 | 0% | 1% | 0% | 0% | 0% |

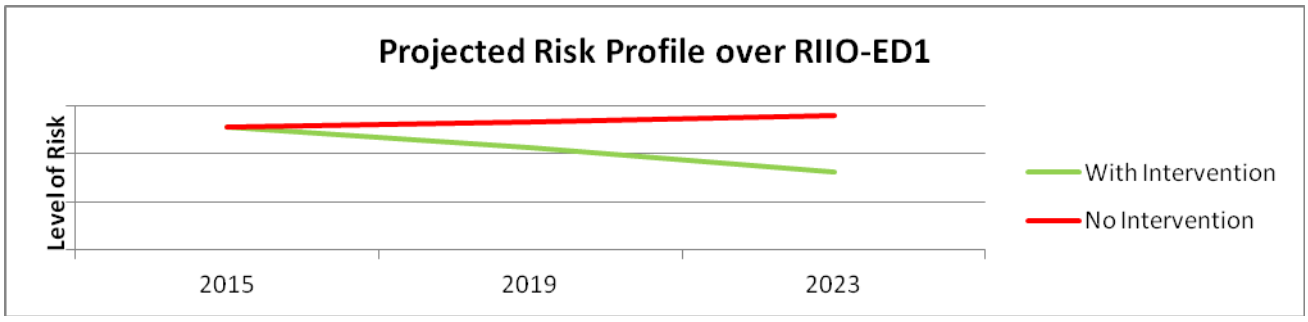
## EHV Cable (Oil)

Oil-filled cables use the oil as an electrical insulator within the cable structure. These cables are also complemented with a series of valves and gauges to monitor the pressure of the oil, and alarms to notify us of oil leakage. In order to ensure that these are operating acceptably, these components are inspected and tested frequently. We use data from these inspections, fault history and leakage history to determine the Health of these assets, and we determine the criticality by analysing the cost to replace the asset, safety, the environmental impact of any leak and the number of customers dependant on that asset.

### SHEPD

Like all other DNOs, we no longer lay new oil-filled cables, preferring to use non-pressurised, or “solid”, cable to replace the pressurised assets when they reach the end of their working life. In RIIO-ED1, we will invest £3.9m to remove 21kms of oil filled-cables from our SHEPD area with non pressurised cable.



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 8% | 14% | 9% | 5% | 9% |
| | CI 2 | 7% | 11% | 7% | 3% | 7% |
| | CI 3 | 4% | 6% | 4% | 2% | 4% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 8% | 14% | 9% | 1% | 1% |
| | CI 2 | 7% | 11% | 7% | 0% | 1% |
| | CI 3 | 4% | 6% | 4% | 0% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

### SEPD

In our SEPD area our asset volume is significantly larger with over 12 times the length of cable as employed in SHEPD. Replacing significant volumes of these assets would come at significant cost and would not, we feel, deliver best value for our customers. We cannot however ignore the issue of FFCs or our stakeholder feedback on the subject and so we have looked to Innovation to seek a manageable solution. We have trialled a technique whereby we “tag” oil filled cables, enabling a hugely improved leak location time and subsequent improvement in repair times. For a significantly reduced investment we estimate we can achieve a similar reduction in leakage level as a simple replacement programme. Whilst we forecast the replacement of 55kms of oil-filled cable in the SEPD area during RIIO-ED1, the main driver for this activity is Environmental. As Environmental works are not included in the current Ofgem methodology for Composite Risk, this activity has no affect on the SEPD figures.

## EHV OHL Support – Poles

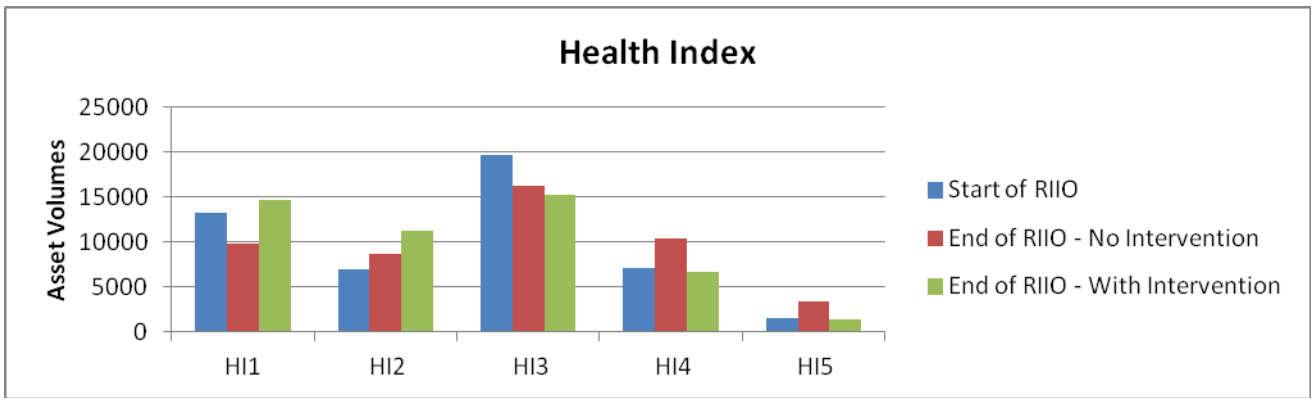
We inspect, maintain and refurbish our overhead line assets on the basis of a 12 year cyclical approach. This includes a 4 yearly foot patrol inspection and maintenance with refurbishment or replacement of assets in the 12th year. Additional inspections and intervention is provided for parts of our network which are considered High Risk, such as at recreational sites.

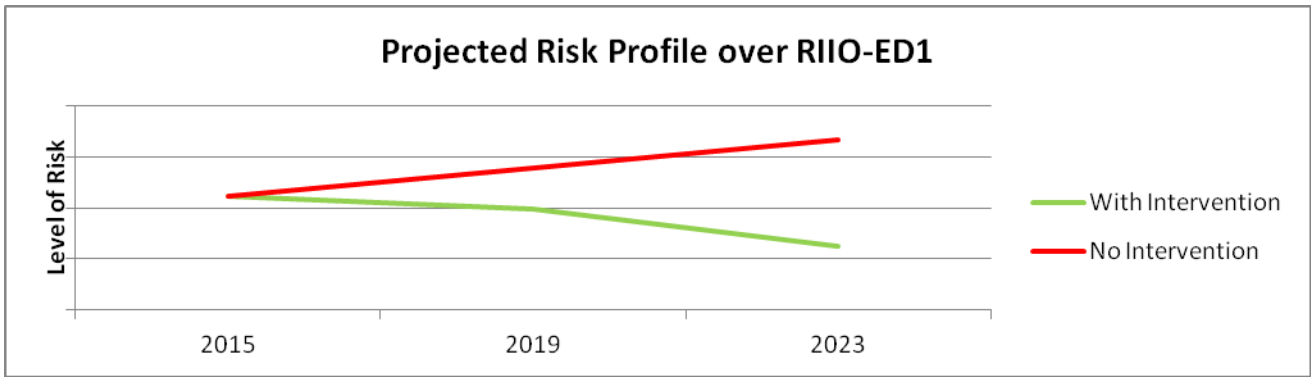
We consider the condition of our equipment, their safety in the surrounding environment, and the reliability of the network. We review the adequacy of the design of the overhead line to withstand the weather conditions and the local environment, and we confirm that the capacity of the line remains adequate to meet the required standards for security of supply (P2/6). In establishing the scope of our works we consider options for investment that achieve best value, taking into account all the information available. For example, in many cases the majority of the overhead line will be in good condition and it will only be necessary to replace individual components. In other cases it may be necessary to completely rebuild the circuit or to replace it with underground cable, in whole or in part, which can be more cost effective.

Our overhead line programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 12% realised from the investment of £27m in the replacement and refurbishment.

### SHEPD

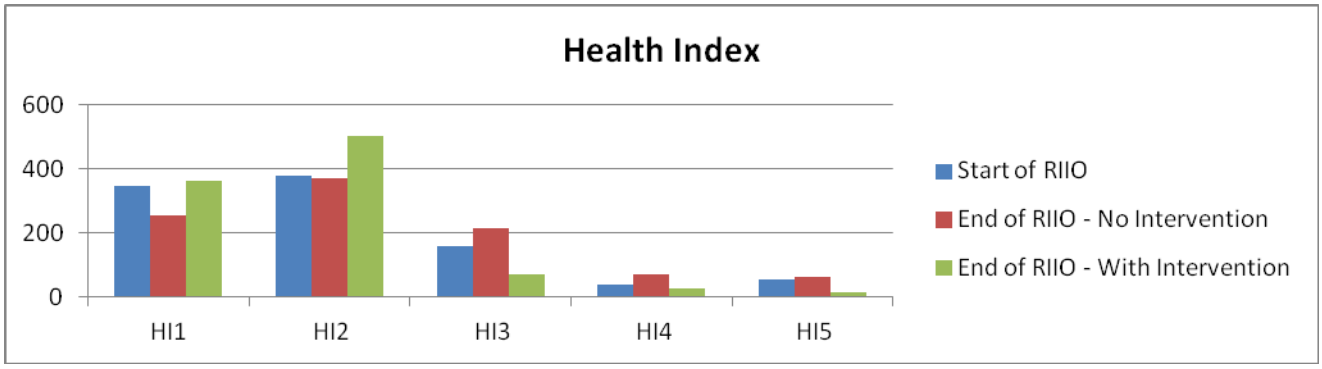


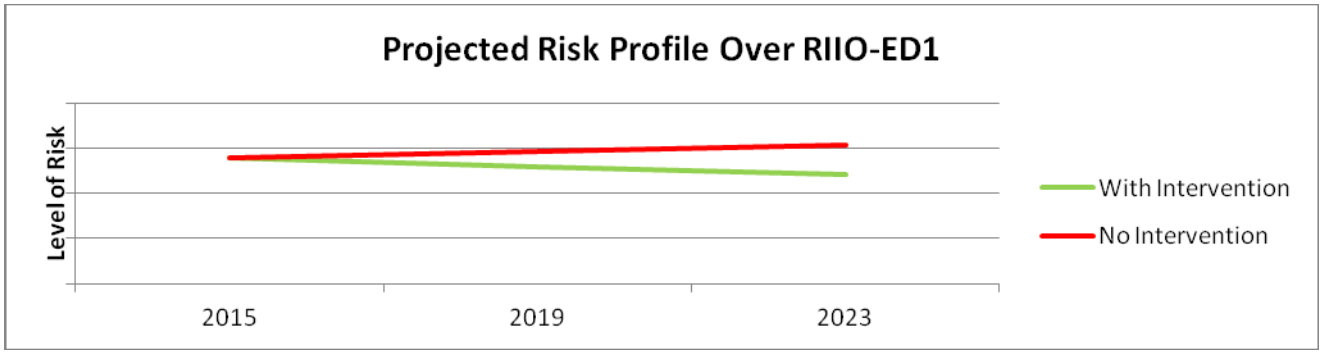



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 18% | 16% | 30% | 19% | 6% |
| | CI 3 | 2% | 2% | 3% | 2% | 1% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 27% | 20% | 28% | 12% | 2% |
| | CI 3 | 3% | 2% | 3% | 1% | 0% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

## SEPD



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 2% | 3% | 2% | 1% | 0% |
| | CI 2 | 19% | 27% | 16% | 5% | 5% |
| | CI 3 | 5% | 8% | 5% | 1% | 1% |
| | CI 4 | 0% | 0% | 0% | 0% | 0% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 4% | 1% | 0% | 0% |
| | CI 2 | 27% | 37% | 5% | 2% | 1% |
| | CI 3 | 8% | 11% | 1% | 1% | 0% |
| | CI 4 | 0% | 1% | 0% | 0% | 0% |

## EHV Fittings and Conductors (Towers)

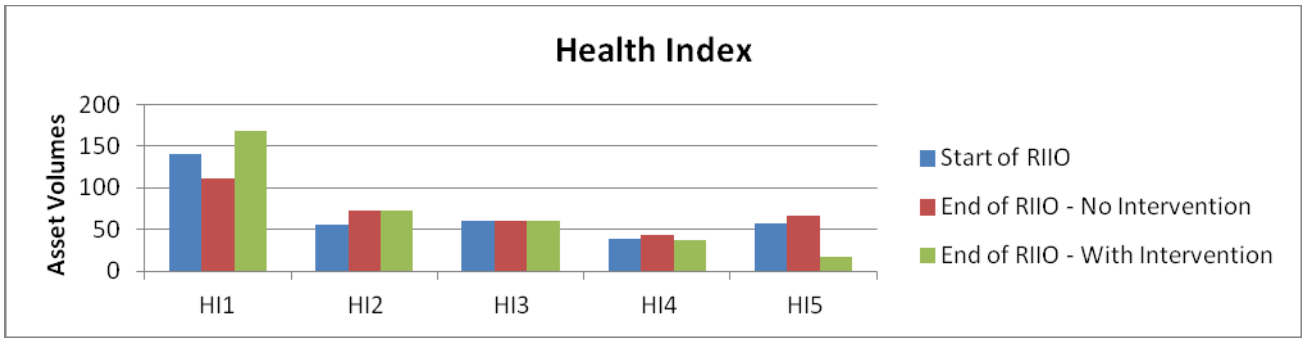
We inspect, maintain and refurbish our overhead line assets on the basis of a 12 year cyclical approach. This includes a 4 yearly foot patrol inspection and maintenance with refurbishment or replacement of assets in the 12th year. Additional inspections and intervention is provided for parts of our network which are considered High Risk, such as at recreational sites.

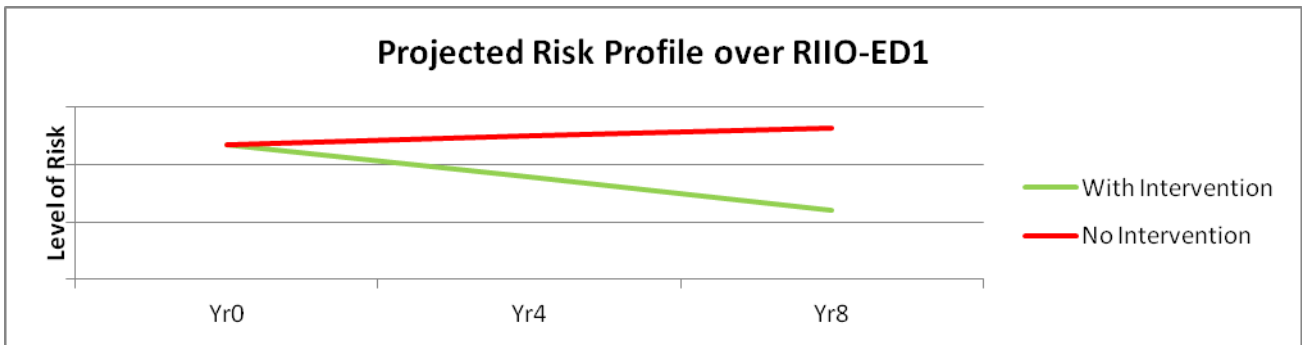
We consider the condition of our equipment, their safety in the surrounding environment, and the reliability of the network. We review the adequacy of the design of the overhead line to withstand the weather conditions and the local environment, and we confirm that the capacity of the line remains adequate to meet the required standards for security of supply (P2/6). In establishing the scope of our works we consider options for investment that achieve best value, taking into account all the information available. For example, in many cases the majority of the overhead line will be in good condition and it will only be necessary to replace individual components. In other cases it may be necessary to completely rebuild the circuit or to replace it with underground cable, in whole or in part, which can be more cost effective.

Our overhead line programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 13% realised from the investment of £4.84m in the replacement and refurbishment.

### SEPD only



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 3% | 2% | 2% | 1% | 2% |
| | CI 2 | 2% | 1% | 1% | 1% | 1% |
| | CI 3 | 5% | 3% | 3% | 2% | 3% |
| | CI 4 | 22% | 14% | 12% | 8% | 13% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 5% | 2% | 2% | 1% | 1% |
| | CI 2 | 3% | 1% | 1% | 1% | 0% |
| | CI 3 | 7% | 3% | 3% | 2% | 1% |
| | CI 4 | 33% | 14% | 12% | 7% | 3% |

## 132kV Circuit Breakers

132kV circuit breakers are managed on an individual basis due to the site specific nature of the asset and its criticality. We target investment based on internal and external condition, operational feedback, location, information on known operational safety issues and consideration of the consequences of asset failure, including the number of customers reliant on the asset.

The majority of our expenditure in our capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where it is a lower cost alternative to complete replacement.

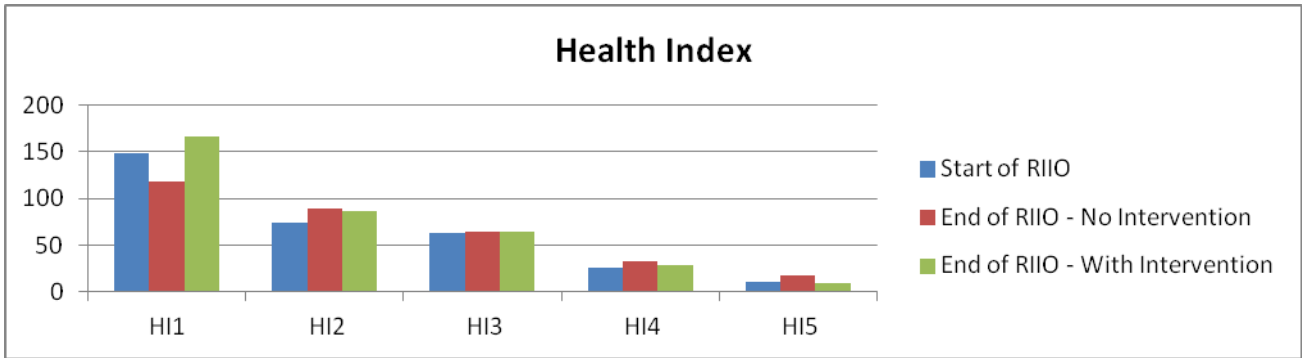
We use a large number of diagnostic tools to monitor and manage our substation equipment. These are documented in our ARM Manual which is at the heart of our approach to the good stewardship of these assets. Over the period of DPCR5 we have improved our understanding of these assets by using techniques such as:

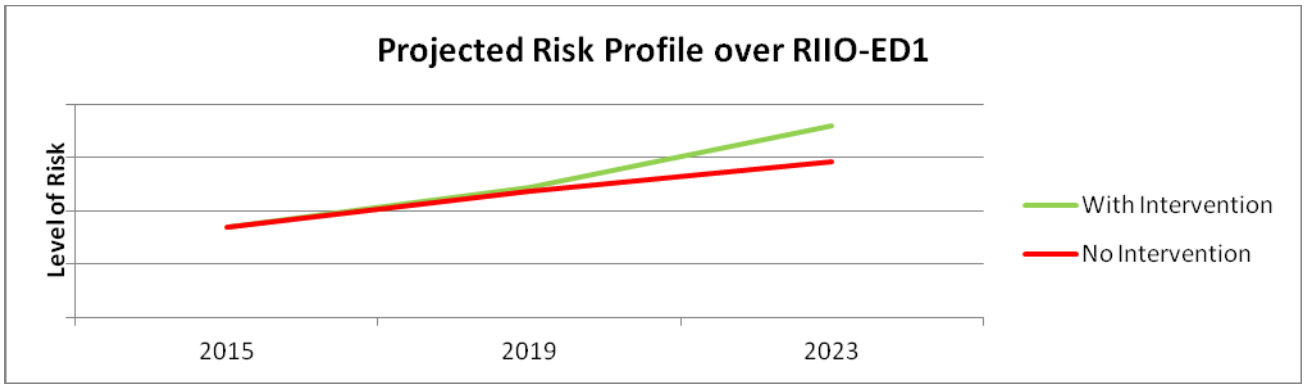
- Dissolved gas analysis of transformer oil to predict incipient faults and potential plant failures
- Furfuraldehyde Analysis - Another oil based analysis which is used to determine the rate of deterioration of the paper components.
- Measurement of voltage and current waveforms to identify potential faults in equipment

Over the period of DPCR5 we have reduced our unit costs compared to our original DPCR5 forecast and delivered more for less by using innovative techniques and strong cost management.

We forecast an increase in risk of 3% realised from the investment of £4m. This is due to an increase in our overall asset base.

### SEPD only




| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 4% | 3% | 2% | 1% | 1% |
| | CI 2 | 10% | 8% | 6% | 3% | 2% |
| | CI 3 | 10% | 7% | 5% | 2% | 1% |
| | CI 4 | 12% | 10% | 7% | 4% | 2% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 5% | 3% | 2% | 1% | 0% |
| | CI 2 | 14% | 7% | 5% | 2% | 1% |
| | CI 3 | 12% | 6% | 5% | 2% | 1% |
| | CI 4 | 17% | 9% | 6% | 3% | 1% |

## 132kV Transformers

132kV transformers are managed on an individual basis due to the site specific nature of the asset and its criticality. We target investment in transformers based on internal and external condition, operational feedback, location, information on known operational safety issues and consideration of the consequences of asset failure, including the number of customers reliant on the asset.

The majority of our expenditure in our DPCR5 capital investment plan relates to the refurbishment or replacement of plant that is in poor condition, and it is necessary to ensure that this plant does not fail in service. In some cases this requires full replacement of the equipment as it is at the end of its life. However in many occasions it is entirely possible and more economically viable to refurbish the equipment in order to defer replacement for many years. We continue to actively support refurbishment of electrical plant where it is a lower cost alternative to complete replacement.

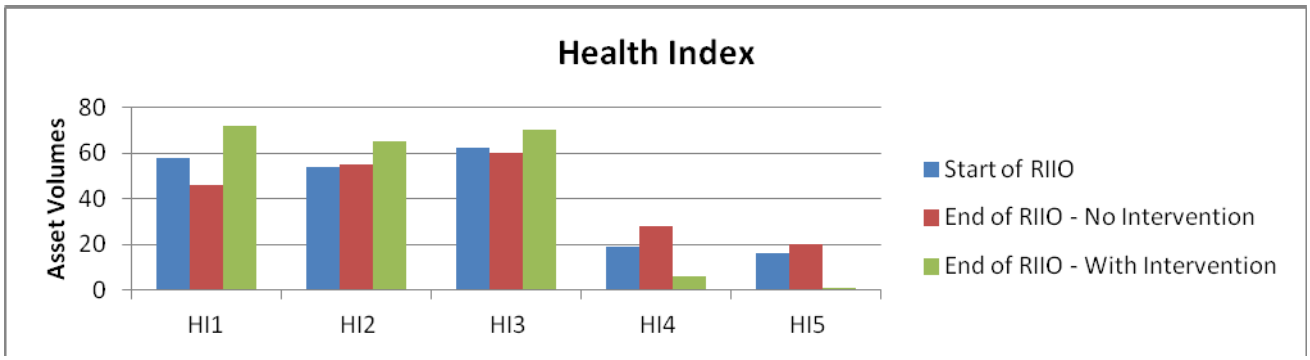
We use a large number of diagnostic tools to monitor and manage our substation equipment. These are documented in our ARM Manual which is at the heart of our approach to the good stewardship of these assets. Over the period of DPCR5 we have improved our understanding of these assets by using techniques such as:

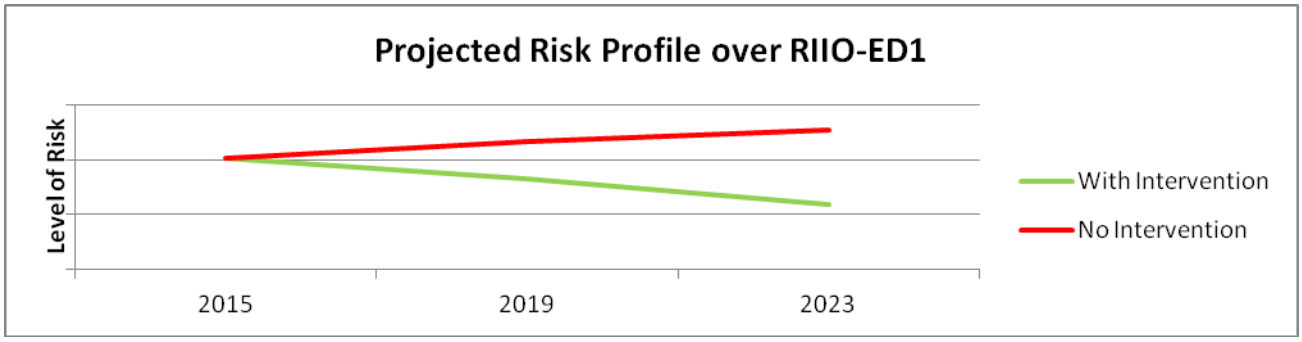
- Dissolved gas analysis of transformer oil to predict incipient faults and potential plant failures
- Furfuraldehyde Analysis - Another oil based analysis which is used to determine the rate of deterioration of the paper components.
- Measurement of voltage and current waveforms to identify potential faults in equipment

Over the period of DPCR5 we have reduced our unit costs compared to our original DPCR5 forecast and delivered more for less by using innovative techniques and strong cost management.

We forecast a reduction in risk of 7% realised from the investment of £23.7m.

### SEPD only






| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 2% | 3% | 3% | 1% | 1% |
| | CI 2 | 6% | 9% | 8% | 4% | 3% |
| | CI 3 | 6% | 6% | 7% | 3% | 2% |
| | CI 4 | 8% | 9% | 10% | 5% | 3% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 4% | 3% | 3% | 0% | 0% |
| | CI 2 | 11% | 9% | 9% | 0% | 0% |
| | CI 3 | 8% | 7% | 8% | 1% | 0% |
| | CI 4 | 10% | 11% | 12% | 1% | 0% |

## 132kV UG Cable (Oil)

### SEPD only

Oil-filled cables use the oil as an electrical insulator within the cable structure. These cables are also complemented with a series of valves and gauges to monitor the pressure of the oil, and alarms to notify us of oil leakage. In order to ensure that these are operating acceptably, these components are inspected and tested frequently. We use data from these inspections, fault history and leakage history to determine the Health of these assets, and we determine the criticality by analysing the cost to replace the asset, safety, the environmental impact of any leak and the number of customers dependant on that asset.

Replacing significant volumes of these assets would come at significant cost and would not, we feel, deliver best value for our customers. We cannot however ignore the issue of FFCs or our stakeholder feedback on the subject and so we have looked to Innovation to seek a manageable solution. We have trialled a technique whereby we “tag” oil filled cables, enabling a hugely improved leak location time and subsequent improvement in repair times. For a significantly reduced investment we estimate we can achieve a similar reduction in leakage level as a simple replacement programme. Whilst we anticipate replacing some volume of oil-filled cable as a result of this innovative process, actual volumes cannot be estimated until the results of the tagging are known.

However, as this activity is being completed for environmental purposes, there is currently no mechanism for this work to be included within the Health and Criticality matrices for this asset category. As such, we have not included 132kV UG Cable (Oil) within the Health and Criticality tables for RIIO-ED1. Should this methodology change in the future, we will be happy to include it.

## 132kV Fittings and Conductors (Tower Lines)

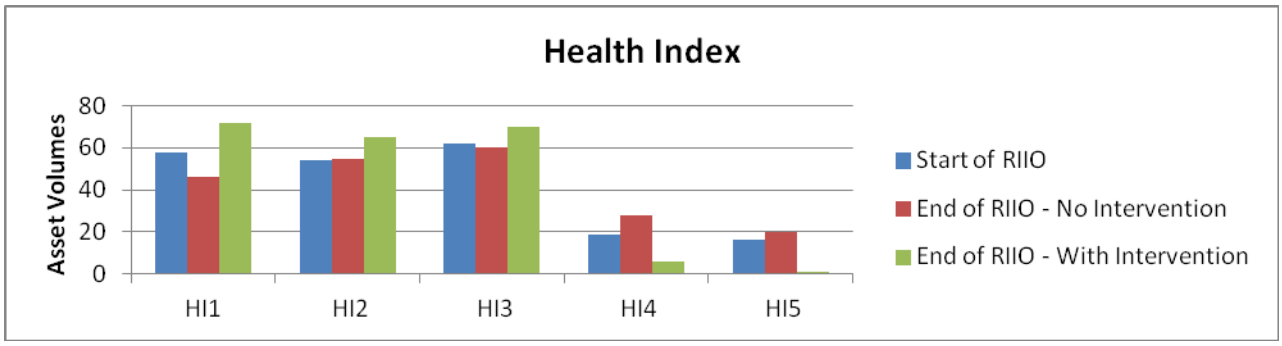
### SEPD only

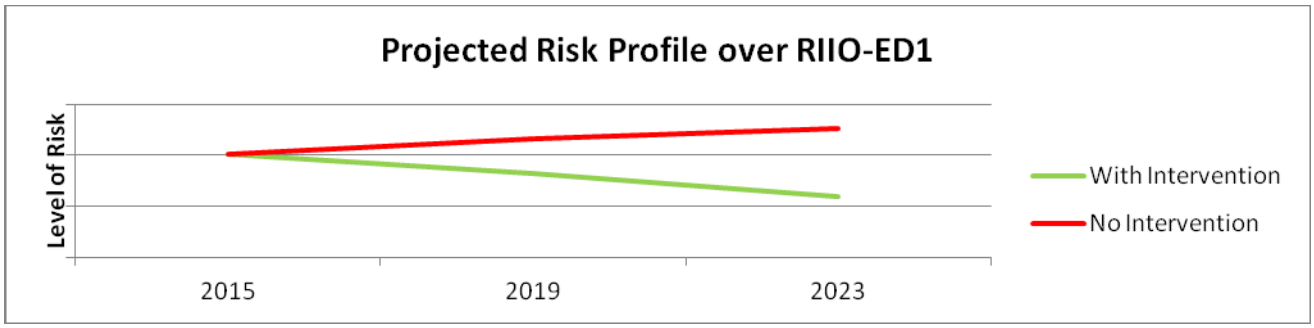
We inspect, maintain and refurbish our overhead line assets on the basis of a 12 year cyclical approach. This includes a 4 yearly foot patrol inspection and maintenance with refurbishment or replacement of assets in the 12th year. Additional inspections and intervention is provided for parts of our network which are considered High Risk, such as at recreational sites.

We consider the condition of our equipment, their safety in the surrounding environment, and the reliability of the network. We review the adequacy of the design of the overhead line to withstand the weather conditions and the local environment, and we confirm that the capacity of the line remains adequate to meet the required standards for security of supply (P2/6). In establishing the scope of our works we consider options for investment that achieve best value, taking into account all the information available. For example, in many cases the majority of the overhead line will be in good condition and it will only be necessary to replace individual components. In other cases it may be necessary to completely rebuild the circuit or to replace it with underground cable, in whole or in part, which can be more cost effective.

Our overhead line programme seeks to manage risks on our assets at minimum cost, and to improve the reliability of supply to customers through timely investment.

We forecast a reduction in risk of 20% realised from the investment of £34.6m in the replacement and refurbishment.



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 5% | 4% | 3% | 3% | 5% |
| | CI 3 | 6% | 5% | 3% | 4% | 7% |
| | CI 4 | 13% | 11% | 7% | 9% | 14% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 0% | 0% | 0% | 0% | 0% |
| | CI 2 | 10% | 4% | 2% | 1% | 3% |
| | CI 3 | 13% | 5% | 3% | 2% | 4% |
| | CI 4 | 26% | 10% | 6% | 3% | 7% |

## Submarine Cables

Submarine cable replacement forms a material part of our Network Condition expenditure in our SHEPD area. Our condition monitoring of these assets has improved in recent years and has provided a better insight into the likely future performance and investment requirements. Our experience during DPCR5 is that the failure rate of these cables is greater than we anticipated, and now exceeds our allowance in this area.

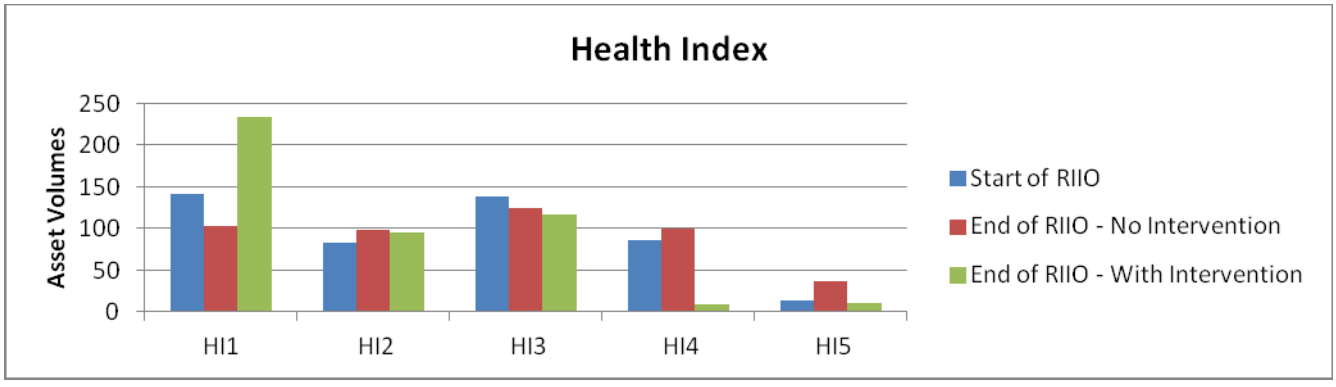
We have 108 submarine cable circuits supplying 60 island networks. Of these we have 3 x 132kV circuits in our SEPD area supplying the Isle of Wight, one of which is being replaced in DPCR5. The other 2 cables are in good condition. As such we have no planned investment in submarine cable replacement in SEPD during RIIO-ED1.

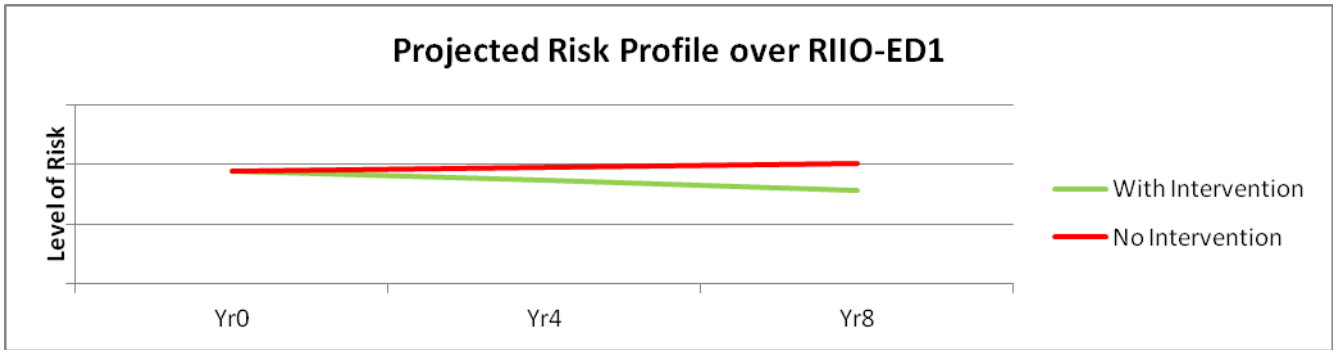
The majority and remaining 105 submarine cables are in our SHEPD area. Many of these cables were installed in the 1980s and are already around 30 years old. They were installed to meet the requirements of sparse demand and are now much more heavily loaded, typically connecting community wind farms on the islands. In fact many circuits, such as on Orkney, are fully loaded and are protected from overload by our innovative Active Network Management system on that part of the network.

Our comprehensive condition monitoring information (derived from ROV Sub Sea Surveys) and experience of ongoing failure rates has indicated a need to increase the level of our investment. We propose to replace 112 km of submarine cable at an expenditure of £41.78 million during the RIIO-ED1 period. As with all our cable replacement projects, each project will be assessed to determine whether a cable with a larger cross sectional area (more conductor) can be installed to reduce losses, with the added benefit of reducing any future network constraints (albeit at the expense of some of the original losses savings – see Environmental paper for details).

We forecast a reduction in risk of 20% realised from the investment of £41.8m.

### SHEPD only



| COMPOSITE RISK MATRIX- END OF RIIO NO INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 4% | 4% | 5% | 4% | 2% |
| | CI 2 | 8% | 8% | 10% | 8% | 3% |
| | CI 3 | 4% | 4% | 5% | 4% | 1% |
| | CI 4 | 6% | 6% | 7% | 6% | 2% |

| COMPOSITE RISK MATRIX- END OF RIIO WITH INTERVENTION | | | | | | |
|---|---|---|---|---|---|---|
| | | HEALTH INDEX | | | | |
| | | HI 1 | HI 2 | HI 3 | HI 4 | HI 5 |
| CRITICALITY INDEX | CI 1 | 10% | 4% | 5% | 0% | 0% |
| | CI 2 | 18% | 7% | 9% | 1% | 1% |
| | CI 3 | 9% | 4% | 4% | 0% | 0% |
| | CI 4 | 14% | 6% | 7% | 1% | 1% |

# Demand on our Networks

## Introduction

In addition to managing asset health and criticality, we also monitor and predict the impact that future changes in electricity demand will have on the loading of our infrastructure. If demand exceeds capacity then:

• In the event of a fault, we may be unable to restore all customers from an alternative source. This means that some customers could experience longer interruptions to their supply.

• Running assets in excess of their rating for extended periods of time presents a safety risk, wears them out more quickly and requires them to be replaced much earlier than would normally be the case

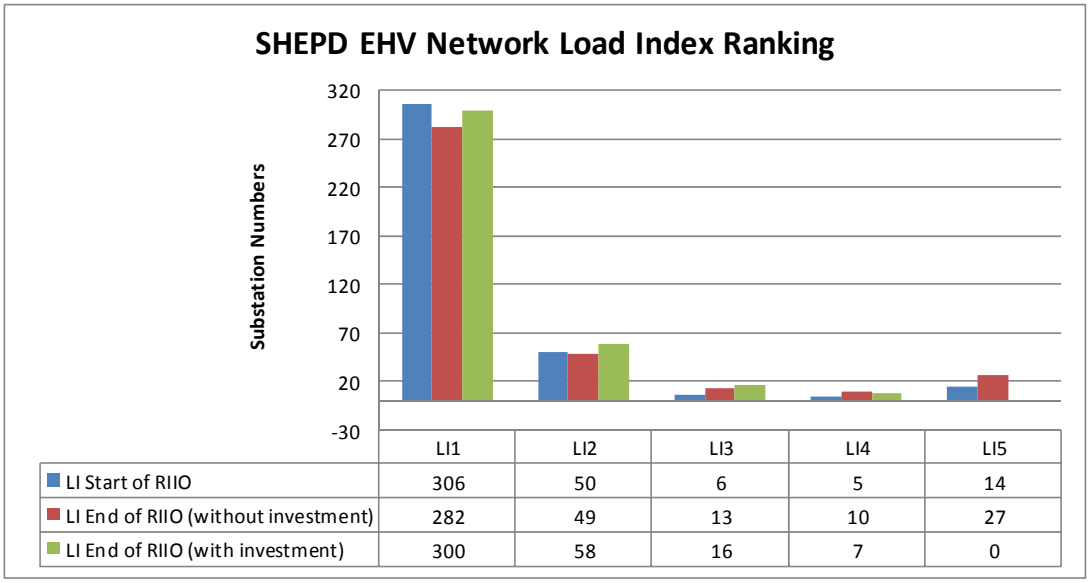
## Determination of Load Index

We analyse the demand on our assets using a Load Index (LI) on our EHV and 132kV substations. The LI for each individual substation is determined by examining if the site is overloaded and, if it is, for how many hours per year.

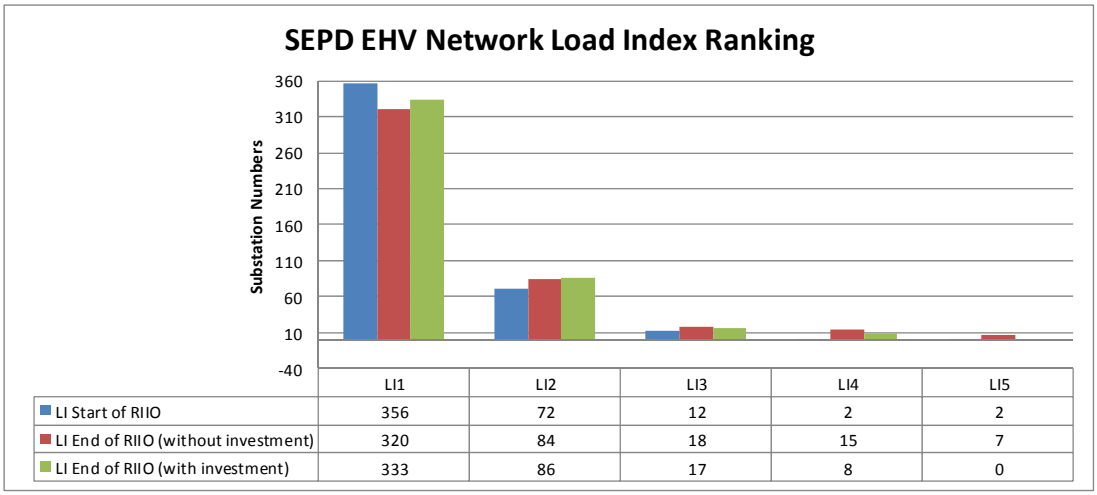
| Load Index | |
|---|---|
| LI1 | Between 0 and 79% of rating |
| LI2 | Between 80% and 95% of rating |
| LI3 | Between 95% and 99% of rating |
| LI4 | Over 99% loaded for less than 9 hours per year |
| LI5 | Over 99% loaded for 9 hours or more per year |

Our investment programme is based on reviewing where substations and demand groups have breached or are forecast to breach their capacity limits. The LI scale gives us a way of articulating this. Each actual or forecast substation at LI4 and LI5 is investigated to determine the most appropriate intervention option and an associated investment planned.

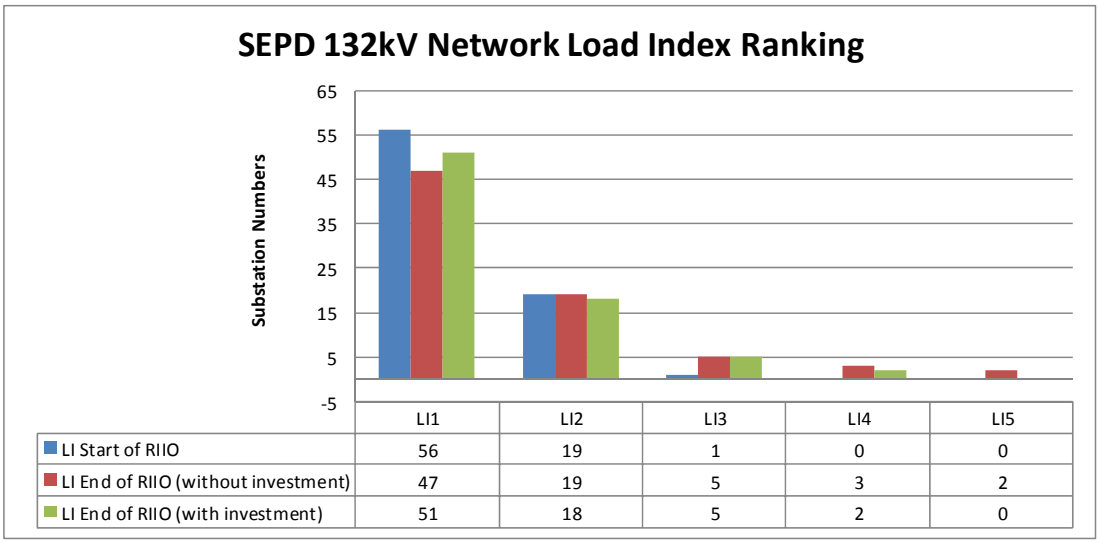
## Forecast Load Indices in RIIO-ED1




| | LI1 | LI2 | LI3 | LI4 | LI5 |
|---|---|---|---|---|---|
| LI Start of RIIO | 306 | 50 | 6 | 5 | 14 |
| LI End of RIIO (without investment) | 282 | 49 | 13 | 10 | 27 |
| LI End of RIIO (with investment) | 300 | 58 | 16 | 7 | 0 |




| | LI1 | LI2 | LI3 | LI4 | LI5 |
|---|---|---|---|---|---|
| LI Start of RIIO | 356 | 72 | 12 | 2 | 2 |
| LI End of RIIO (without investment) | 320 | 84 | 18 | 15 | 7 |
| LI End of RIIO (with investment) | 333 | 86 | 17 | 8 | 0 |




| | LI1 | LI2 | LI3 | LI4 | LI5 |
|---|---|---|---|---|---|
| LI Start of RIIO | 56 | 19 | 1 | 0 | 0 |
| LI End of RIIO (without investment) | 47 | 19 | 5 | 3 | 2 |
| LI End of RIIO (with investment) | 51 | 18 | 5 | 2 | 0 |

# Resilience

## Introduction

Resilience refers our ability to continue to supply electricity to customers during disruptive events, such as floods or severe storms. We are required to design and operate our networks in accordance with relevant statutes, codes and standards. Climate change and increasing customer expectations have driven us to review how we manage the resilience of our networks. We believe we should invest to mitigate the effects of increased flooding risk, extreme weather events and the implications of a total UK shutdown of the grid (Black Start). Our plans reflect how we plan to address these issues across our networks.

## Flood Mitigation

In order to maintain a safe and secure supply to our customers, we must ensure that our substations are not exposed to unnecessary risks of flooding. Flood risk mitigation has been ongoing during the period of DPCR5 and aims to address the risk of flooding affecting large numbers of customers. Using data from the Environment Agency (for England and Wales) and SEPA (for Scotland), we have been able to identify which of our substations are at risk of flooding, and may result in the loss of supply to our customers. In order to provide the best economic return, flood risk mitigation has been targeted at grid and primary substations and not at local secondary substations.

We used specialist flood risk calculations and modelling to predict the impact of different flooding scenarios; these were a 1 in 200 event, a 1 in 1000 event and a 1 in 200 plus 20% for climate change. It is the information taken from these statistical models that we calculated our risk assessments on.

We will complete all currently identified flood mitigation schemes in our SHEPD and SEPD areas within the DPCR5 period, with the exception of the two SEPD primary substation sites, Aldershot and Melksham, which require to be entirely re-sited and will be completed by the second year of RIIO ED1. We have included £2m in our business plan submissions to cover for relocation of these primary sites.

The impact of updated flooding data is a significant risk as to how much this may affect levels of future new investment. Similarly the Environment Agency has indicated that standards are likely to be tightened, requiring further action and investment, but it is uncertain how much this would be as the new data will be constantly updated and improved. For example, in the last 12 months, this has added 398 new sites to the list of affected locations which are still to be assessed.

Based on our experience and historical data we would expect this new data to demonstrate that around a third of our primary sites in our SEPD area will require civil works intervention and a fifth of them to require electrical modifications. Based on these assessments we have included a submission of £19.79m in our RIIO ED1 business plans for flood mitigation works in our SEPD area.

## Black Start

"Black Start" is the term used to describe a scenario where the UK power network experiences a complete black-out, requiring the national electricity grid to be recreated and built up gradually. In the case of the UK power network it recognises that this may take some considerable time to achieve and that battery systems in our distribution network substations may well have become "flat" such that our equipment could not be operated until the battery power was restored. It generally requires DNOs to take action to achieve 72 hour battery resilience in its grid and primary substations.

We have commenced works to deliver the necessary level of resilience during DPCR5, and forecast that we will complete 240 sites in SEPD area and 262 sites in SHEPD area by the end of the period. This work is planned to continue into, and be completed during, the RIIO ED1 period.

After actively participating in the ENA working group on Black Start Resilience we have accepted their recommendations and timescales for implementation. This commits us to having all our 132 and primary substations sites compliant by the end of 2019.

In order to achieve this compliance, we will complete the works programme already started in SEPD and are instigating a full program of works in our SHEPD area. We have included in our submission a sum of just over £6.89 million for completion of these works. We believe that based on ENA, Ofgem and DECC guidance and on the feedback from our Stakeholder engagement program that this is the best option.

## Overhead Line Resilience

Overhead Line Resilience relates to the capability of our overhead networks to withstand severe weather events. Ofgem have recognised that stakeholders want to see our networks being made more resilient to severe weather events such that their fault rate, including exceptional events does not get worse over time.

Our existing approach to addressing overhead line resilience in DPCR5 is addressed in 2 main areas:

- An ongoing programme of Resilience Tree Cutting on the EHV and HV networks
- Addressing poor performing or badly affected lines during maintenance, refurbishment or replacement works.

We have included an allowance in RIIO-ED1 for Resilience and Maintenance Tree cutting works, and this will need to be carefully managed as Resilience tree cutting arrangements are still generally by agreement with landowners, including the Forestry Commission. Costs for compensation and sterilisation of land are therefore subject to negotiation. We always negotiate to ensure best value for our customers and stakeholders. Increasing growth rates in recent years attributed to climate change have increased the need for and frequency of repeat visit maintenance cuts and may ultimately affect the level of Resilience Tree Cutting undertaken.

Secondly, as part of our strategy for maintaining refurbishing and replacing our overhead line networks we give consideration to the line condition and performance. Options for improving overhead line reliability are normally considered on a scheme by scheme or site by site basis as part of our line refurbishment proposals.

We have engaged widely with our Stakeholders asking them what they see as important to them and what we should be investing in to improve the quality of service we can provide. Our Stakeholders recognise the changing weather patterns affecting us and tell us that they want to see increased overhead line reliability during severe weather events, such as storms. Ofgem have acknowledged the need for this and plan to measure progress through long term fault rates, including exceptional weather events.

Our Overhead Line resilience works have been underway throughout DPCR5 and demonstrate real improvements in network performance for our customers. We are confident that continuing with the resilience improvements delivered through network refurbishment and rebuilds and our resilience and maintenance tree cutting programmes will build on the improvements to our overhead networks performance realised in the DPCR5 period. The network undergrounding proposals in our SEPD area will deliver further tangible benefits for our customers.

We forecast an investment of £20.7m on ETR132 Resilience Tree Cutting and £386.4m in Overhead Line Refurbishment.

## Resilience Summary

Based on the feedback gleaned from our Stakeholders we believe that the programme of Resilience works proposed delivers the best value response to meet the needs and wishes of our Stakeholders and Customers, and that real tangible benefits will be realised that will improve the quality of service and levels of customer and stakeholder satisfaction that we can deliver.