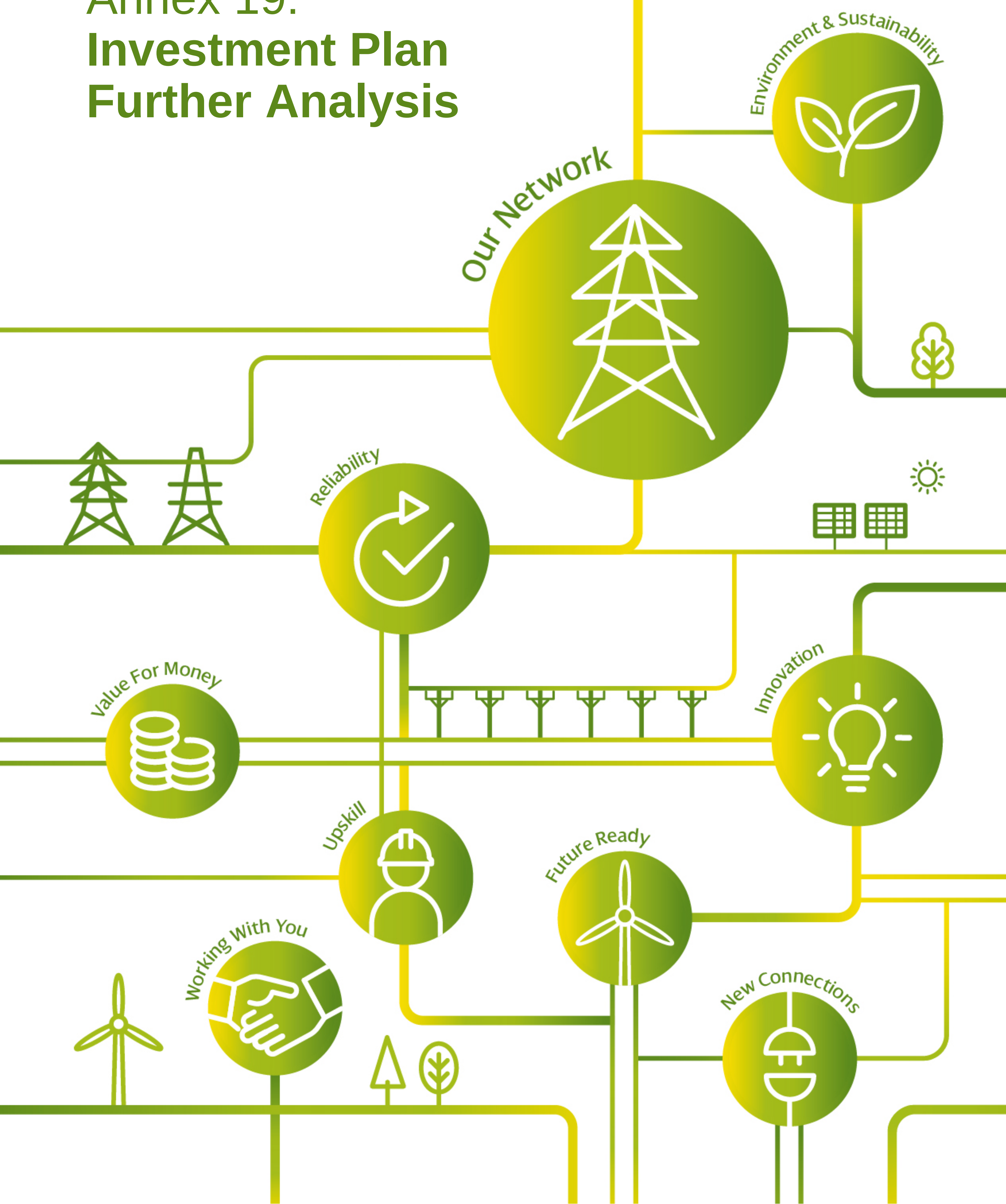
SP ENERGY NETWORKS

SP Energy Networks, RIIO-T2 Business Plan
December 2019 Submission

Annex 19:
Investment Plan Further Analysis



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LIST OF APPENDICES

REVISION	Date	Comment
1	01/10/19	Initial issue
2	09/12/19	Updated reflecting final business plan

1.0 INTRODUCTION

This annex supplements the core business plan document to provide further detailed analysis addressing the requirements defined in the RIIO-2 Business Plan Guidance. The output of this analysis is summarised in the relevant sections of the core business plan document.

1.1 Business Plan Guidance References

The following table summarises the Business Plan Guidance (BPG) requirements and the relevant sections of this document which provide analysis to supplement the core business plan document.

BPG Reference (Sep 2019)	Section Number	Comment
2.18 Asset Health, criticality and replacement priorities	2.7 & 2.10	Note that this terminology is relevant to the NOMS methodology in place at the start of RIIO-T1. The core business plan and this document uses terminology consistent with the current NARM/NOMs methodology
3.10 Cost information: drivers, options, justification, efficiency & innovation	2.5, 2.9 & 3.0	

2.0 NON-LOAD RELATED EXPENDITURE (NLRE)

Non-load related investment is, at its core, ensuring that the assets are in a suitable condition to perform their required duty. The investment planning process is designed to do this by paying due regard to the role of the assets in the network (their criticality) and the consequences of their failure on safety, the environment and the network.

Our fundamental principle in the creation of this business plan is that every intervention is individually justified. We do not plan interventions by using run-rates or assumed levels of activity. We consider the condition of assets in detail and undertake an extensive optioneering exercise to determine the right course of action. CBAs are used extensively to determine which option provides the greatest level of consumer benefit. Our baseline for the CBAs is deferring the intervention, which helps us balance the costs between current and future consumers.

We consider the issues that limit the remaining lives of the assets and forecast, using the accepted NARM methodology, when the risk associated with their failure will be intolerable. We manage the need to balance risk and cost by a detailed analysis of the network and the condition of all of the assets including those that are not part of the NARM methodology. Note that Ofgem has renamed NOMS as Network Asset Risk Metric (or NARM).

Each of our interventions is designed at a detailed scoping level, considering all material factors and constraints of the assets, the environment and the operation of the network. This means that there are few projects that are immediately comparable with those from RIIO-T1. Our benchmarking work with Arcadis has highlighted the fact that a simple top-down comparison does not provide reliable information and that detailed analysis of the components of each scheme is essential.

2.1 Condition & Criticality Data

As detailed in Annex 3, we have expended significant effort in making sure that our plan is supported by complete and up-to-date condition data.

We have not provided the complete set of inspection and test reports (due to the volume of information) but these are available if required. In our engineering justification papers, we summarise the results of inspections, tests and forensic reports for the individual interventions. These test values are inputs to the NARM models (for lead assets) which have generated the asset health indicators (known as EOL in the methodology) at an individual asset level.

The NARM methodology for lead assets has been developed by the three onshore Transmission Owners and Ofgem since the beginning of RIIO-T1. The methodology used in the compilation of the RIIO-T2 business plan was 'not rejected' by Ofgem on 8th August 2018.

Our decision making process for investment planning takes account of both the asset condition and the consequences of failure that, for lead assets, are combined using the NARM methodology to generate a value of risk. Risk values are determined for individual lead assets and for overhead lines and cables, down to individual towers, spans or cable sections.

This methodology provides detailed criteria and calculations for consequence of failure as follows:

- System consequence, incorporating loss of demand, loss of generation, impact on major system boundary transfers and loss of reactive compensation.
- Safety consequence which uses publically available values for the costs of a range of impacts on staff and the public, modified by exposure to the individual assets.
- Environmental consequence captures issues such as contamination and emissions of SF_6.
- Financial consequence quantifies the cost to recover from the failure, such as repair or replacement of the failed asset.

This methodology is published on Ofgem's website and the consequence values for every asset were applied in 2019.

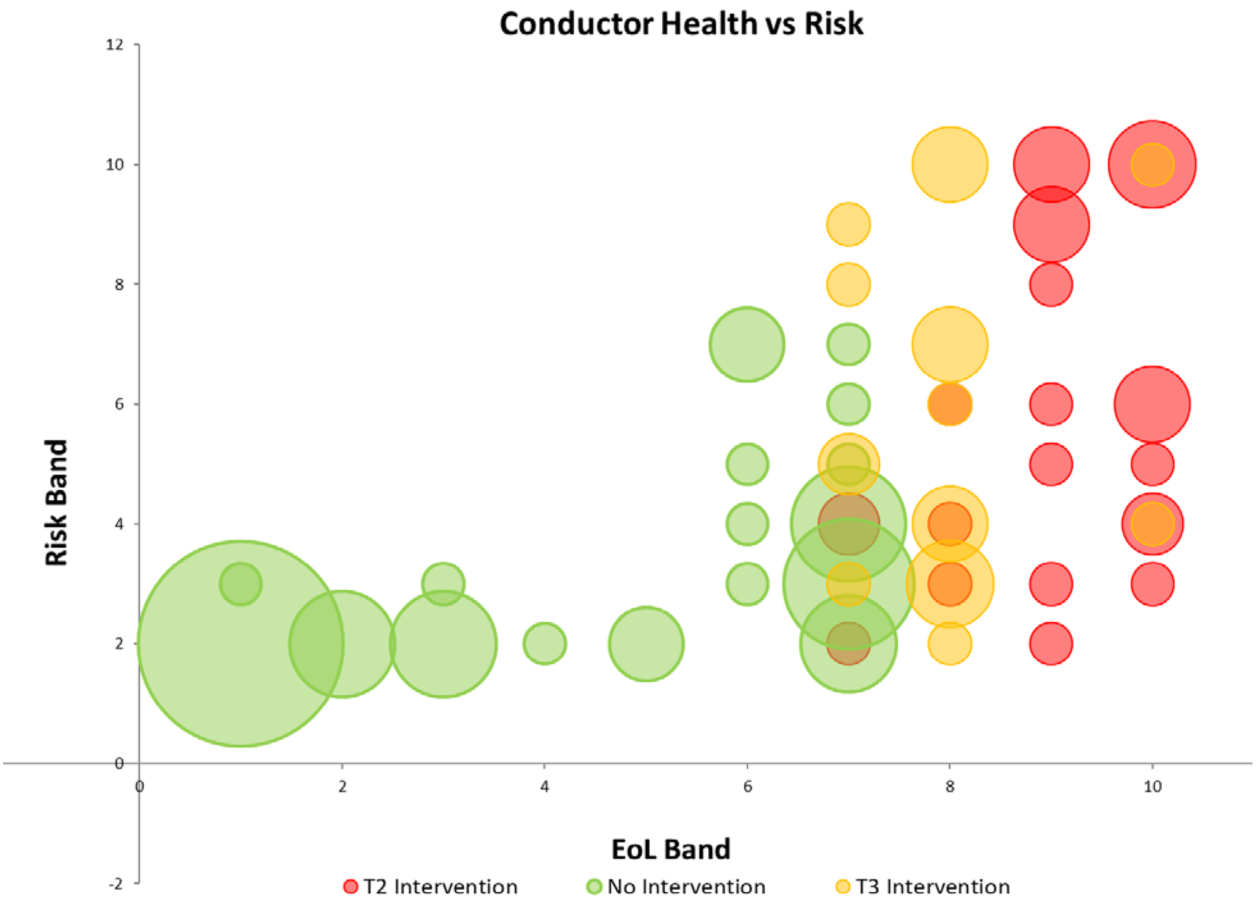
2.2 Network Asset Condition and Criticality

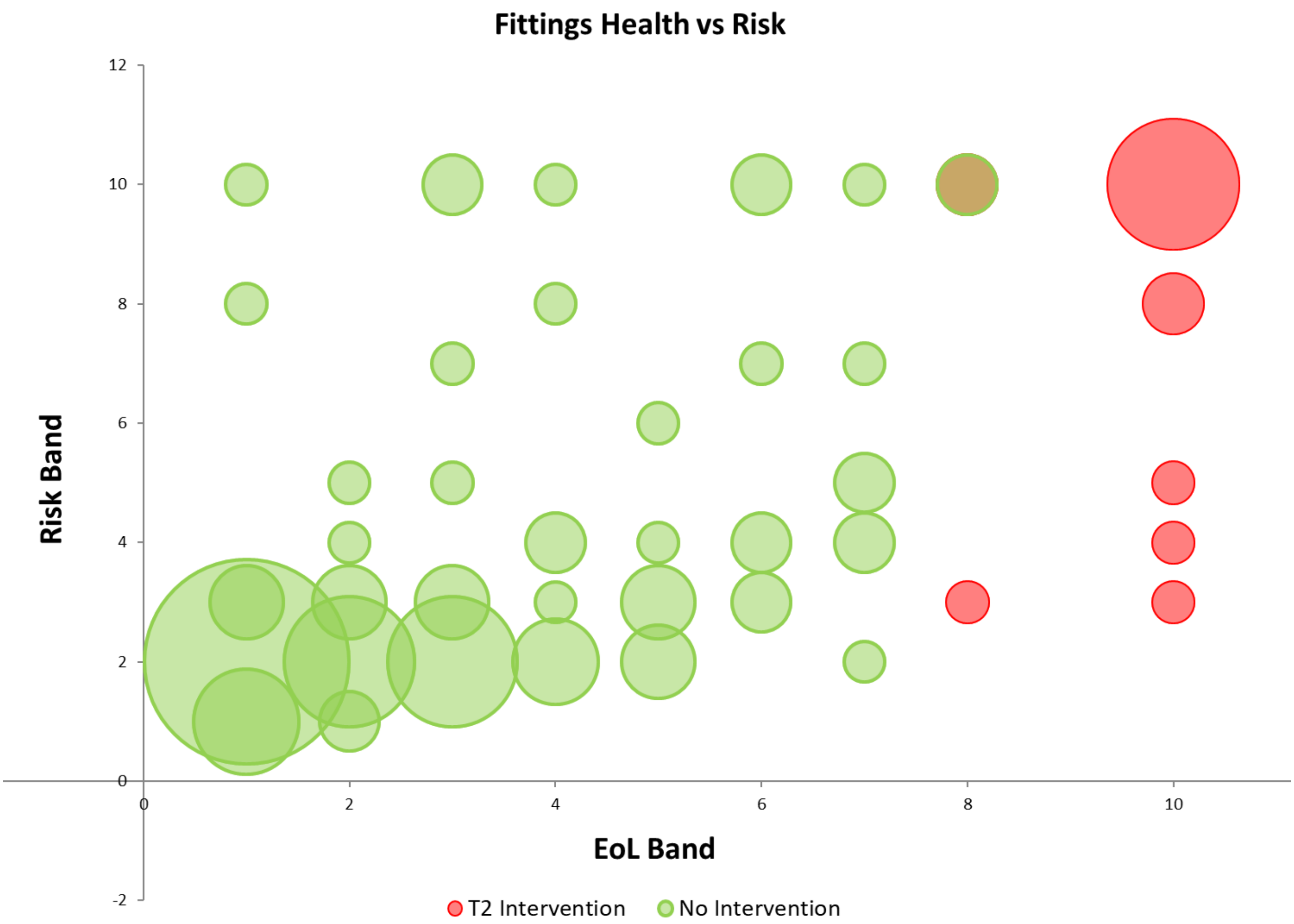
We note that section 2.18 of the Business Plan Guidance references "health, criticality and replacement priorities". This terminology is particularly relevant to the NARM (NOMS) methodology in place at the commencement of RIIO-T1 and it is notable that the current version (v18) has superseded these concepts. We have presented asset condition and risk using the concepts and terminology of the current version of the methodology and believe that this was the intent of section 2.18 of the Business Plan Guidance.

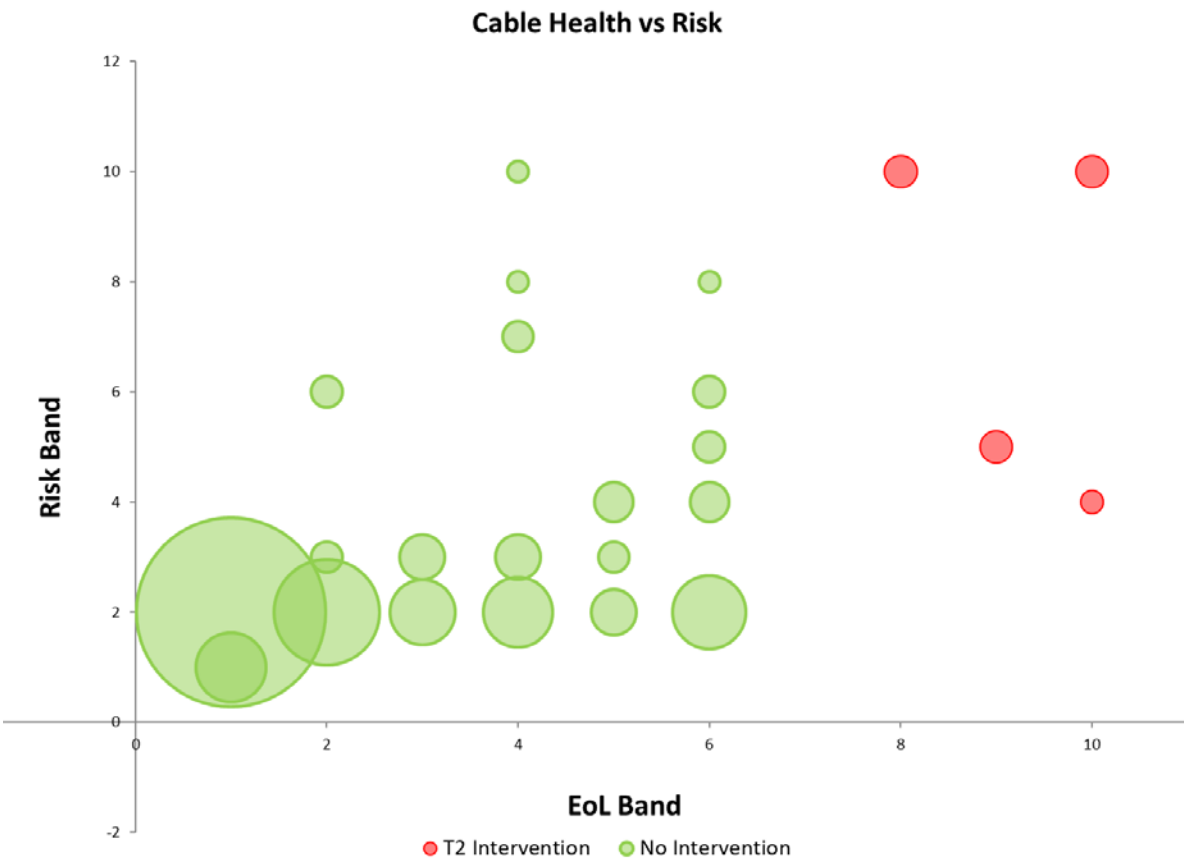
The lead asset condition (via the methodology's EoL (End of Life Modified) parameter) and risk is categorised in bands as defined in the NARM business plan data tables. The number of bands has been set by Ofgem and the methodology for calculating the band values has been agreed with them. Details of the bands can be found in Annex 3. The engineering justification papers provide the full detail of these parameters for every lead asset in the respective projects.

The following charts show the network lead assets by Health (EoL) and Risk at the end of RIIO-T2 with no intervention, identifying the assets that are included in the RIIO-T2 business plan and those that we currently forecast to require intervention in the RIIO-T3 period.

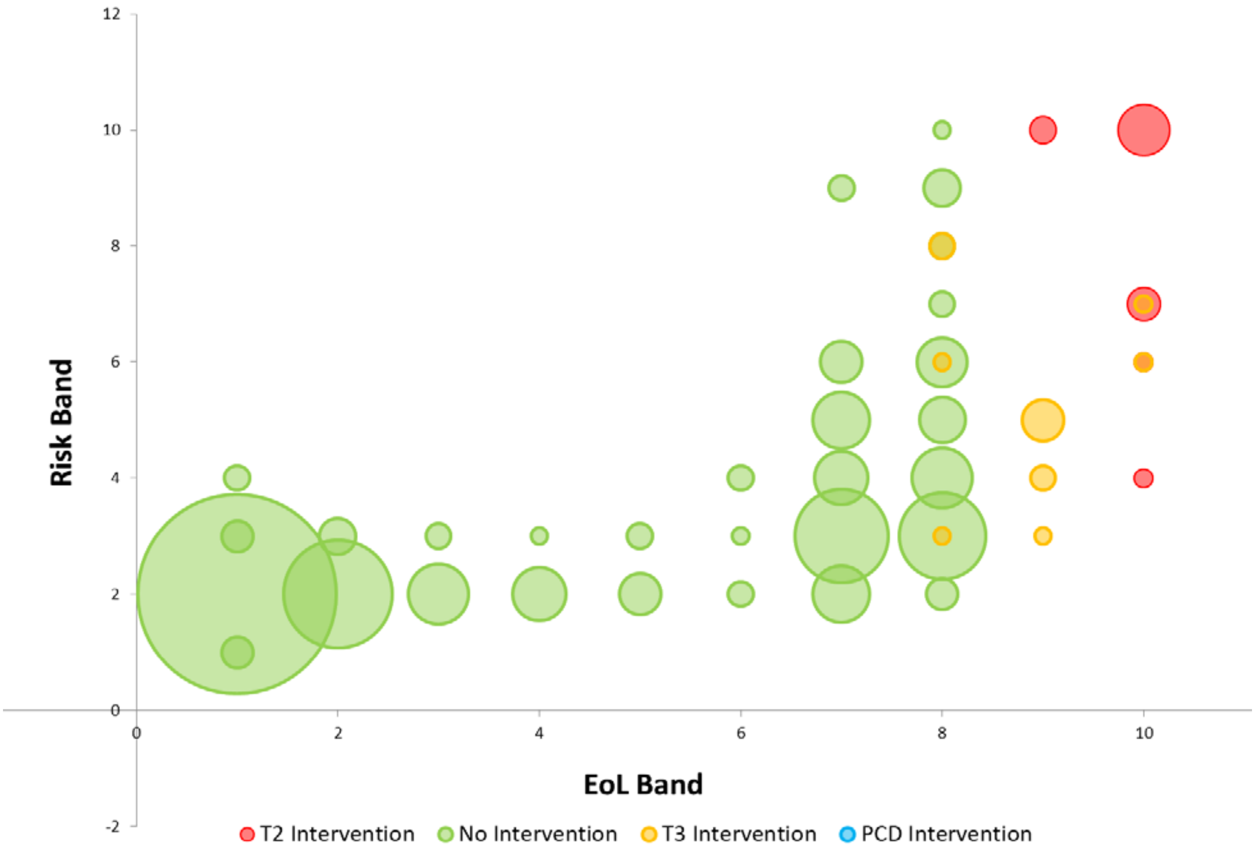
The charts below (where the size of the circle indicates the number of assets) and those in Annex 3 indicate that 99% of the reduction in monetised network risk is delivered by assets in the two bands representing the poorest condition. As we discuss in section 2.3, the assets in these bands would be at end of life if there was no intervention in RIIO-T2. In the charts below, the size of the circle indicates the number of assets or routes in each risk and health (EoL) band. Note that PCD interventions in blue are those identified as uncertain in the business plan and ring-fenced as Price Control Deliverables.



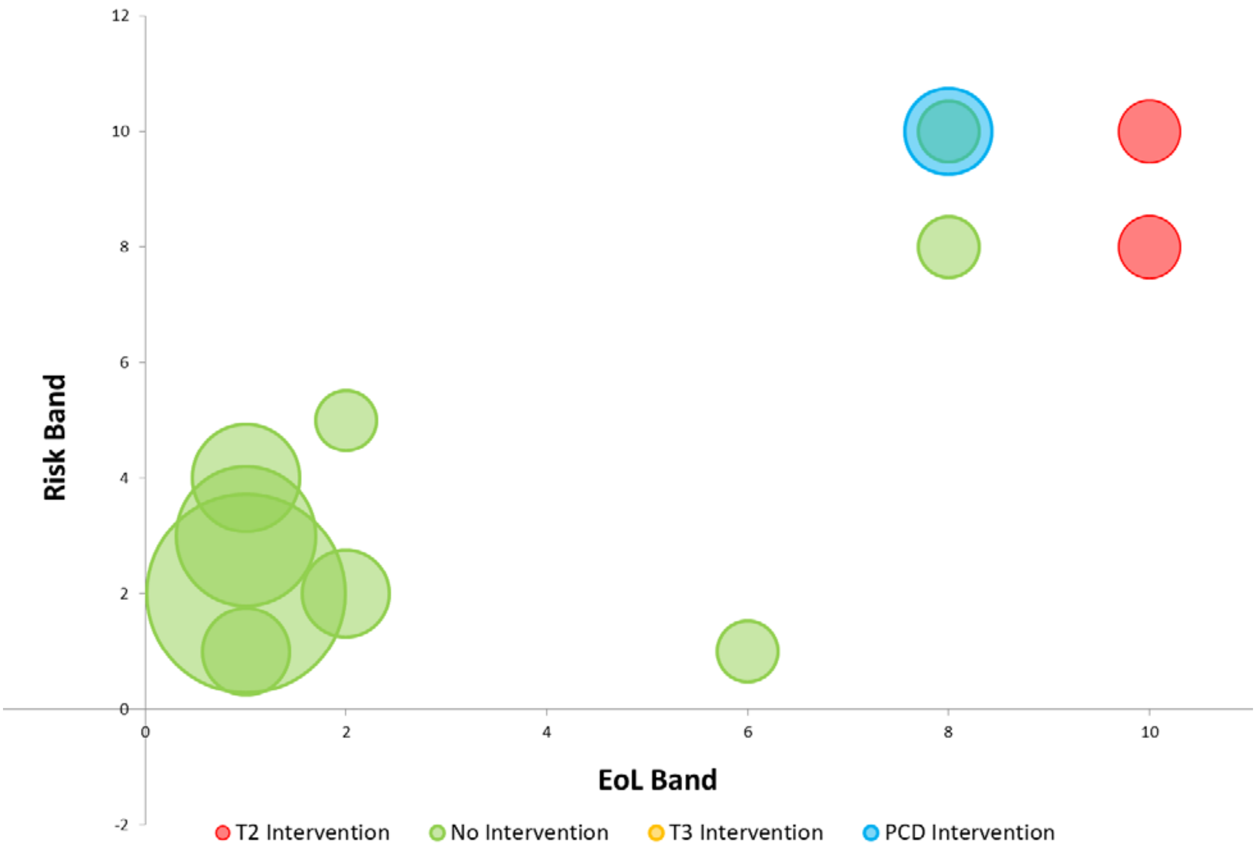

Fittings Health vs Risk
Risk Band
12
10
8
6
4
2
0
-2
0
2
4
6
8
10
EoL Band
T2 Intervention
No Intervention

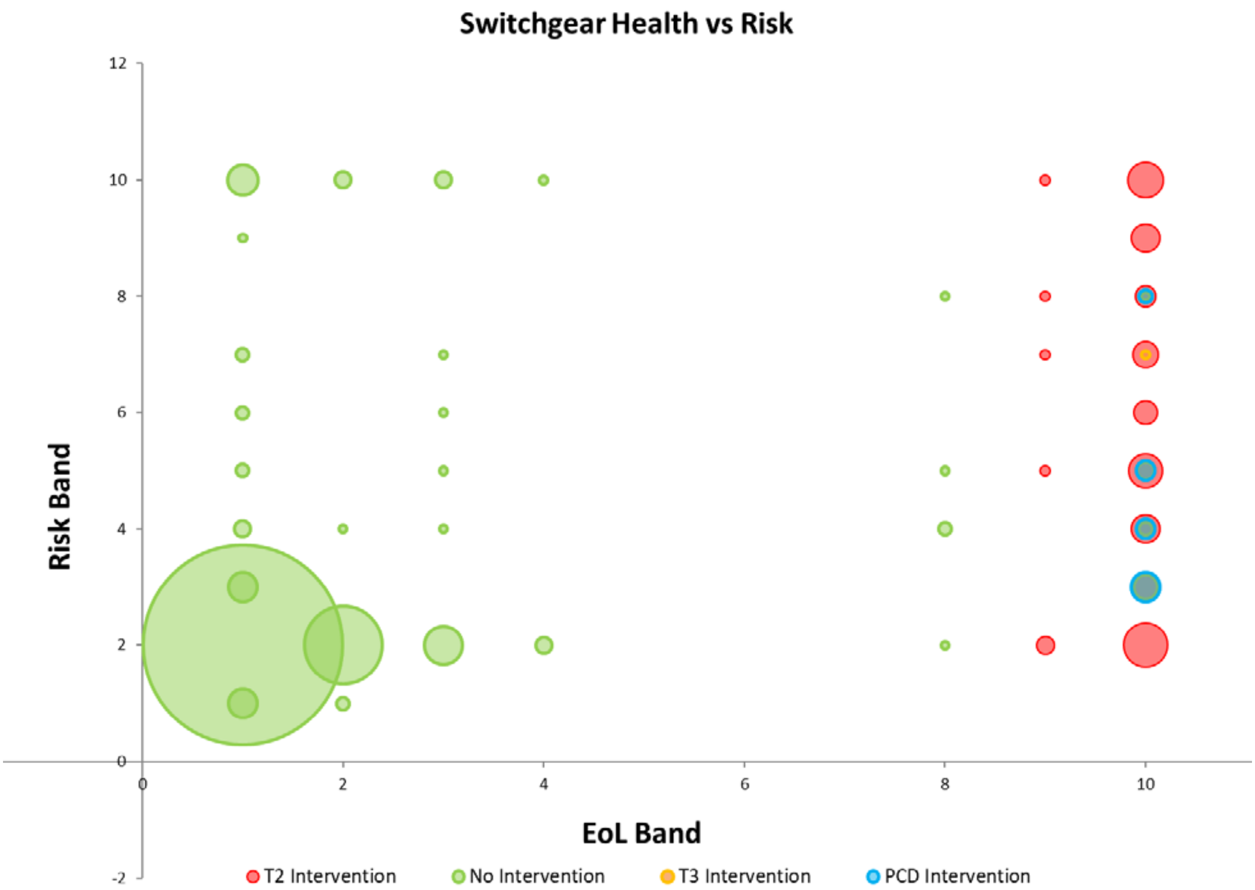

Cable Health vs Risk
Risk Band
EoL Band
12
10
8
6
4
2
0
-2
0
2
4
6
8
10
T2 Intervention
No Intervention

Transformers Health vs Risk



Reactors Health vs Risk





We note that there are some assets in higher bands that we have not planned for intervention until RIIO-T3. We have profiled these interventions this way for the following reasons:

— There is an interactive load-related project planned in RIIO-T3. The load-related works in some cases require the same solution but the non-load works have not been included in the RIIO-T2 plan to avoid unnecessary outages affecting major system boundaries. In other cases, the load-related solution may be different and the approach taken avoids stranded investment. In all cases, a detailed assessment of the assets has verified that the risk is manageable until the load-related project is delivered.

— We have prioritised some interventions over others with the same lead asset issues. The projects that we plan to complete in RIIO-T3 do not have as severe issues with non-lead assets. The holistic view of the whole asset base – not placing undue focus on the single risk value of the lead assets – has informed these decisions.

— One 132kV overhead route (AT) is aligned with the load-related works in RIIO-T3.

— Two transformer schemes (Partick and Giffnock) have been programmed such that intervention on one transformer in each scheme is completed at the end of RIIO-T2 and the other is at the beginning of RIIO-T3.

We have analysed the detailed failure mechanisms and the physical and electrical arrangements of all assets. Where the decision has been taken to defer an intervention as outlined in the two points above, we ensure that we have plans in place to increase surveillance (where applicable), and to recover from failures should they occur.

There are some interventions on assets in lower bands included in the business plan:

— The conductor condition is not the primary driver on three 132kV overhead line routes (G, R and S). These are the only interventions in the plan which are driven by the condition of the towers.

2.3 Need Case & Certainty

We have refreshed our condition data to ensure that we have the most up-to-date picture of the network assets. We have subjected representative elements to invasive (e.g. tower foundations and substation structures) or forensic (e.g. overhead line conductors) testing to provide even greater confidence in our view of current condition. For key condition assessments such as overhead line conductor and transformers, we have sought external challenge which has validated and refined our methodologies (details can be found in the assurance section of the business plan).

We have forecast future condition and remaining life based on findings from decommissioned and failed assets. Current and future condition is quantified by the NARM models. There is excellent correlation between the model outputs and the findings of fault and decommissioning reports.

The outcome is that the observed and measured condition, the asset numerical modelling and historical experience have converged to produce a plan with a very high degree of certainty of the need cases. We have sought external challenge (please refer to the Ramboll report in Annex 23) for the need case and optioneering of our plan. We have reviewed and revised our proposals as a result.

2.4 Intervention Optioneering

In Annex 3, we set out the optioneering process that we have completed to compile the business plan. The aim of this process is to ensure that the scope of work is detailed to produce the most economic and efficient outcome and to consider interactions with other investments, such as load related programmes. We also consider the future network needs to ensure that we are neither proposing assets which may not be needed as far as can be foreseen, nor that would be blockers to future development towards net zero. We have produced CBAs which also demonstrate that the interventions in the plan result in greater consumer benefit than if they were to be deferred. These are summarised in the engineering justification papers for each scheme and we have again provided the full set of CBA files.

2.5 Activity Levels & Comparison with RIIO-T1

In section 2.7 and Annex 3 we have provided a detailed explanation of how we determine which assets will require intervention in RIIO-T2 to manage their condition and hence network risk.

It is clear from this process that we do not plan capital investments on the basis of a run rate. We demonstrate that all steps are taken to ensure that the intervention is needed, that the most economic option to meet the need has been identified and that the intervention has been timed to provide the greatest consumer value.

The following sections illustrate that the breakdown of activities in each of the main asset categories differs from RIIO-T1 but the levels of comparable works are not materially higher.

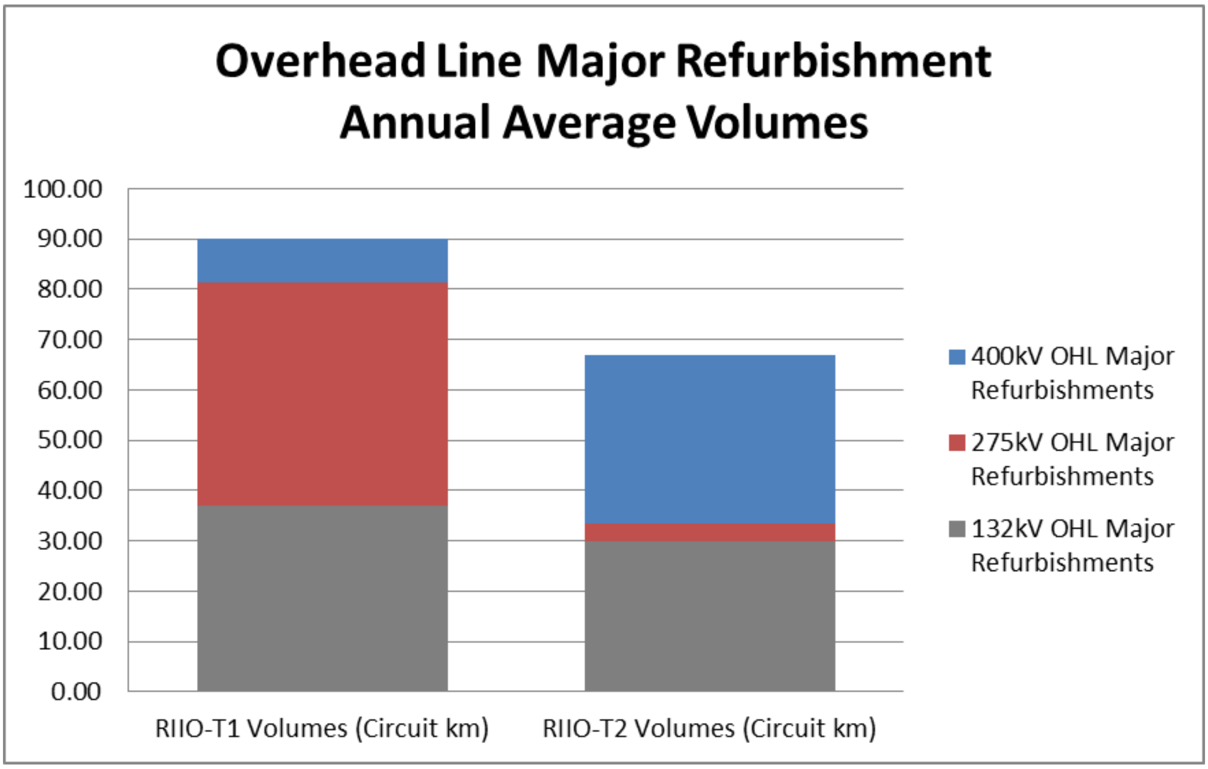
2.5.1 Overhead Lines

We have disaggregated the activity volumes into minor refurbishments, major refurbishments, re-builds and by voltage level to reflect the different intervention needs of the overhead line asset base.

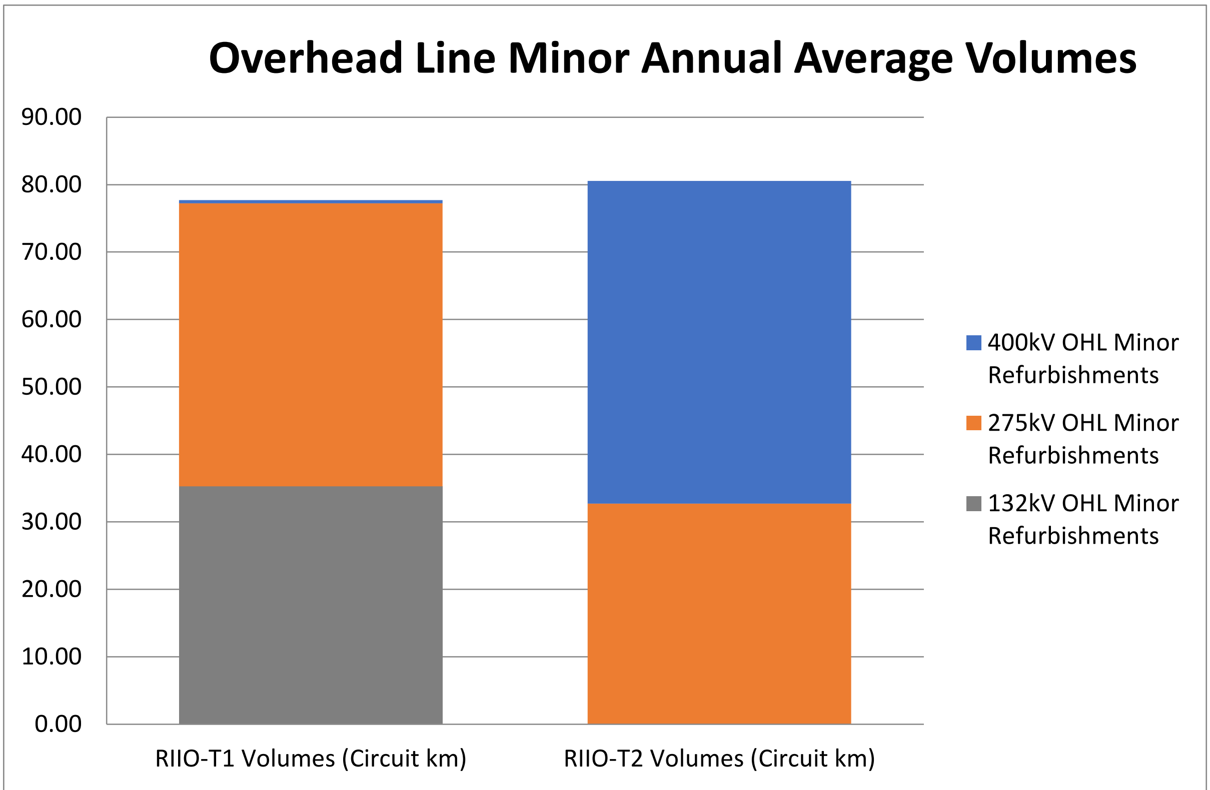
Major refurbishments typically comprise the replacement of conductor systems, earthwire, insulators and fittings. It is common to paint the towers and remediate corroded tower steelwork by repair or replacement of individual members and to repair on average 10% of foundations. As we perform a detailed analysis of the intervention needs for each route, the scope of works may not include all possible elements.

Minor refurbishments can generally be considered to exclude the conductor and earthwire replacements from the scope of major refurbishment.

We are now reaching the stage where the condition of the earliest steel tower lines (some dating from 1929) and wood pole lines (some dating from 1959) are such that major intervention is required. When considered in conjunction with the conductor system, the only technical and the most economical solution is to rebuild the route. The limitations of the original design and the deteriorated condition of the towers and poles renders them unsuitable for reconductoring and the limited remaining life would, in any case, quickly lead to the stranding of the investment in the conductor system. For this reason the single-circuit overhead line routes G, S, R, U and AT (which has a load-related driver influencing the intervention date) are proposed for replacement. The individual engineering justification papers set out the need case and optioneering for each of these routes which is supported by condition data.



The circuit kilometres of baseline major refurbishments is less than the forecast out-turn in RIIO-T1 (90.15km per year in RIIO-T1 vs 67.04km per year in RIIO-T2). As we have described in preceding sections and in Annex 3, the inclusion of major refurbishments in the RIIO-T2 plan is based on condition and prioritised on risk and deliverability. Based on our analysis of the remaining asset base and our forecast for intervention requirements in RIIO-T3 (please refer to Annex 3), this level of activity is appropriate to manage the risk and condition issues presented by the routes in question.



We are proposing minor interventions on fewer routes (1.8 per year) than in RIIO-T1 (3.75 per year) which was dominated by the requirements of the 132kV system. In RIIO-T2, the routes whose condition needs to be managed are at 275kV and 400kV and are on average 216% longer than in RIIO-T1, leading to a slightly greater number of overall circuit kilometres (77.68km per year in RIIO-T1 vs 80.56 per year in RIIO-T2). The scope of work is also different as the higher voltage lines have quad and twin bundled conductor configurations which entails more complex fitting arrangements and spacer replacements which are not required for single-conductor 132kV lines.

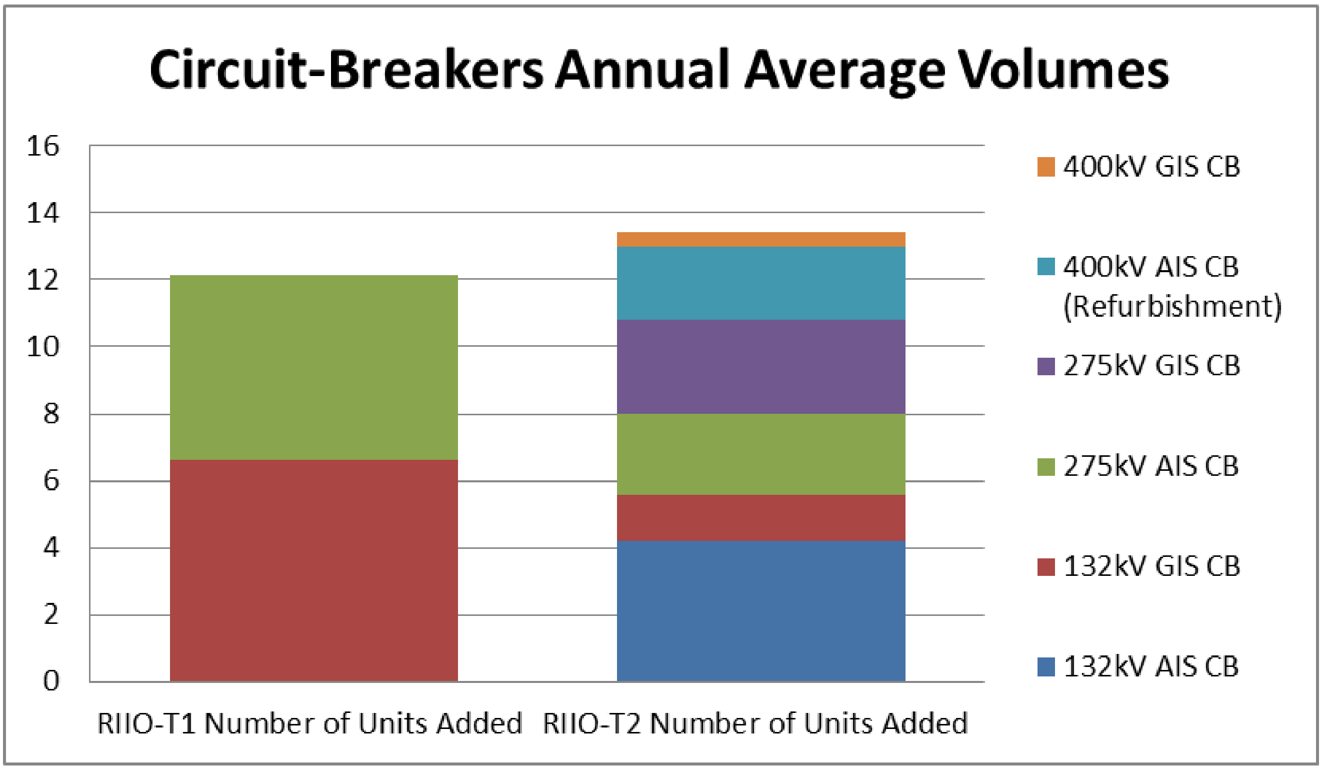
The RIIO-T1 plan includes the rebuild of the single-circuit G route overhead line with a single-circuit wood pole line with the current forecast that the work will conclude in the RIIO-T2 period. Referring to engineering justification paper EJP_SPT_SPNLT20109 (Glenlee to Tongland Modernisation), the need case for the rebuild of the R route (Glenlee to Tongland) and S route (Tongland to Dumfries) single circuit steel tower lines with a double circuit steel tower line from Glenlee to Tongland was established in RIIO-T1. This was identified as part of a wider project to reinforce the network in Dumfries and Galloway. This is a new activity for which there is no equivalent in RIIO-T1 but is required for the reasons set out above.

2.5.2 Cables

The business plan section on cables sets out the status of the cable network and the drivers behind investment. The proposed refurbishments in the business plan will maximise the life of the cable systems and the programme is supported by CBA. There were no major refurbishments required in RIIO-T1 but the replacement of one route is in progress and the majority of the activity (and hence cost) will occur in the RIIO-T2 period. We have identified through detailed condition surveys that three routes require to be refurbished during RIIO-T2.

2.5.3 Circuit-Breakers

Our strategy for managing the condition and risk of the various circuit-breaker types is set out in the business plan. The following chart details the volumes of circuit-breakers added through replacements.



The volume of planned replacements of 400kV air-blast circuit-breakers in RIIO-T1 was seven but ultimately the allowance was used to reconfigure the network to remove the substation (Inverkip) from the network following the termination of the power station's connection agreement. In the RIIO-T2 baseline plan, there are two new GIS units planned (and extension of the existing Hunterston East substation). Three AIS SF_6 circuit-breakers at Strathaven and the eight GIS units at Torness are planned for mechanism refurbishment. The emerging issues with the original designs of pneumatic and hydraulic mechanism units are a key difference between RIIO-T1 and RIIO-T2.

RIIO-T1 is forecast to out-turn 44 275kV circuit breakers, 5.5 per year. The RIIO-T2 baseline plan (plus Westfield 275kV) is for 26, or 5.2 per year. It should be noted that the emerging issue with pneumatic and hydraulic mechanisms highlighted previously constitutes 4 of the 26 units, so on a like-for-like basis the annual rate is 4.4 per year, a reduction of 20% on the RIIO-T1 average.

The plan in RIIO-T1 is forecast to add 53 new units to replace non-SF_6 132kV circuit-breakers, which is an average of 6.6 per year. The RIIO-T2 business plan proposes to replace 11 132kV non-SF_6 circuit-breakers which, at 2.2 per year, is a third of the annual average for RIIO-T1. The emerging pneumatic and hydraulic mechanism issues relate to 20 units (4 per year). Replacements under the proposed greenhouse gas reduction programme will depend on the feasibility and effectiveness of repairs.

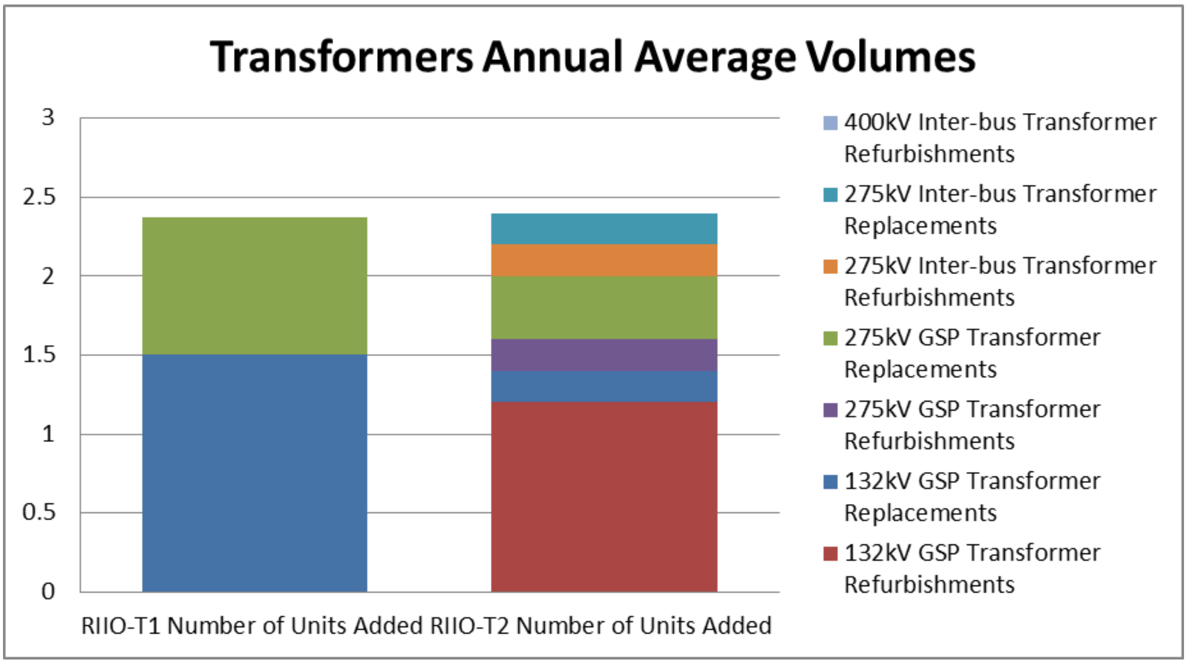
2.5.4 Transformers

Using the empirical information we gained from the forensic investigation of the removed T1 units, we have improved our knowledge of transformer deterioration mechanisms to introduce a programme of refurbishments in RIIO-T2 at lower cost than replacement. This has also allowed us to better estimate end-of-life, resulting in the maximum value being extracted from the existing units.

We had no works associated with 400kV transformers in RIIO-T1. To maximise their remaining lives, we plan to refurbish two transformers at Torness.

In RIIO-T2 the average annual replacement rate of 275kV transformers is 0.6 compared to 0.875 in RIIO-T1. We propose to refurbish 2 transformers in the period.

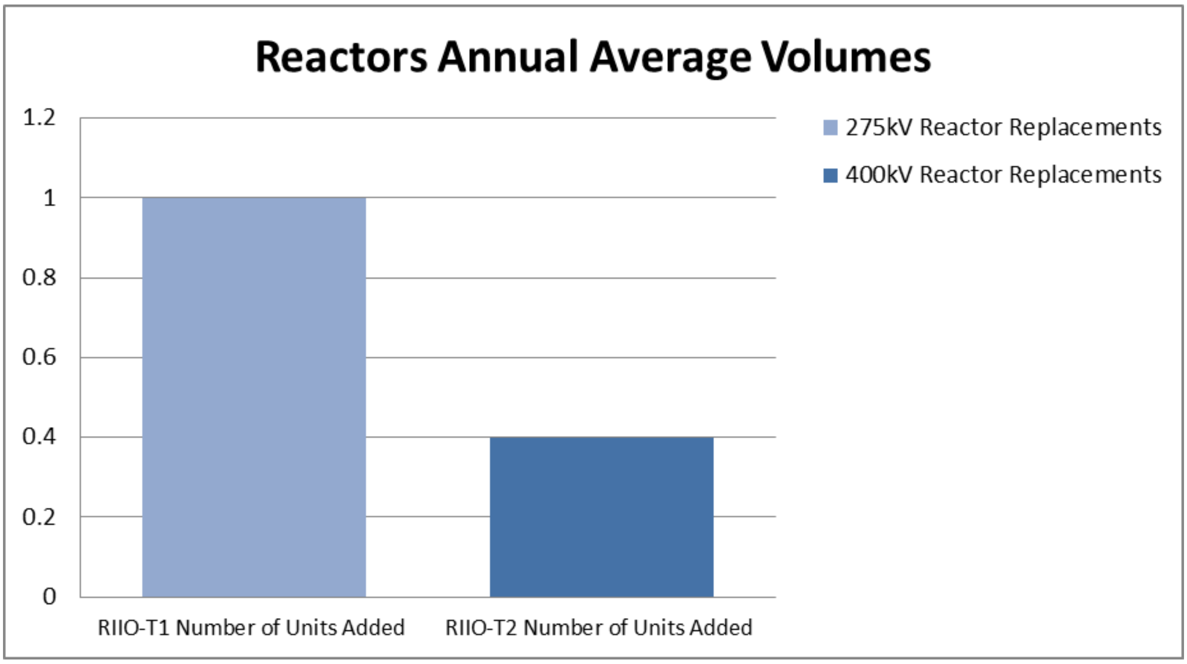
The average annual replacement rate of 132kV transformers has fallen from 1.5 to 0.2 while the proposed average refurbishment rate is 1.2 per year.



2.5.5 Reactors

In RIIO-T1, significant reactor and associated circuit-breaker condition issues led to the replacement of 8 units. These were 33kV units connected to the 33kV side of 275/33kV GSP transformers but categorised as 275kV in accordance with the RIIO-T1 Regulatory Instructions and Guidance.

In RIIO-T2, the baseline plan proposes only the replacement of the two 400kV reactors at Torness.



2.6 Schemes common to RIIO-T1 and RIIO-T2

As detailed in the respective engineering justification papers, there are three projects that were in our original RIIO-T1 business plan that we seek to progress in our baseline RIIO-T2 plan. There is an additional scheme that is proposed as a Price Control Deliverable in RIIO-T2.

2.6.1 Windyhill 275kV Switchgear Replacement (SPNLT 2033)

The replacement of the circuit-breakers was included in the RIIO-T1 business plan for completion in 2020. However, when considered in the context of baseline wider works, generation connections and associated reinforcements, the other switchgear replacement schemes and overhead line modernisation works, the availability of system access was challenging. Following extensive coordination with National Grid ESO, the decision was taken to substitute additional OBR30/60 replacement works at Wishaw 275kV and Strathaven 275kV and to defer the works at Windyhill to RIIO-T2. Applying the NARM framework in place at the time of the decision, the result was an equivalent number of Replacement Priority 1 circuit breakers being replaced in the revised intervention plan as had been agreed in the final proposals. That is, the substitutions were like for like. The management of the population of air-blast circuit-breakers was defined in the RIIO-T1 business plan as a multi price control strategy and the reordering of the replacement of the OBR30/60 circuit breakers was consistent with that strategy.

The proposal being presented now for RIIO-T2 has taken account of the engagement with the ESO during RIIO-T1 period, with the new proposal designed around minimising outage requirements and constraint costs. Additionally, the operating environment has changed, and will change further, from when the RIIO-T1 business plan was agreed. For example, the early closure of Longannet Power Station has, and the planned closure of Hunterston Power Station will result in an increased reliance on the Western Link to secure demand in Scotland during times of low wind. This is particularly relevant to Windyhill given its connectivity on boundary B5 and south towards Hunterston.

2.6.1 YK Route 275kV Minor Refurbishment (SPNLT2015)

YK was included as a ‘best view’ scheme in RIIO-T1. There have been a small number of substitutions of the overhead line portfolio and YK route was deferred as part of this. The overall position for overhead lines is that the schemes substituted in are forecast to meet the targets for this category. The full funding allocated to YK route in RIIO-T1 has been transferred to other schemes through substitution.

2.6.2 EMS Replacement (SPNLT2049)

The RIIO-T1 business plan proposed a minor hardware refresh followed by an EMS replacement to be completed by the end of RIIO-T1. However, the most effective option was determined to be a greater level of refresh and to defer the replacement to RIIO-T2. The deferral allowed a whole systems approach to be taken by creating a common platform with the distribution system. This will provide benefit in new whole system applications which cross the transmission/distribution boundary such as Active Network Management.

2.6.3 Giffnock SGT1 and SGT2 Replacement (SPNLT2066)

The replacement of these two transformers was deferred in RIIO-T1 due to their condition not deteriorating as quickly as expected at the time when the investment was being progressed by internal approval. We now plan to replace one unit at the end of RIIO-T2 and the other at beginning of RIIO-T3.

There was an additional deferral at Kilmarnock Town for a similar reason. However, we have added units at Charlotte Street and Shrubhill which were not in the RIIO-T1 plan which can be considered substitutes for the deferrals. It is expected that if the substitutions lead to under-delivery against targets, the NARM incentive mechanism will return the associated allowance to consumers.

2.6.4 XH & XJ Routes 400kV OHL Major Refurbishment (SPLNLT20111)

XH and XH Routes were included as a ‘best view’ scheme in RIIO-T1. For deliverability reasons, there have been a small number of substitutions of the overhead line portfolio and XH and XJ routes were deferred as part of this. The overall position for overhead lines is that the schemes substituted in are forecast to meet the targets for this category. The full funding allocated to XH and XJ routes in RIIO-T1 has been transferred to other schemes through substitution. This project is proposed as a Price Control Deliverable in the RIIO-T2 business plan.

2.6.5 Cockenzie Building Improvement Works (SPTNLT20103)

Within the RIIO-T1 allowance a ‘Substation Civil Refurbishment’ programme was agreed. During RIIO-T1 it was identified that the substation building at Cockenzie was in need of major refurbishment and £2.9M of the ‘Substation Civil Refurbishment’ allowance has been used to fund the programme of works at Cockenzie during RIIO T1. Due to system access restrictions and the complexity of the work associated with the scheme the overall project will not be completed until 2022. The project costs being incurred in RIIO-T2 are included in the RIIO-T2 business plan.

2.7 Overall plan value for network risk management.

Our aim is to undertake each required intervention when it provides the greatest consumer benefit, subject to the constraints of co-ordination and deliverability. We have used Cost Benefit Analysis to inform our decision making and the preferred option provides the highest Net Present Value in most cases. There are a small number of proposals where this is not the case and the Engineering Justification Papers provide the reasons behind the decisions (please also see section 2.9.6). Our improving understanding of asset lives, supported by the numerical models, provides increasing confidence that the interventions are the correct balance of maximising the economic life of the asset and avoiding failures.

This means that it is not necessarily the lowest cost justified interventions that are included in the business plan for any particular price control period. To select interventions only on the basis of lowest cost would cause higher cost projects (which we demonstrate are justified and efficient) to be deferred. To do so would not take due account of costs to future consumers; the interventions with higher costs will remain necessary and would need to be delivered in a future price control period. It can also lead to higher costs overall as opportunities to reduce outages and scope overlaps through co-ordinated activities with other programmes of work can be missed.

We undertook a detailed review of condition data, the output of the NARM asset condition models and a qualitative engineering assessment to identify all assets which will be at the end of their operational lives by the end of RIIO-T2 and where intervention is required in the period. The assets identified were generally in the health bands 9 and 10. We have also made a detailed assessment of the assets which are very high risk and will be approaching the end of their operational lives during RIIO-T2 to determine whether intervention should be planned for RIIO-T2 or developed as RIIO-T3 interventions.

In each asset category, the assets were initially prioritised by their risk values with a further check on the intervention needs of non-lead assets which are not part of the monetised risk methodology. The process to determine the deliverable level of activity considered co-ordination opportunities, internal and supply chain capability and, in particular, system access. This was done at a programme level and also considered load-related activity and operational works. While this process is iterative in nature, with a small number of exceptions, this resulted in the lowest risk assets in each category being deferred to RIIO-T3 (please see section 5.0 for further details).

The prioritisation and co-ordination process has resulted in lead asset schemes with total costs of £81m (19% of the total investment in lead assets) being deferred to at least RIIO-T3, providing increased consumer benefit through asset life maximisation and activity coordination.

2.8 Volumes and Activity: Conclusions

When considered on a like-for-like basis, the activity levels in the main asset categories are at or below RIIO-T1 levels. The current plan has been optimised to target the poorest condition and highest risk assets. We have determined from the numerical models 'not rejected' by Ofgem that these assets will be at the end of their operational lives by the end of RIIO-T2 if we do not intervene, and this correlates with the engineering assessment.

There are a number of new issues that have not been present in RIIO-T1 and there are differences in the characteristics of assets that result in additional volumes in some areas.

Our baseline plan is the result of a long-term investment strategy considering the full life cycle of the assets and their interactions with other investments, such as load related programmes. We have proposed to defer some interventions to RIIO-T3 to balance the cost between current and future consumers.

2.9 The costs of our investments

2.9.1 Basis of Scheme Costing

As set out in the business plan, we have delivered efficiency savings through the course of RIIO-T1. The efficient costs of delivered projects are the basis of scheme costs in RIIO-T2.

As we explain in Annex 3, we have undertaken a bespoke engineering design exercise to ensure that the costs are compiled with a high degree of confidence and that the scope of work is specific to each particular intervention. This minimises the risks of unnecessary costs due to the application of assumptions or averaging. Where there are feasible options to deliver an intervention, we have considered all of these and shortlisted those that are the most economical. We have undertaken the bespoke design and costing exercise on the shortlisted options which are included in the CBAs. The process is explained in more detail in Annex 3 and the details for each scheme are provided in the engineering justification papers.

2.9.2 Cost profiling

The delivery programme for the proposed investments was developed by the prioritisation of the schemes based on remaining life of the assets. This is modified by the development of a detailed outage plan to ensure that the most efficient combination of outages is programmed for all activities. We have had regular interaction with ESO on our outage plans.

The cost profile is derived from the scheme-by-scheme development and delivery programmes and considers the timing of pre-engineering, contract awards and construction periods.

2.9.3 Unit & Project Costs

Ofgem define the scope of works that constitute unit costs in the Regulatory Instructions and guidance for RIIO-T1 and the Transmission Glossary for RIIO-T2. An important consideration is that the definitions of unit costs have been changed significantly by Ofgem for RIIO-T2. However, the completion of table C2.7 requires the translation of the costs of projects from RIIO-T1 into the format defined for RIIO-T2. We note that the allocation of actual and forecast costs from RIIO-T1 in the format specified in RIIO-T2 requires a degree of expert judgement. It should also be noted that the definition of 'replacement' and 'refurbishment' in the RIIO-T2 guidance causes refurbishment costs for some assets to be included in the replacement table where the replacement of assets is the primary driver for the project. For example, in an overhead line minor refurbishment project, the primary driver is replacement of insulators but the necessary conductor repairs would be classified as refurbishment but are included in the replacement table. This distorts the unit costs which would be derived directly from the table values so we have excluded these costs from the unit cost comparison exercise.

As we note in section 1.0, there are few directly comparable schemes between RIIO-T1 and RIIO-T2 as we undertake a bespoke engineering exercise to ensure that the scope of work is optimised. The definitions of the lead asset costs in the Ofgem Transmission Glossary are such that even within each unit cost element, there will be material differences in scopes.

For example, for 132kV GIS, there is only one project in RIIO-T2 and it is associated with a nuclear site. The differential for RIIO-T2 is the more complex cabling arrangement whose costs are within the definition of circuit-breaker.

The table below illustrates comparable unit cost elements for sufficiently comparable RIIO-T1 and RIIO-T2 schemes.

RIIO-T2 Prime Asset Definition	RIIO-T2 Average Unit Costs (£m)	RIIO-T1 Average Unit Costs (£m)
132kV CB (Gas Insulated Busbars)(ID) (GM)		
275kV CB (Air Insulated Busbars)(OD) (GM)		
275kV CB (Gas Insulated Busbars)(ID) (GM)		
132kV Transformer		
275kV Transformer		
132kV OHL (Tower Line) Conductor		
132kV Fittings		
132kV Tower		
275/400kV OHL (Tower Line) Conductor		
275/400kV Fittings		
275/400kV Tower		

The unit costs for RIIO-T1, noting the difficulty in accurately translating out-turn and forecast costs from RIIO-T1 into the correct categories can be seen to be close to those in the RIIO-T2 business plan. There are variances between some costs which are attributable to market conditions, scope differences and the translation process.

2.9.4 Cost Drivers

The charts below show the non-load capital expenditure changes between RIIO-T1 and RIIO-T2 in the following categories:

- Overhead Lines and cables
- Circuit-breakers
- Transformers and reactors

We have included an additional chart with all of the elements included. Note that as the annual average expenditure in non-lead assets is almost unchanged between the two periods, we have not explored this area.

As described throughout this document, the intervention needs in each price control period are determined by the condition issues and risk of the assets at that particular time. Therefore the contents of the RIIO-T1 and RIIO-T2 business plans are significantly different. This is described in section 2.5. We have presented the analysis as requested, however due to the differences in content of the two work programmes the meaningful conclusions that can be drawn from the requested analysis are limited.

Overhead Lines and Cables

We explain the differences in the composition of overhead line and cable schemes between RIIO-T1 and RIIO-T2 in section 2.5. These can be summarised as:

- The necessary rebuild of end of life 132kV overhead lines (please refer to engineering justification papers for the need case and optioneering).
- The increased complexity of 275kV and 400kV twin and quad conductor minor refurbishments compared to the RIIO-T1 need which was predominantly on single conductor 132kV systems. This is condition and risk-based, please refer to the engineering justification papers.
- The condition issues associated with fluid filled cables that require intervention to avoid electrical faults, environmental impacts and earthing-related safety issues.
- The increased complexity of quad conductor and L9 tower works associated with 400kV overhead line major refurbishments that were not required in RIIO-T1.
- The intervention needs of the Forth river crossing towers.
- The regulatory reclassification of tower painting as a capital activity.
- More efficient provision of overhead line civil works.
- A 2.5% efficiency stretch.

Circuit-Breakers

The following is a summary of the cost drivers for circuit-breakers in RIIO-T2:

- The increasing focus on minimising SF_6 leakage.
- Significant deterioration of hydraulic and pneumatic mechanisms of early SF_6 circuit-breakers, with no economical refurbishment options, has arisen recently and was not a feature of RIIO-T1. Please refer to the engineering justification papers.
- The CBA for Windyhill 275kV substation demonstrates that the most economical solution is a GIS substation due to reduced constraint costs during the construction when compared with AIS options. This is a higher capex solution but the forecast net saving to consumers is between £5.6m.
- There is an increase in costs to extend a 400kV GIS substation. There was no equivalent activity in RIIO-T1.
- The circuit-breaker schemes in RIIO-T2 require activities such as transformer movements and overhead line diversions that were not required in similar schemes in RIIO-T1.
- We will be rolling out our Digital Substations initiative as a business-as-usual transition from the RIIO-T1 NIC project FITNESS, resulting in baseline Totex reductions.
- We have also identified efficiencies during the design process and have set an additional stretch target of 2.5%.

Transformers and Reactors

- The delivery of the replacements of the two Giffnock transformers is timed to commission one transformer at the end of RIIO-T2, followed by the commissioning of the second at the beginning of RIIO-T3. This means that almost all of the expenditure is incurred in RIIO-T2 but with no associated volume or risk benefit output until RIIO-T3.
- The programme in RIIO-T1 did not include replacement of Supergrid autotransformers and the RIIO-T2 plan includes the replacement of Neilston SGT1.
- The programme in RIIO-T1 did not include replacement of 400kV shunt reactors and the RIIO-T2 plan includes the replacement of two units.
- We have implemented a programme of refurbishments which has resulted in reduced costs, please refer to section 2.5.4.
- We have also identified efficiencies during the design process and have set an additional stretch target of 2.5%.

Lead Assets' Total

The chart below combines the movements for all asset classes.

2.9.5 Efficiency & Innovation

As described in the business plan, we have incorporated the efficiency benefits achieved through RIIO-T1 in our costs for RIIO-T2. These efficiencies can be broadly categorised as:

- Delivery model: the disaggregated model rather than an Engineer, Procure, Construct (EPC) or turnkey approach has allowed us to avoid cumulative overhead costs through subcontracts by the principal contractor. We have also developed the supply chain to incorporate a larger number of smaller contracting companies with lower overheads which also increases competitive pressure on costs. For example, we achieved savings towards the end of the MSC(DN) programme by disaggregating the elements of the package that had previously been awarded on an EPC basis.
- Procurement: we operate main plant frameworks and free-issue materials to our installation contractors. This results in lower costs for the main items. We also undertake global Iberdrola group bulk purchasing of high value items such as transformers. While prices are volatile due to macro-economic factors such as metal prices and Brexit, this results in lower costs than would otherwise be the case.
- Design: we have introduced efficiencies such as new specifications for GIS switchgear to take advantage of technology advances in this area. By undertaking the detailed design in-house, as opposed to it being the responsibility of the contractor, there has been a direct focus on optimising designs to reduce costs wherever possible.

In RIIO-T2, we have built-in these efficiencies and set an additional stretch target of 2.5% which is included in our baseline Totex, as outlined in the business plan.

As outlined in the business plan, we will roll out solutions developed through RIIO-T1 innovation mechanisms where these reduce our baseline Totex or have benefits to other parties such as the ESO and users of the network. We describe this in the Innovation section of our business plan and provide extensive detail in Annex 6, however some examples (including both load and non-load applications) are:

- Business as usual implementation of HTLS conductor on load-related schemes, allowing increased capacity on existing overhead line routes, avoiding the costs of re-building. This flows from our successful RIIO-T1 IRM project.
- New techniques for overhead line accesses, resulting in lower baseline Totex
- Optimal harmonic filter design, based on the outcome of an SPT NIA project.
- Business as usual implementation of Digital Substations, based on the SPT FITNESS NIC project.
- Re-use of concrete structures using knowledge gained during an SPT NIA project.

The cumulative Totex reduction from the implementation of proven innovations is forecast to be £30m.

We will deliver further benefits to our connecting customers through quicker connections (from HTLS conductor projects) and to the ESO from enhanced circuit ratings and roll out of technology developed in our Phoenix and Visor NIC projects.

The innovation benefits also accrue in areas such as the following which do not reduce our Totex:

- Safety: we will reduce the number of tower climbing operations by increasing our use of drones.
- Environmental: our strategy of using alternatives where viable will avoid the addition of 9,721kg of SF_6 to our inventory.
- The roll-out of solutions from our SIARA NIA project will enable a new generation of wide-area protection applications to meet the demands of the achievement of net zero, for example enhanced Low Frequency Demand Disconnection.

We present a cost-benefit analysis with our innovation strategy, supporting the funding proposal for innovation in RIIO-T2. We describe in each relevant engineering justification paper which innovation initiatives have been considered and implemented in the designs.

2.9.6 Consumer Value

We have demonstrated that our unit costs for comparable activities have not increased materially from current forecasts of final costs for the RIIO-T1 period. We have described how there are differences in work scopes in each transmission capital non-load project and that we have embedded innovation and efficiency into the costs of these. Activity levels of comparable interventions are similar to RIIO-T1 (increases in some areas and decreases in others) and we have described the certainty of the need cases and drivers for the additional investments.

Cost Benefit Analysis has been applied to all project options delivering lead asset interventions and the baseline option for the analysis has been the deferral of the investment to the next Price Control period. The outcome of the CBAs shows that there is greater consumer value in undertaking the works in RIIO-T2 than in deferral.

There are a small number of exceptions where the proposed option was not supported by a CBA:

- Some of the proposed transformer refurbishment projects had a marginally lower NPV than the replacement option (but both were greater than deferral). We have proceeded with the lower Capex solution as we believe that the value in extracting additional life from the transformers (for example by avoiding the creation of waste) and qualitative environmental benefits outweigh the marginal NPV difference.
- In some switchgear schemes, alternatives to SF_6 perform less well in the CBA. We have set out our strategy to avoid the use of this potent greenhouse gas where viable and the current values of the cost of carbon (as defined in the template issued by Ofgem) may change to reflect societal priorities on climate change.
- Our proposals for substation energy use reduction do not have a positive NPV. We have proposed these measures in the business plan in line with our Environmental Action Plan to reduce these controllable losses.

The detailed CBAs for each scheme have been provided and the results are summarised in each engineering justification paper.

2.10 Network Asset Risk Metric

2.10.1 Intervention Cost and Risk Benefit Relationship

The methodology was ‘not rejected’ by Ofgem on 8th August 2018 and the monetised risk framework is being used for investment planning for the first time in RIIO-2. There is significant complexity in the newly developed system consequence element of the asset models, and it is envisaged that there will be continued development in this area.

The longer-term risk benefit (LTRB) calculation was introduced by Ofgem in March 2019 and has not yet been subject to robust testing. This calculation measures the reduction in the risk value for each asset intervention against a notional counterfactual of no intervention for the lifetime of the intervention. The LTRB is, as directed by Ofgem and agreed by us, used in the CBA as a societal benefit and the sum of the LTRBs of interventions undertaken in RIIO-T2 is Ofgem’s proposal for the network risk target.

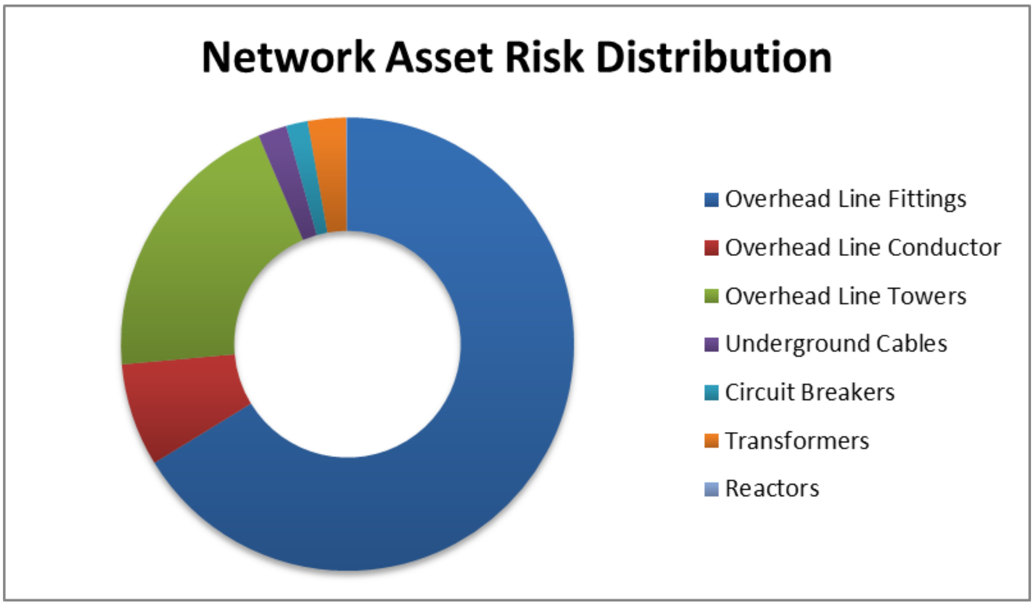
The NARM methodology is currently defined (for SPT) for seven lead asset categories:

- Circuit-breakers
- Transformers
- Reactors
- Underground cables
- Overhead line towers
- Overhead line conductors
- Overhead line fittings

Currently, none of the electrical or civil non-lead assets are part of the methodology but work is planned during RIIO-T2 to extend the methodology. We have developed monetised risk models for disconnectors, earthing switches, CTs and VTs. We propose to set a monetised risk target for the works in our business plan that are associated with these non-lead assets.

Network Asset Risk Distribution

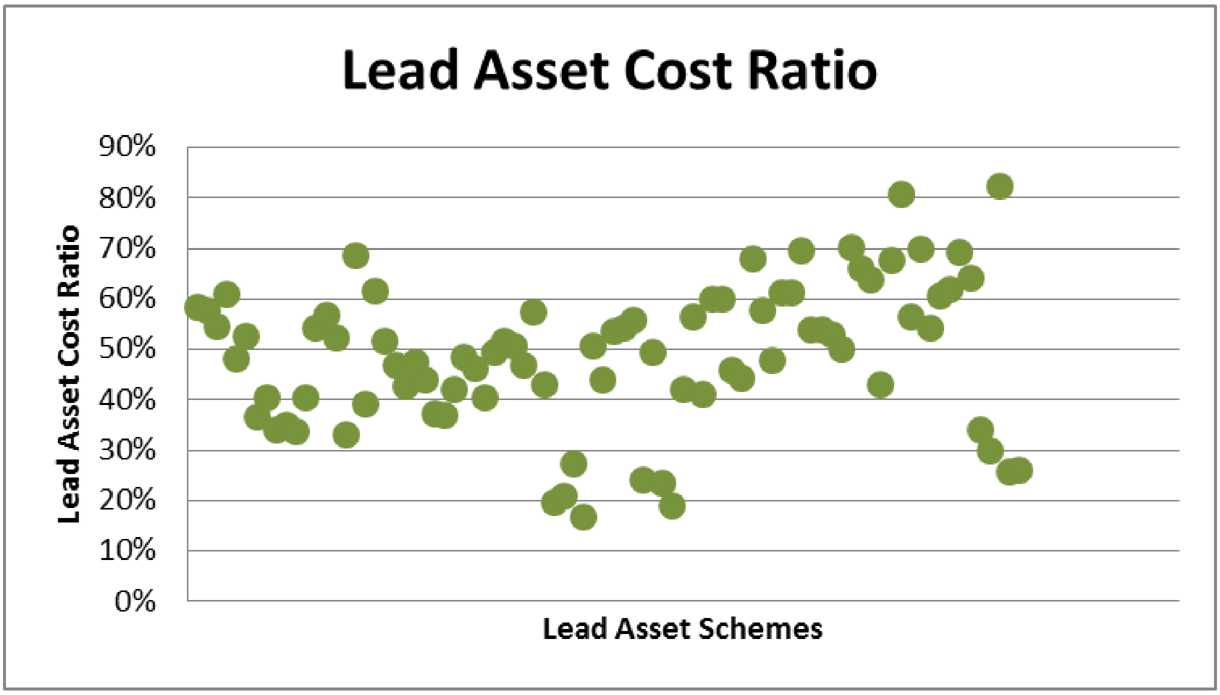
The breakdown of risk in each asset category is shown in the chart below:



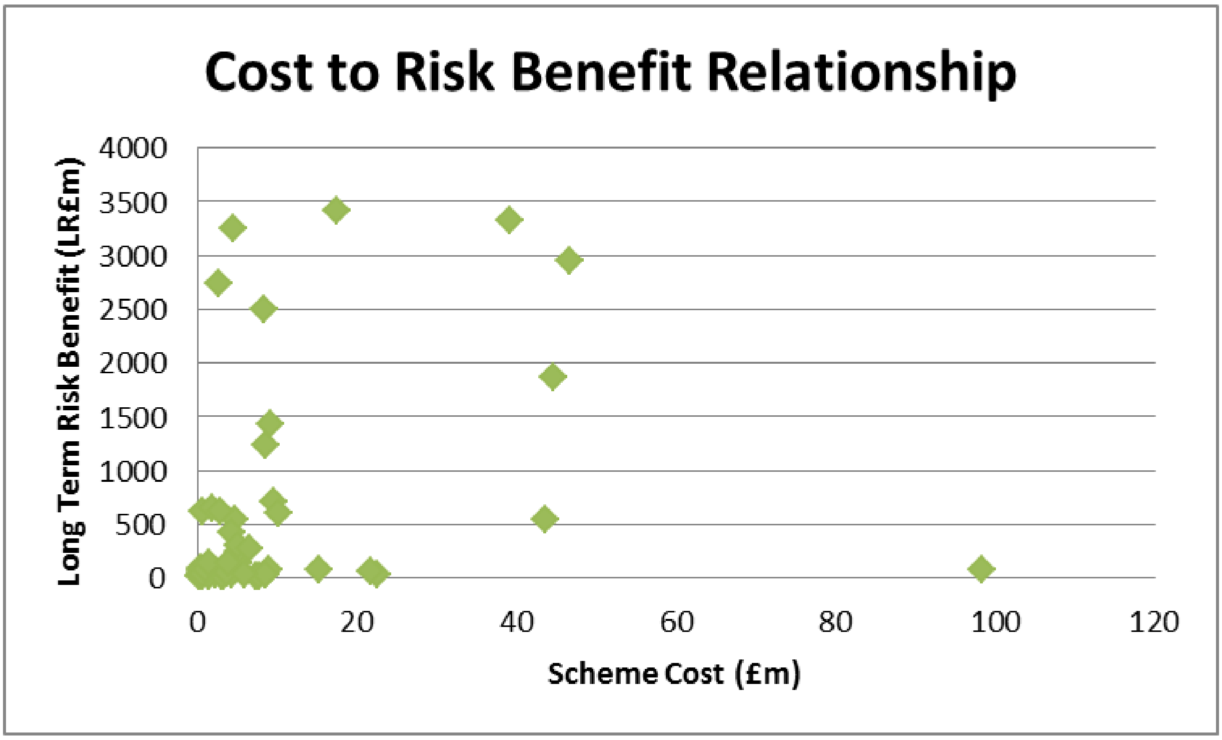
It is important to note that the magnitudes of the variances of the risk values between asset categories leads to significant differences in the monetised risk benefits of interventions.

Intervention Costs Related to Risk Benefit

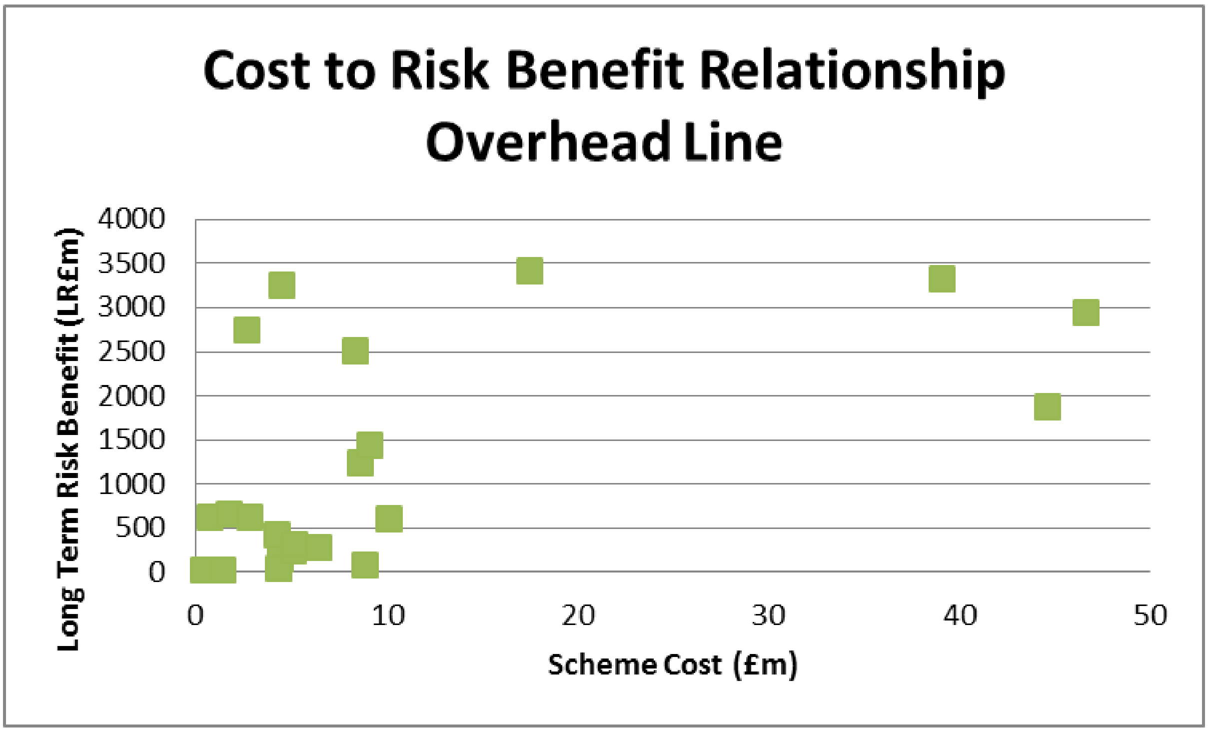
The costs of interventions in lead assets include expenditure in non-lead electrical and civil assets, and indirect activities. Our analysis shows that the expenditure in lead assets in relation to the total project cost can be as low as 17%, as high as 80% and for the portfolio of work, the average is 49%. This is illustrated in the chart below. As we explain throughout this document, the scope of work of each scheme is bespoke and there is a range of cost drivers which influence the individual costs. It is also notable that the consequences of asset failures in the models are dominated by the system consequence element rather than the financial cost to repair or replace the failed asset. While the risk composition varies for each individual asset, at an aggregated network level 98% of the network risk is system risk and financial risk is 0.91% of the total. This further weakens the linkage between intervention cost and risk benefit.

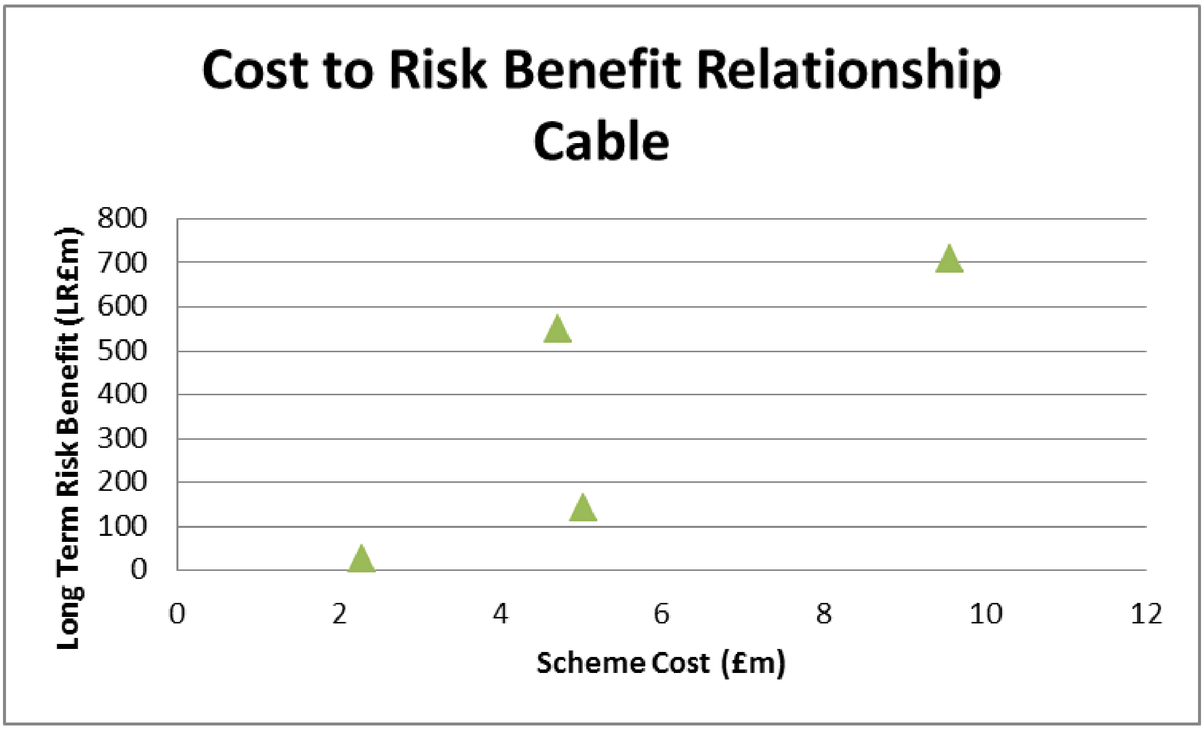


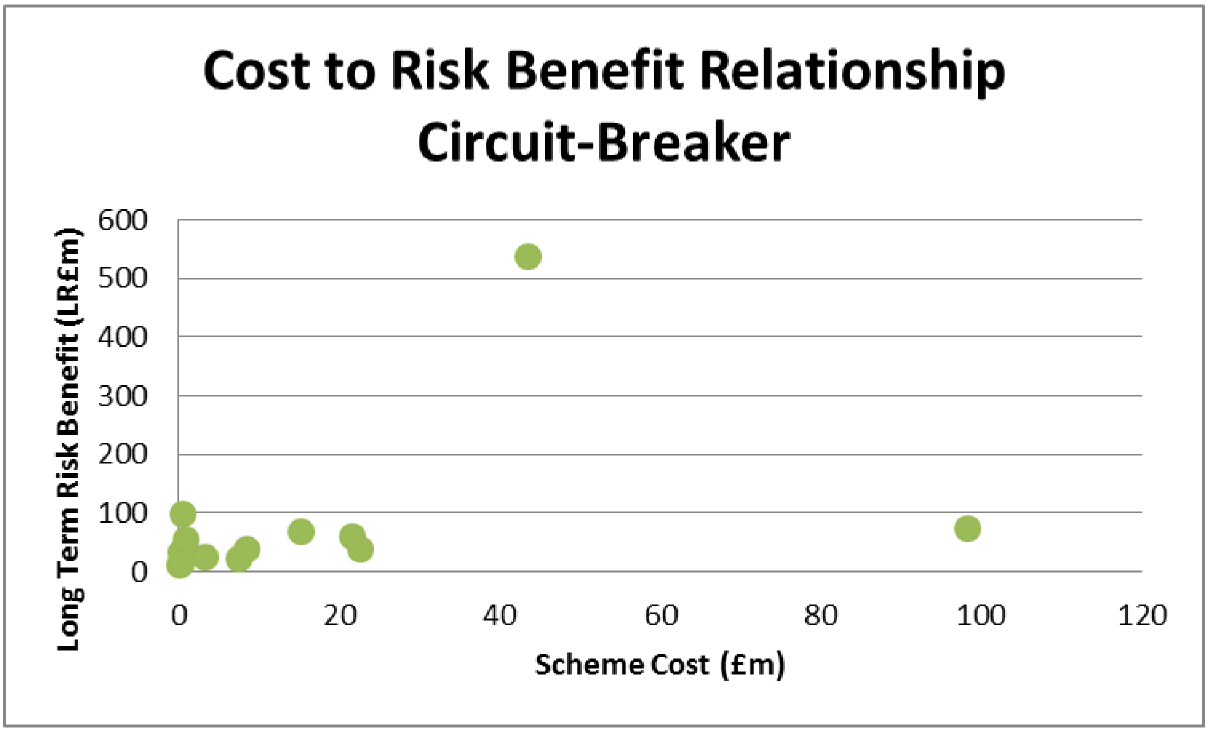
The chart below illustrates that there is no reliable relationship between the intervention cost and the risk benefit, either at a network or asset category level.

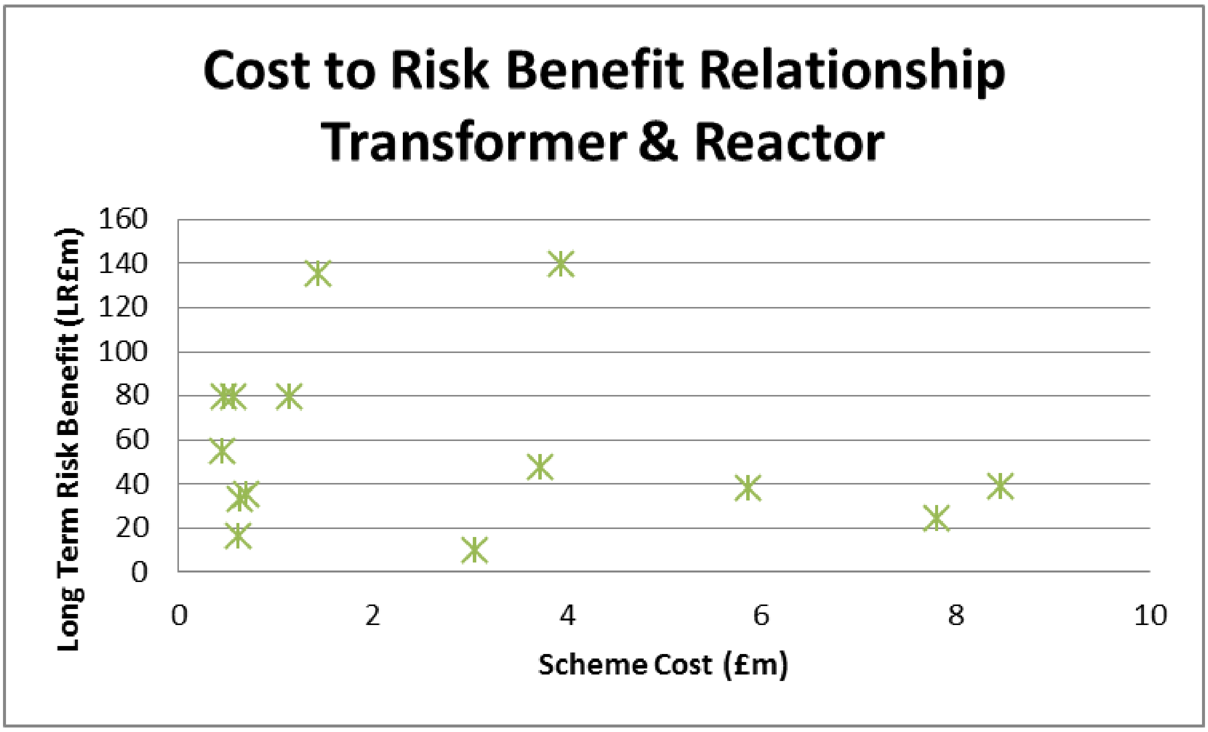


The following charts are for the individual asset categories to provide clarity.




Cost to Risk Benefit Relationship
Cable
Long Term Risk Benefit (LR£m)
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
Scheme Cost (£m)


Cost to Risk Benefit Relationship
Circuit-Breaker
Long Term Risk Benefit (LR£m)
600
500
400
300
200
100
0
0
20
40
60
80
100
120
Scheme Cost (£m)



2.10.2 Intervention Justification & Target Setting

The variability of scheme costs which directly result in monetised risk benefit and the significant differences in risk values between asset categories combine to prevent simplistic approaches to the planning and assessment of investments with respect to monetised risk. This is reflected in the approach set out in section 2.7 and annex 3.

There are two principal issues with attempting a simplistic prioritisation based on cost to risk benefit ratio.

- The wide range of risk benefit per pound spent results in some asset categories being preferred over others. It is therefore not a robust method for identification of interventions at a network level. The following two schemes are from our business plan. A simplistic cost to risk benefit ratio would lead to schemes such as Devol Moor not being prioritised when there is a strong need case supported by robust evidence.

Scheme	Investment Cost (£m)	Lead Asset Cost Ratio	Longer Term Risk Benefit (LR£m)	Cost to Risk Ratio (£/LR£m)
Devol Moor 132kV Switchgear Replacement	8.47	20%	38.32	0.221
ZD & ZC(S) Overhead Line Minor Refurbishment	8.38	58%	2,505.70	0.00335

- Within an asset category, the intervention cost is influenced by the situation, environment, and solution. For example, assets located in city centres, in nuclear or COMAH sites require works and activities which can have higher costs that are not in proportion to the monetised risk value. The interdependence of the lead and non-lead assets also influences the overall investment costs as does the opportunity to build on-line or off-line. Planning investments on a cost to risk benefit ratio basis will result in some assets not being prioritised due to the non-lead asset and other costs 'penalising' them. It is therefore not a robust method for the identification of interventions within asset categories. Please see the examples below from our business plan.

Scheme	Investment Cost (£m)	Lead Asset Cost Ratio	Longer Term Risk Benefit (LR£m)	Cost to Risk Ratio (£/LR£m)
Windyhill 275kV Switchgear Replacement	43.64	51%	535.35	0.0814
Westfield 275kV Switchgear Replacement[1]	17.41	22%	38.99	0.579

The factors described therefore demand a more sophisticated approach to the identification of interventions to be included in the business plan than is provided by the simplistic cost to benefit ratio. We describe this approach in section 2.7 and Annex 3.

[1] Note that in the final business plan submission Westfield is proposed as an uncertain project due to its interaction with a NOA reinforcement. The costs in this table relate to construction at 275kV.

3.0 DIRECT OPEX

The RIIO-T2 definitions of direct Opex costs have changed significantly from RIIO-T1. We have presented the RIIO-T2 direct opex costs in the RIIO-T1 format, expressed as a 5-year equivalent for direct comparison, please see the table below. There follows a commentary on the differences between RIIO-T1 and RIIO-T2.

Direct Opex Total Costs by cost category	RIIO T2 Total	RIIO-T1 5 Year	RIIO-T2 Increase	Commentary
Fault Repairs			2.73	
Transformers and reactors			(0.11)	Process Enhancements
Switchgear			0.34	Asset Deterioration
SVC's and MSC's			0.25	New Technology
Protection & control			0.04	De Minimus Variances
LVAC			0.20	Network Growth
Site Care			0.66	Asset Deterioration
Tower painting			-	
Towers and Foundations			0.05	De Minimus Variances
Conductors, Insulators, Fittings etc.			0.02	De Minimus Variances
Gas (Cable)			-	
Oil (Cable)			1.29	Process Enhancements
XLPE (Cable)			-	
Planned Inspections & Maintenance			(10.17)	
Transformers and reactors			0.46	Network Growth
Switchgear			1.82	Process Enhancements
SVC's and MSC's			1.09	New Technology
Protection & control			1.63	New Technology
LVAC			0.34	Network Growth
Site Care			(2.07)	Process Enhancements
Security Costs			(2.15)	Recategorisation of Security Costs
Circuit Breaker refurbishment			-	
Decommissioning (Substations)			(0.82)	One off cost
Tower painting			(10.77)	Recategorisation as Capex
Towers & Foundations, Conductors, Fittings etc.			2.44	Process Enhancements
Decommissioning (OHL)			(5.13)	One off cost
Gas (Cable)			-	
Oil (Cable)			3.01	Process Enhancements
XLPE (Cable)			-	
Vegetation Management			0.19	Network Growth
Operational Property Management			-	
CNI			4.12	Legislative Compliance
Security Costs (Armed Guards etc.)			2.15	Recategorisation of Security Costs
Allowed Innovation Costs (incl. IFI)			-	
BT 21 C Teleprotection			6.15	Network Growth
Offshore Transmission Project			12.27	New Technology
Total (Excluding RPM Adjustment)			17.43	
Annual Average			3.49	

The review of operations and maintenance activities has taken into account the expansion of the network in RIIO-T1 and the introduction of new technologies with additional maintenance requirements and anticipated fault and defect patterns. We have also extended our review to the forecast network position during RIIO-T2 to determine the necessary activities. New legislative requirements have been introduced in the intervening period and our plan reflects compliance with these. The final area is related to deterioration of assets resulting in higher operational costs until interventions take place.

3.1 Network Growth

The expansion of the network to connect renewable generation and reinforce the system has increased the length and number of overhead line routes. Additionally, we have increased operating voltages and temperatures on a number of routes. All of these changes require increased management of vegetation and our RIIO-T2 plan reflects both historical network growth and forecast growth in RIIO-T2.

In order to ensure that our substations are resilient to loss of auxiliary supplies, in RIIO-T1 we have installed and renewed diesel generators such that all substations will have the required supply resilience by the end of the period. There is a need to maintain these generators and the costs to do so are now captured in this area. We have also forecast increased costs for faults and defects occurring in the much larger population.

As described in the main business plan and Engineering Justification Papers SPNLT2052, SPLNLT2055 and SPNLT2056 we have identified the need to enhance our operational telecomms network. This project recognises the increasingly critical role telecomms plays in the protection, control and monitoring of the transmission system. To deliver the quality of service necessary to maintain transmission network availability, to enable new applications such as Active Network Management and wide area control, and to enable the most effective cyber security provisions, the telecomms asset base is proposed to grow significantly. The costs associated with the real-time management of the telecomms system and responding to equipment failures are greater by virtue of both the increased sophistication of the delivery of services in a more resilient way and the greater asset population. Note that the naming of these costs as BT21C Teleprotection in RIIO-T1 and Protection Communication Circuits in RIIO-T2 are not accurate descriptions and we have provided feedback to Ofgem on this point.

3.2 New Technology

Over the course of RIIO-T1 a number of new technologies have been installed on the network and these have additional maintenance requirements and more complex defect management procedures:

- Western Link HVDC Converter Station. The HVDC converter station has specialised maintenance requirements for the power electronics, harmonic filters, cooling and air conditioning systems. The schemes are complex and subject to high levels of thermal and electrical stress resulting in frequent defect management activities. This is normal and expected for HVDC converters. The primary electricity supply for the ancillary systems is sourced from the local distribution network and the costs associated with this are included in the network operations costs.
- Western Link DC Cable. Regular subsea inspections and seabed remediation are required to verify and secure the integrity of the installation.
- Hunterston Converter Station STATCOM. The static compensator is the first of its kind for GB Transmission Owners and is integrated in the Western Link scheme. The maintenance and defect management activities are similar to the HVDC Converter Station.
- Series and Shunt Compensation. This type of plant has a large number of power capacitors with an expected failure rate that is rectified either during maintenance or as a fault defect. This equipment is maintained every two years; series compensation maintenance requirements are extensive due to the nature of the capacitors and other components that comprise the installation.

3.3 Legislative Compliance

The introduction of the Network and Information Systems (NIS) regulations places additional requirements on network operators. Additional operational costs are incurred in relation to managing additional infrastructure, monitoring activity and performance, and responding to potential incidents. In the first two years of RIIO-T2 we have included a testing regime for Polychlorinated Biphenyl contamination of insulating oils. This will ensure compliance with the Persistent Organic Pollutants regulation.

3.4 Process Enhancements

Process enhancements comprise both improved effectiveness and efficiency of execution of like-for like activities which result in cost reductions and additional activities that add value which result in cost increases.

The widespread availability of drone technology has opened up opportunities for improved overhead line asset information with potential safety enhancements. The RIIO-T2 plan employs drones to replace climbing inspections, with the benefits of avoiding people having to work at height. We also plan to use them for detailed condition assessments of the overhead line network. Drones allow for greater flexibility and can photograph areas of the line that are difficult to reach with helicopter surveys. However, the costs of drones are currently higher than for climbing and helicopter works.

We will enhance our monitoring of overhead lines with aerial ground clearance surveys and will survey our network every five years to provide detailed information on the asset base. This will detect age-related sagging of conductors, which may affect statutory clearances and any issues with verticality of towers. We will integrate the survey data with our overhead line design software to provide a full digital model of our network.

The conventional approach to overhead line tower painting was time-based with the intervals set for the average effective life of the paint system. For RIIO-T2, the enhancement of our condition assessments will provide the information we need to change this approach to focus on the condition of the painted surfaces. We have forecast a reduction in the level of routine tower painting as a result which is reflected in reduced costs for this activity in the business plan.

We have updated our inspection and condition assessment practices to ensure that the data required by the NARM methodology is captured. This leads to increased levels of activity across the asset base.

The review of switchgear maintenance has led to a reduction in frequency of maintenance of spring-mechanism SF_6 circuit-breakers as service experience had produced sufficient confidence for this relatively new technology, resulting in a saving for each circuit-breaker of this type. This is offset to a degree by network growth, however, increasing the number of circuit-breakers. As noted in Annex 3, we plan to increase our maintenance activity in other types of switchgear where service experience is highlighting operational issues that could be avoided.

The cable maintenance policy has been reviewed and we have made some changes to our practices for fluid-filled cables. These reflect the point in their lives of the cable population. The significant failure rate of 132kV XLPE terminations has led to the introduction of routine partial discharge monitoring activities. Both of these activities have increased the costs associated with cable inspections. The increase in inspection and testing is likely to lead to the identification of a greater number of defects and we have forecast costs that will be incurred to rectify these.

The investments in RIIO-T1, and those planned for RIIO-T2, have reduced our forecast of fault costs for transformers. The targeted investment programme will manage condition issues that have led to fault defect repairs.

The effect of enhancing our processes is to improve our understanding of our assets' condition, improving our ability to optimise the timing of interventions and to more accurately define the scope of the works. We will also detect defects and emerging issues even earlier to prevent them becoming more significant. Ultimately, the improved information and earlier interventions will lead to reduced costs in future capital programmes.

3.5 Asset Deterioration

Our business plan will manage the condition and risk issues most likely to affect network availability and reliability. However, assets where interventions are planned in RIIO-T2 will remain on the network for a period pending the completion of the works. We have forecast additional costs to keep these assets operational until the intervention is complete. We have also made provision for the deterioration of assets which are included in our initial view of interventions in RIIO-T3.

3.6 RIIO-T1 One-Off Costs

These costs relate to the decommissioning of Inverkip 400kV substation and sections of associated overhead lines. This relates to network re-configuration following the termination of the power station's connection agreement.

3.7 Cost Recategorisation

In RIIO-T1, costs for overhead line tower painting were classified as opex but in RIIO-T2 these are treated as capex, causing a reduction in operating costs. The associated increase in capital costs is seen in section 3.9.4.

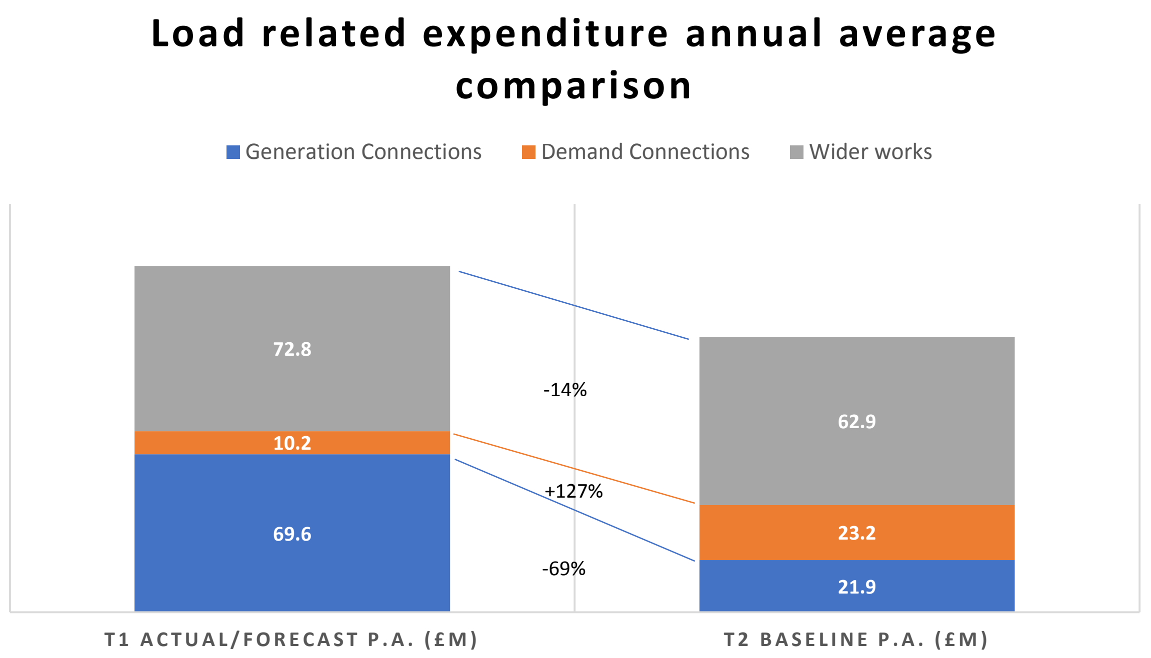
4.0 LOAD RELATED EXPENDITURE

The section provides further information in relation to our Load related expenditure to address the questions received from the Challenge Group. In this section we have provided:

- A comparison of our RIIO-T2 plans with RIIO-T1
- Key drivers of change to costs and volumes between price review periods
- An overview of cost drivers
- A comparison against the different scenarios we have used in planning for RIIO-T2
- A reconciliation of the ENA Common Scenario with our business plan (October 2019 draft)

4.1 Introduction

Load related expenditure can be split into three main categories – generation connections, demand connections and wider works which includes boundary upgrades as well as other reinforcements. A comparison of the annualised average cost categories for RIIO-T1 and RIIO-T2 is shown below.



Our RIIO-T2 plan has been built on projects which have a high certainty to justify the expenditure as being required on an ex-ante basis. For other activity which is less certain, a suite of uncertainty mechanisms is proposed that will allow revenues to be adjusted accordingly. We deem this to be a justified approach as it reduces the risk to consumers and the company as it ensures that uncertain revenues are not being recovered in the baseline which will then need to be adjusted in future years. Uncertainty mechanisms also allow for adjustment for changes that cannot be anticipated at the time when the plan is set.

All RIIO-T2 projects have been designed at a detailed scoping level, considering all material factors and constraints of the assets, the environment and the operation of the network. This means that there are few projects that are immediately comparable with those from RIIO-T1. Our benchmarking work with Arcadis has highlighted the fact that a simple top-down comparison does not provide reliable information. These costs have been based on the same sources as non-load plans.

For those projects included in baseline, a more comprehensive level of detail has been applied to the projects. Engineering Justification papers will be provided for all the material baseline projects as per Ofgem's guidance for the final submission of the business plan in December. For projects which fall into the uncertainty mechanisms, these have been developed to a level that provides confidence in the costs but recognises the uncertainties associated with them, particularly where those projects are for the latter part of RIIO-T2 as it is expected that the transmission network will change by then, affecting the proposed solution.

4.2 Generation Connections

Generation connection projects are comprised of two elements: the connection assets for the customer and the infrastructure which supports this. The infrastructure element is then split into sole use infrastructure and shared use infrastructure.

The funding for customer connections is provided by the customer requesting the works rather than a socialised cost. This element is excluded from the analysis and is reported as an excluded service and sits separate to the price review process.

Sole use infrastructure assets are defined in the Connection Use of System Code (CUSC Section 14) as “those assets solely required to connect an individual User to the National Electricity Transmission System, which are not and would not normally be used by any other connected party”.

Shared use infrastructure assets are the Transmission infrastructure works associated with the connection of more than one new or additional generating station to a part of the licensee’s Transmission System (or connected to a distribution system which in turn connects to a part of the licensee’s Transmission System).

The historic run rate for costs and volumes has been provided below as a high-level comparator. Each connection is unique, and we do not believe that the cost per unit of capacity is a valuable indicator due to the factors that influence the costs. We have provided this data to comply with the information requested.

4.2.1 Sole Use Infrastructure

The current position for the RIIO-T1 period as per RRP 2018/19 is summarised in the table below.

Transmission Connections	2014	2015	2016	2017	2018	2019
No of connections	2	0	1	6	7	2
Annual (MW)	400	0	69	403	489	139
Cumulative (MW)	400	400	469	872	1361	1500
No of connection offers	52	88	116	63	60	104

All 18 new connections are onshore wind farms which have a total capacity of 1500MW. A further 259MW of onshore wind generation is forecast to connect in the remainder of RIIO-T1, taking the T1 total installed capacity to 1620MW in the T1 period. The average annual capacity for the first five years was 272MW per annum and is forecast to be 202.5MW over the full RIIO-T1 period.

In RIIO-T2 period, our baseline plan is to connect 900MW over the full RIIO-T2 period, and annual average of 180MW which is slightly lower than the RIIO-T1 average. As this is only our high confidence projects, we expect the out turn may be substantially higher.

4.2.2 Sole Use Infrastructure – Volumes

All 18 new connections to date are onshore wind farms which have a total capacity of 1500MW. A further 259MW of onshore wind generation is forecast to connect in the remainder of RIIO-T1, taking the T1 total installed capacity to 1620MW in the T1 period. The average annual capacity for the first five years was 272MW per annum and is forecast to be 202.5MW over the full RIIO-T1 period.

In RIIO-T2 period, our baseline plan is to connect 900MW over the full RIIO-T2 period, and annual average of 180MW which is slightly lower than the RIIO-T1 average. As this is only our high confidence projects, we expect the out turn may be substantially higher.

4.2.3 Sole Use Infrastructure - Costs

The cost of connections in the RIIO-T1 period comprises of several elements:

- Project completion costs from TPCR4 for which the generation was energised and the volume recorded in the final year of the previous price review (late 2012/early 2013)

- Costs associated with generation which is connected in the period
- Costs associated with developing projects which will be completed in the subsequent price review, RIIO-T2.

The total cost of sole use infrastructure in the first five years totalled £153m, of which £77.9m related to the first two categories shown above (completion of projects which commenced in TPCR4 and projects which were completed in this period). From reviewing this expenditure, this subset is comparable with the baseline expenditure in our RIIO-T2 business plan. For example, our plan does not currently include any expenditure associated with developing projects which will be delivered in RIIO-T3, this will require to be treated separately through the generation connections uncertainty mechanism.

On a like for like, per MW basis, our RIIO-T2 plan is £44k/MW compared to £57k/MW for the first five years of RIIO-T1.

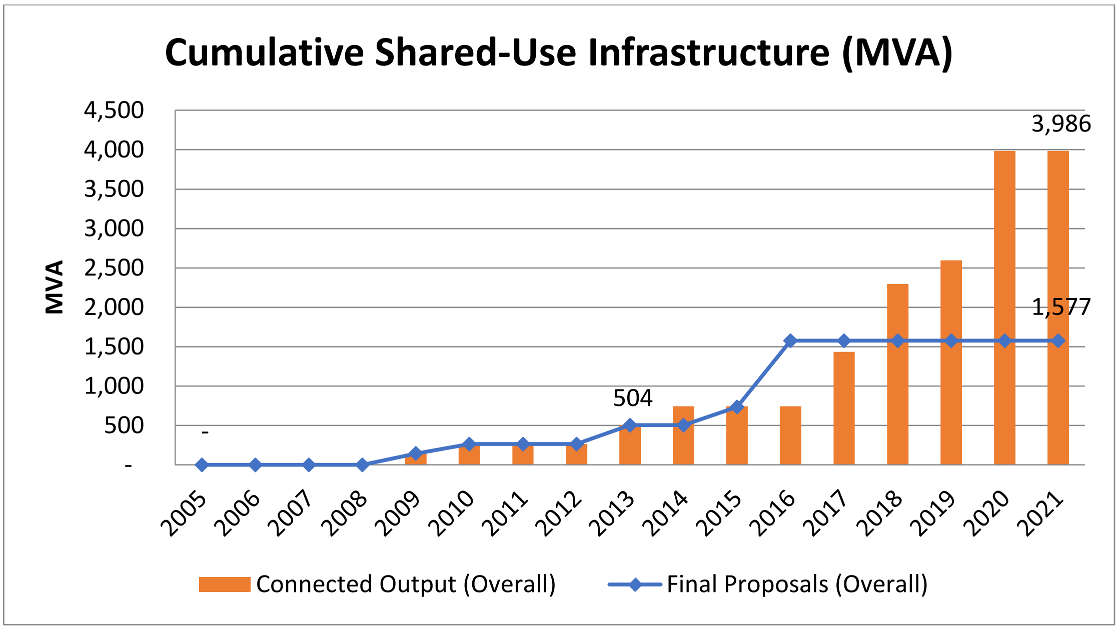
The mix of assets that make up these costs will vary between projects as the costs will be a function of the length of overhead line or cable to connect the customer to the network and the works required at the SPT substation. Not all these components are driven on the MW capacity of a new connection. The distance of a new generator from the SPT main interconnected transmission system will drive the SPT costs that are incurred and has a lesser dependency on the capacity. The modifications required at a substation to accommodate its connection is also dependant on a range of factors such as the available capacity and substation design and the scope of work can vary from site to site.

From analysing projects across both periods, outputs have remained largely consistent however costs have decreased. This can be attributed to a number of factors ranging from different circuit lengths due to an increase in collector substations reducing the length of connections, the application of innovation such as HTLS conductor which allows for higher capacity circuits as well as efficiencies throughout the process. The establishment of new shared infrastructure nodes on the network such as in South West Scotland has also helped reduce the cost and time of connections.

The RIIO-T2 cost forecast has been built on a consistent basis with all other projects. An analysis of these costs is included in section 2.93 which compares the RIIO-T1 and T2 average unit costs on a like for like basis of the main network components. Load related expenditure has some differences such as the construction of new assets on greenfield sites as well as the use of a range of technology that has had limited deployment in RIIO-T1 such as high temperature low-sag conductor.

4.2.4 Shared use infrastructure - Outputs

The shared use infrastructure which has been delivered in RIIO-T1 is substantially higher than was planned. This is due to connection projects being further from existing infrastructure and larger volumes of generators, including embedded generators, being in similar areas such as South West Scotland which led to major infrastructure upgrades of assets that are shared by multiple generators.



In RIIO-T1 we have completed 1793MVA of shared use infrastructure in the first five years of RIIO-T1 and are forecasting to complete 3,482MVA by the end of the period, an annual average of 435MVA. This is substantially higher than the RIIO-T1 plan which was for 1,073MVA, an average of 134MVA per annum.

In RIIO-T2 our baseline plan is for 2,027MVA of shared use capacity, 405MVA per annum. This is lower than the RIIO-T1 average. There are various reasons for this change, including the high large capacity that has been created in RIIO-T1 as part of works across Dumfries and Galloway as well as South West Scotland. These upgrades are triggered by sole use connection projects which are included in our baseline plan.

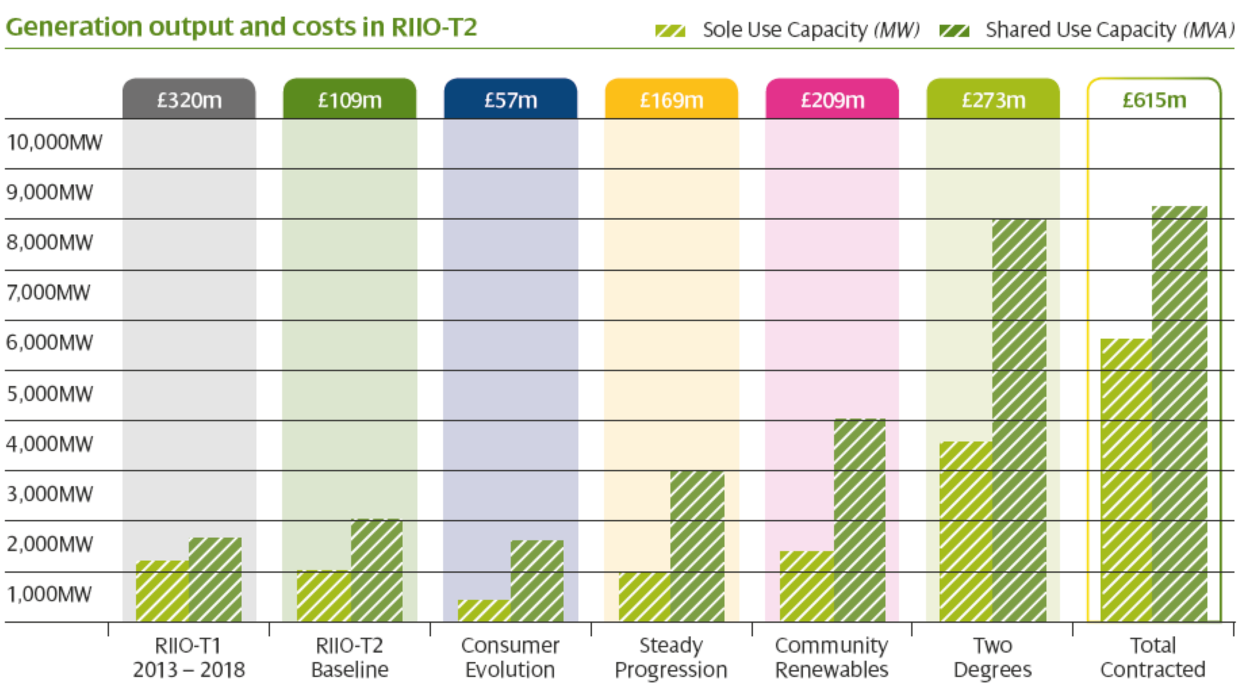
4.2.5 Share use infrastructure – Costs

With a similar approach to sole use connections, shared use infrastructure costs comprise of a range of different assets which are used to create the capacity. This can include the creation of a new substation, building new overhead lines, or the deployment of smarter controls to manage the generation in real time, all of which have very different unit costs for the capacity that they provide.

We have analysed the costs incurred in the first five years of RIIO-T1 and the costs for shared use infrastructure totals £332m, of which £242.7m relates to the delivery of projects that commenced in TPCR4 and completed in RIIO-T1, as well as projects which were completed in that period. This gives an average cost of £135k/MVA of capacity. Several of these projects involved the establishment of green field substations which have a high cost due to the need for land purchase and supporting infrastructure such as access roads.

On a like for like basis in RIIO-T2, this cost is £69m, or £14m per annum. This gives a unit rate of £34k/MVA of capacity created. This considerably lower rate than that seen in RIIO-T1 is due to greater use of innovative alternatives such as our Generation Export Management schemes, and the high costs and output schemes completed in RIIO-T1.

We have replicated this analysis for each of the future energy scenarios contained in our business plan as well as our total contracted generation portfolio. For each of these scenarios there is a different combination of generation (distribution/transmission connected) which has a different bearing on the sole and shared use costs.



4.2.6 Competition for connection works

As identified in the business plan, our baseline plan comprises of 25 projects, 12 sole use and 13 shared use which range in value from £360k up to £25m. None of these projects meet the competition criteria for either late or early competition models.

4.3 Demand Connections

Demand connections are similar in nature to generation connections except they are driven by customers who are regarded as demand rather than generation customers. The way in which the charging methodology splits costs between sole and shared use mirrors generation connections. However, there are several key differences. SP Distribution is the main demand customer for SP Transmission. A large number of demand connections are modifications to existing points of connection (Grid Supply Points) to address emerging issued as a result of increasing volumes of renewable generation connecting to the distribution network. Additionally, new points of connection for SP Distribution and Network Rail are generally closer to existing infrastructure or have the flexibility to be located in the vicinity to minimise costs.

In RIIO-T1, demand connections were very low as few demand connection applications were received. Embedded generation which connected used the existing headroom on the network which did not require upgrades as this was offsetting local demand. With substantially higher levels materialising, this has led to a number of Grid supply points (the interface between transmission and distribution) exceeding the design parameters. Two new connections and two new Grid Supply Points will also be required within the T2 period. In RIIO-T1 the total annual expenditure is forecast to be £81.6m (£10.2m p.a.), compared to £116.2m in RIIO-T2 (£23.2m p.a.).

As discussed above, a greater amount of work is required in T2 compared to T1 for demand connections due to issues arising at Grid Supply Points. Furthermore, two demand connections and two new Grid Supply Points will be required in T2 increasing costs relative to T1. All these projects are triggered by a contractual request from the connecting party.

The costs for these projects have been developed in a consistent way, similar to other parts of the plan. The increase in the number of projects in RIIO-T2 is based on applications from SP Distribution and Network Rail therefore run-rate is not reflective of the levels of activity that are required.

4.4 Wider Works

Reinforcement of the network to ensure compliance with the various standards and codes that apply to transmission owners is classed as wider works. This activity is not attributable to individual customers and is associated with ensuring the network has sufficient capacity to allow power flows across Great Britain and providing a compliant and operable system for the ESO.

In RIIO-T1, total expenditure on wider works is forecast to be £582.4m. This includes the following projects:

Project	***RIIO-T1 expenditure***	***Output***	***Comparability to RIIO-T2***
MSCDN installations	£8.6m	4x MSCDN installations	No comparable project in T2
East West upgrade	£81.5m	Network re-configuration to increase boundary capacity by 1100MW	Overall project not comparable on a run rate basis
Western Link HVDC	£363.1m	HVDC cable to increase B6 capacity by 2.2GW	No comparability – eastern link is excluded from baseline plan
Series capacitors	£64.6m	Series capacitance at four sites	No comparable projects in T2
Hunterston-Kintyre subsea link	£31.9m	SPT works for accommodate a new interconnector with SHETL	Overall project not comparable on a run rate basis. SPT had limited scope to connect to cable.
Voltage control – shunt reactors	£15.1m	7 60MVAr shunt reactors	A comparable programme of shunt reactors is planned in RIIO-T2
Other works	£17.3m	Preparation for RIIO-T2	No

Wider Works projects are generally major projects to increase the capacity across Great Britain. They generally have a high capital cost, may extend beyond the scope of only one TO and have other unique elements. Therefore, they are generally bespoke, and it can be difficult to consider a like for like comparison of project costs.

Only the shunt reactors programme in RIIO-T1 is continued in RIIO-T2 to address voltage issues on the network. In RIIO-T2 we are proposing to install 515MVArs of reactors and compensation to address voltage non-compliance following the closure in generation and demand profiles. Some of this capacity will be provided through STATCOMs to provide a more flexible voltage response that the network requires. This is an application of a technology that SPT have not used in RIIO-T1.

4.5 Sensitivity analysis – reconciliation to ENA Common scenario

As detailed above, for generation connections and demand connections, these are driven by customer contracts and therefore a comparison with historic volumes is not an effective comparator for looking forward. Wider works comprises of a small number of high value projects which does not allow for a like for like comparison.

As requested by the Challenge Group, we have compared our baseline plans with the ENA Common RIIO-2 scenario. Our plans align with the ENA Common scenario or are lower than the low range for all the building blocks for electricity transmission, as per the Business Plan Guidance. Our plan is designed with the flexibility to adapt to different outcomes using the uncertainty mechanisms.

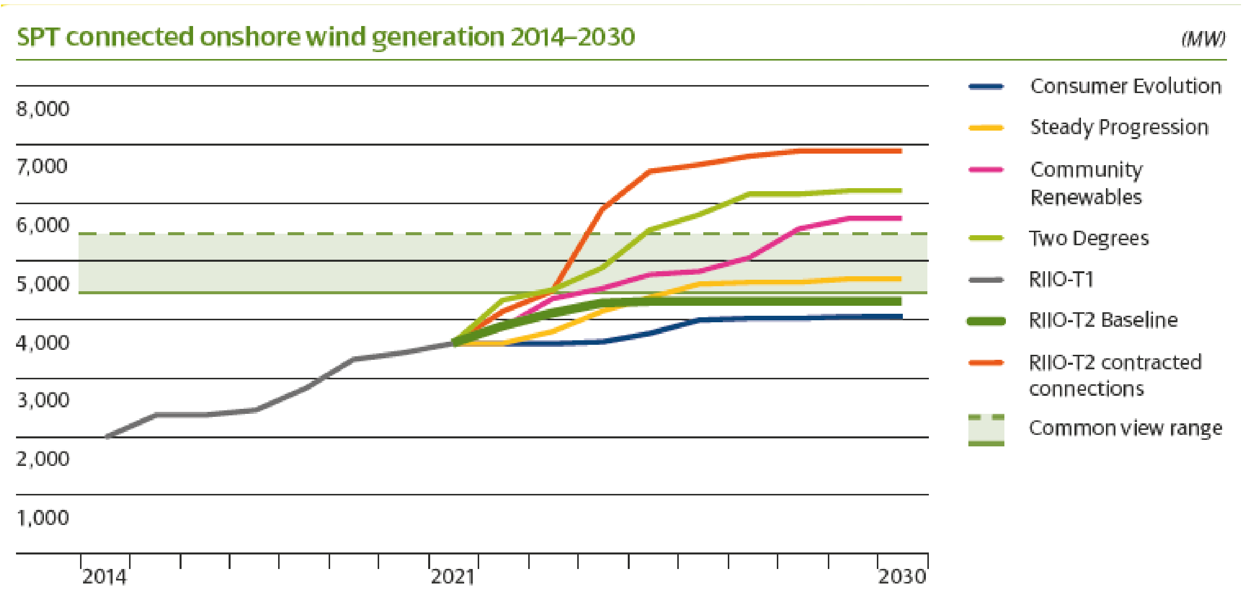
For the sensitivity analysis we have considered each of these items in turn and the relative alignment with the ENA lower case assumption.

Key Drivers	SPT 2017 starting point	SPT 2026 levels from our baseline plan	Common view of 2030 range for SPT *Low*	*High*	Notes
Offshore wind – *Transmission connected*	0.0GW	0.45GW	1.0GW	2.5GW	Additional generation is still uncertain and is funded through uncertainty mechanisms.
Onshore wind – *Transmission connected*	2.9GW	4.4GW	4.6GW	5.5GW	High probability projects in RIIO-T2. Includes 600MW of generation to connect by the end of RIIO-T1.
Nuclear	2.2GW	1.2GW	0.0GW	0.0GW	Alignment with Common view. Torness nuclear power station is expected to close in 2030.
Distribution Generation	1.6GW	2.1GW	2.4GW	2.9GW	Reflects updated ENA common scenario.
Other generation – *Transmission connected*	0.3GW	0.3GW	0.1GW	0.2GW	Differences due to assumptions around existing site closures, differences have low impact.
Interconnectors	0.5GW	0.5GW	0.5GW	1.0GW	Moyle interconnector only.
Storage – *Transmission connected*	0.44GW	0.44GW	0.5GW	0.8GW	Additional storage will be funded through uncertainty mechanism.
Electric Vehicles	5,157	Up to 158,000	680,000	720,000	Significant uptake expected in period from 2026-2030 as government targets get closer.
Alternative heat	5,252 dwellings	Up to 67,000 dwellings	80,000 dwellings	164,00 dwellings	Low materiality to transmission.
Peak demand	3.3GW	3.4-3.5GW	4.1GW	4.2GW	Range of scenarios considered as high and low demands have different impacts on the network.

Onshore wind generation - The ENA Common RIIO2 Scenario report identified between 4.6GW and 5.5GW of onshore wind by 2030 for SPT. In RIIO-T2 we have a high confidence that 900MW of additional onshore generation will connect to the transmission network. By the end of RIIO-T1 we expect to have 3.5GW of generation connected, and with the addition of the 900 MW this will increase the total connected to at least 4.4GW by 2026 which is below the lower end of the ENA common scenario of 4.6GW by 200MW. We expect further generation will connect, but the volumes, types of projects and locations are far less certain. We believe that this is probable based on discussions with generation developers and the ongoing interest we are seeing in on-shore projects being developed on a subsidy free basis. Stakeholders have also highlighted the likelihood of repowering existing windfarms as they approach end of life. From speaking to existing customers and examining the relevant sites, we expect very few of these projects in RIIO-T2.

We have no onshore wind generation currently contracted to connect beyond the RIIO-T2 period and therefore our view is that the current baseline plan provides a view that is consistent with the Common scenario.

We will be reviewing the generation portfolio prior to the final submission of our business plan in December to take account of other projects which have emerged since this analysis which was completed in May 2019 to reflect the most up to date position.



Offshore wind generation - We have 2.1GW contracted for connection in RIIO-T2, plus 450MW in construction which we expect to be energised for the end of RIIO-T1. At present this additional 2.1GW of generation is not included in our baseline projection due these projects not having a contract for difference award. The ENA report has forecasted 1–2.5GW to be connected by the end of 2030, which is consistent with our planning assumptions. These projects were not successful in the 2019 CfD but the feedback we have had is that these projects continue to be contracted and the sites are reviewing their options.

Nuclear generation – Two nuclear power stations are connected to the SPT network, Hunterston (1GW) and Torness (1.2GW). Hunterston has an estimated closure date of 2023 while Torness is estimated to close in 2030. This is consistent with the common scenario which has a value of 0GW for nuclear generation in 2030. The ESO Future Energy Scenarios considers the possibility of these closing earlier due to recent shutdowns at Hunterston however we are taking the view of these being operational until the current stated closure date.

Distributed Generation – The allocation of distributed generation connections per DNO licence area have been updated since the initial ENA report was published. There had been an error in the allocation of the different embedded generation technologies by DNO. This has been reviewed and corrected by the ENA working group which has changed the levels of distributed generation and is now consistent with SPT's view. By the end of RIIO-T1, we forecast to have 1.8-1.9GW of generation connected to the distribution network in our area, of which 1.3GW is wind and the remainder comprising of solar and various other sources.

Approximately 300MW of additional distributed generation is contracted to connect to the distribution system, requiring upgrades to the transmission network to allow it to connect and export. This will take the overall levels of generation up to 2.1GW by the end of RIIO-T2. This is consistent with the ENA Common scenario which estimates 2.4-2.9GW by 2030.

This includes wind, solar, gas generation and storage. From engagement with stakeholders, we expect this to rise further as new projects develop in RIIO-T2. One of the main differences in distributed generation from transmission connected generation is that it can be deployed much faster, for example rooftop solar PV requires no prior notification to the network operator.

Other generation (Transmission connected) – at present SPT has 325MW of smaller scale generation connected to the transmission network including biomass, gas and waste generation. We are not aware of the closure of any of these plants in RIIO-T2 but estimate that there may be closures as a result of greater carbon reduction targets which would lead to the common scenario being achieved. These projects have a low materiality and would not result in additional costs as a result of their closure. Any new generation that did materialise would be funded through the generation connection uncertainty mechanism.

Interconnectors – At present the Moyle interconnector is the only link connecting SPT to Ireland. We have had other interest in establishing further links to various parts of Europe, but we have no contracts to support this. The Moyle interconnector provides 500MW of capacity which we expect to continue throughout RIIO-T2 and beyond.

Storage (Transmission connected) – The main storage resource connected to SPT is Cruachan pumped storage. This provides capacity of 440MW and we do not currently expect any change to this in the near term. Further pumped storage capacity is contracted to connect to the SPT network towards the end of the RIIO-T2 period. This project is not included in our baseline plan due to a number of uncertainties. We also have a number of applications for energy storage to connect to the transmission network which are not included in our baseline plan.

Our baseline plan does not include any storage projects in RIIO-T2. The common scenario assumes 0.5-0.8GW of storage by 2030 which we believe is credible based on the variety of projects which are being developed at present and may connect later in RIIO-T2 or early T3. These would be funded through the generation/demand connection uncertainty mechanism.

Electric Vehicles – We estimate that up to 158,000 electric vehicles could be operational in central and southern Scotland by 2026. This is based on the Scottish Government target for no new petrol or diesel cars to be sold by 2032. We expect by 2026 the growth of electric vehicles will be rapid as the cost of ownership becomes less than petrol or diesel equivalents which is based on analysis by several sources. Central and Southern Scotland currently has a vehicle parc of approximately 3million. Our view aligns with the growth projections that are broadly consistent with a 2030 projection of up to 610,000 by 2030.

Alternative heat – The Common scenario estimates between 80,000-164,000 dwellings to be heated by an electric heat pump by 2030. The SPT plan assumes up to 67,000 installations by 2026 as a result of the government decision to end the installation of fossil fuel heating systems in new houses by 2025. Many of these properties are likely to be heated by electricity after this time. The number of installations will increase electricity demand, but this has a very low materiality overall on the transmission network and does not trigger any expenditure in our business plan. Stakeholders have highlighted that this is an area of high uncertainty.

Peak demand – Peak demand is currently around 3.3GW and we expect some further reductions in this in the short term due to ongoing energy efficiency. Our future energy scenarios consider a range of potential pathways, some of which reduce demand further and others which lead to a slight growth as a result of electrification of transport and heat. Different scenarios have different implications on the network. Our plan assumes a lower increase to demand than the common view by 2030 which has a range of 4.1-4.2GW, our projection is a peak demand in 2026 of 3.4-3.5GW.

The above factors influence both generation and demand expenditure. Wider works expenditure has been tested against all four future energy scenarios and are justified in all the above scenarios, although the optimal timing of projects may vary between scenarios.

5.0 APPENDIX 1: ASSET PRIORITISATION

This appendix presents listings of assets for the major lead asset categories whose condition and risk is the primary drover of investment. These listings show the assets whose condition (as defined by the NARM/NOMs methodology's EoL parameter and verified by engineering review) is such that intervention is to be considered in the RIIO-T2 period. The listings identify which of the assets are included in the baseline plan and provides relevant commentary. The assets are ordered from highest monetised risk value to lowest.

Please note that reactors and overhead line towers/poles have not been presented in this way:

— There are only two reactors in the baseline plan for intervention and they are the two highest risk units and are in the poorest condition.

— Interventions in the baseline plan where towers/poles are the primary driver are limited to the Glenlee – Tongland 132kV (R and S routes) and the Devol Moor – Erskine (G route) 132kV projects both of which were initiated in RIIO-T1. Overhead line tower refurbishment works are undertaken in co-ordination with major and minor refurbishments which are driven by conductor and fittings condition respectively.

Please note that the risk and EoL values are subject to ongoing review via data updates and may change in the final business plan.

5.1 Circuit-Breakers

Substation Name	Asset Description	Intervention Period	EoL	Risk	Commentary
WINDYHILL 275kV	WIYH275ACBW100	RIIO-T2	10.04	£ 11,636,530.75	
MOSSMORRAN 275kV	MOSM275GCBS10		9.40	£ 3,698,288.23	Historical SF6 leakage has driven the EoL due to the model using a 5-year window. This will reduce as the effect of the repair is seen in the model, requiring no further intervention.
MEADOWHEAD 132kV	MEAD132GCB120	RIIO-T2	12.14	£ 3,166,695.60	
GLENROTHES 275/33kV	GLRO275OCBS10	RIIO-T2	10.67	£ 1,164,262.14	
STRATHAVEN 400kV	STHA400GCBX405	RIIO-T2	11.97	£ 712,951.98	
HUNTERSTON 400kV	HUER400ACBX505	RIIO-T2	10.93	£ 491,824.30	
HUNTERSTON 132kV	HUER132ACB125	RIIO-T2	11.60	£ 412,051.46	
HUNTERSTON 400kV	HUER400ACBX305	RIIO-T2	10.93	£ 408,054.43	
TORNESS 400/132kV	TORN400GCBX120	RIIO-T2	11.70	£ 404,649.45	
TORNESS 400/132kV	TORN400GCBX520	RIIO-T2	11.70	£ 404,649.45	
TORNESS 400/132kV	TORN400GCBX620	RIIO-T2	11.70	£ 404,649.45	
TORNESS 132kV	TORN132GCB780	RIIO-T2	11.46	£ 376,082.47	
TORNESS 132kV	TORN132GCB330	RIIO-T2	11.46	£ 376,082.47	
TORNESS 132kV	TORN132GCB220	RIIO-T2	11.46	£ 376,082.47	
KILWINNING 132/33kV	KILW132GCB405	RIIO-T2	11.97	£ 369,617.38	
HUNTERSTON 132kV	HUER132ACB630	RIIO-T2	11.60	£ 367,806.32	
HUNTERSTON 132kV	HUER132ACB775	RIIO-T2	11.60	£ 343,275.69	
STRATHAVEN 400kV	STHA400GCBX705	RIIO-T2	9.72	£ 317,205.29	
HUNTERSTON 132kV	HUER132ACB855	RIIO-T2	11.60	£ 306,061.75	
WESTFIELD 132/33kV	WFIE132OCB530	RIIO-T3	10.31	£ 304,252.72	Deferred in preference to Devol Moor due to non-lead asset condition
STRATHAVEN 400kV	STHA400GCBX500	RIIO-T2	9.72	£ 300,414.24	
STRATHAVEN 275/33kV	STHA275GCBL25	RIIO-T2	9.72	£ 298,576.92	
STRATHAVEN 275/33kV	STHA275GCBL55	RIIO-T2	9.72	£ 298,576.92	
DEVOL MOOR 132/33kV	DEVM132OCB580	RIIO-T2	10.83	£ 295,672.38	
DEVOL MOOR 132/33kV	DEVM132OCB480	RIIO-T2	10.73	£ 288,979.54	
WESTFIELD 132/33kV	WFIE132OCB120	RIIO-T3	10.31	£ 271,091.81	Deferred in preference to Devol Moor due to non-lead asset condition
SMEATON 275kV	SMEA275GCBS40		9.24	£ 260,762.12	Historical SF6 leakage has driven the EoL due to the model using a 5-year window. This will reduce as the effect of the repair is seen in the model, requiring no further intervention.
LONGANNET 275kV	LOAN275ACBF35	RIIO-T2	10.54	£ 255,070.36	
LONGANNET 275kV	LOAN275ACBW30	RIIO-T2	10.54	£ 255,070.36	

TORNESS 132kV	TORN132GCB515	RIIO-T2	11.46	£	250,309.44	
TORNESS 132kV	TORN132GCB415	RIIO-T2	11.46	£	250,309.44	
WINDYHILL 275kV	WIYH275ACBL55	RIIO-T2	10.04	£	242,476.04	
DEVOL MOOR 132/33kV	DEVM132OCB210	RIIO-T2	10.73	£	232,864.62	
DEVOL MOOR 132/33kV	DEVM132OCB310	RIIO-T2	10.67	£	228,753.42	
NEWARTHILL 275/33kV	NEAR275GCBS10	RIIO-T2	9.40	£	213,824.10	
TORNESS 400/132kV	TORN400GCBX220	RIIO-T2	9.24	£	213,031.46	
HUNTERSTON 132kV	HUER132ACB585	RIIO-T2	11.69	£	196,720.44	
HUNTERSTON 132kV	HUER132ACB485	RIIO-T2	11.69	£	196,720.44	
MOSSMORRAN 132/33kV	MOSM132GCB380	RIIO-T2	11.46	£	180,765.51	
WESTFIELD 275kV	WFIE275OCBF55	RIIO-T2	10.54	£	176,870.76	
WESTFIELD 275kV	WFIE275OCBH50	RIIO-T2	10.60	£	168,705.53	
WESTFIELD 275kV	WFIE275OCBH20	RIIO-T2	10.54	£	165,979.30	
WESTFIELD 132/33kV	WFIE132OCB355	RIIO-T3	10.31	£	148,985.30	Deferred in preference to Devol Moor due to non-lead asset condition
MOSSMORRAN 132/33kV	MOSM132GCB405	RIIO-T2	11.46	£	147,993.76	
LONGANNET 275kV	LOAN275ACBW40	RIIO-T2	10.54	£	145,615.52	
LONGANNET 275kV	LOAN275ACBF45	RIIO-T2	10.44	£	142,004.77	
WESTFIELD 132/33kV	WFIE132OCB480	RIIO-T3	10.36	£	141,207.68	Deferred in preference to Devol Moor due to non-lead asset condition
MEADOWHEAD 132kV	MEAD132GCB205	RIIO-T2	12.14	£	139,650.36	
MEADOWHEAD 132kV	MEAD132GCB105	RIIO-T2	12.14	£	139,650.36	
WESTFIELD 132/33kV	WFIE132OCB580	RIIO-T3	10.31	£	139,275.16	Deferred in preference to Devol Moor due to non-lead asset condition
WESTFIELD 275kV	WFIE275OCBF85	RIIO-T2	10.60	£	136,454.98	
WESTFIELD 275kV	WFIE275OCBW40	RIIO-T2	10.60	£	136,454.98	
LONGANNET 275kV	LOAN275ACBW20	RIIO-T2	10.64	£	131,374.58	
KILWINNING 132/33kV	KILW132GCB305	RIIO-T2	11.97	£	129,748.42	
LONGANNET 275kV	LOAN275ACBF25	RIIO-T2	10.54	£	128,140.83	
WINDYHILL 275kV	WIYH275ACBH90	RIIO-T2	10.65	£	126,457.30	
WESTFIELD 275kV	WFIE275OCBF65	RIIO-T2	10.60	£	116,115.89	
WESTFIELD 275kV	WFIE275OCBF35	RIIO-T2	10.60	£	116,115.89	
WINDYHILL 275kV	WIYH275ACBH40	RIIO-T2	10.26	£	114,584.32	
WINDYHILL 275kV	WIYH275ACBH115	RIIO-T2	10.21	£	110,738.32	
WINDYHILL 275kV	WIYH275ACBH145	RIIO-T2	10.21	£	110,738.32	
MOSSMORRAN 132/33kV	MOSM132GCB515	RIIO-T2	11.46	£	105,942.03	
MOSSMORRAN 132/33kV	MOSM132GCB415	RIIO-T2	11.46	£	105,942.03	
WESTFIELD 132/33kV	WFIE132OCB255	RIIO-T3	10.31	£	102,751.78	Deferred in preference to Devol Moor due to non-lead asset condition
LONGANNET 275kV	LOAN275ACBF85	RIIO-T2	10.69	£	101,765.49	
LONGANNET 275kV	LOAN275ACBW80	RIIO-T2	10.69	£	101,765.49	
WESTFIELD 132/33kV	WFIE132OCB610	RIIO-T3	10.31	£	92,664.13	Deferred in preference to Devol Moor due to non-lead asset condition

WESTFIELD 132/33kV	WFIE132OCB710	RIIO-T3	10.26	£	91,445.07	Deferred in preference to Devol Moor due to non-lead asset condition
WINDYHILL 275kV	WIYH275ACBL125	RIIO-T2	10.07	£	86,561.53	
HUNTERSTON 132kV	HUER132ACB955	RIIO-T2	11.60	£	85,967.30	
HUNTERSTON 132kV	HUER132ACB120	RIIO-T2	11.60	£	85,967.30	
WINDYHILL 275kV	WIYH275ACBL60	RIIO-T2	10.04	£	85,725.08	
MOSSMORRAN 132/33kV	MOSM132GCB310	RIIO-T2	11.46	£	82,674.02	
MOSSMORRAN 132/33kV	MOSM132GCB210	RIIO-T2	11.46	£	82,674.02	
LONGANNET 275kV	LOAN275ACBF65	RIIO-T2	10.44	£	80,832.33	
LONGANNET 275kV	LOAN275ACBW70	RIIO-T2	10.69	£	79,471.74	
LONGANNET 275kV	LOAN275ACBL40	RIIO-T2	10.54	£	76,440.24	
LONGANNET 275kV	LOAN275ACBW60	RIIO-T2	10.54	£	76,440.24	
LONGANNET 275kV	LOAN275ACBF75	RIIO-T2	10.50	£	75,585.06	
STRATHAVEN 275/33kV	STHA275GCBL75	RIIO-T2	9.72	£	74,791.37	
LONGANNET 275kV	LOAN275ACBL60	RIIO-T2	10.44	£	74,544.80	
GALASHIELS 132/33kV	GALA132OCB320	RIIO-T3	9.89	£	72,340.88	Deferred in preference to Devol Moor due to non-lead asset condition
GALASHIELS 132/33kV	GALA132OCB420	RIIO-T3	9.89	£	72,340.88	Deferred in preference to Devol Moor due to non-lead asset condition
GALASHIELS 132/33kV	GALA132OCB220	RIIO-T3	9.70	£	68,791.74	Deferred in preference to Devol Moor due to non-lead asset condition
GALASHIELS 132/33kV	GALA132OCB620	RIIO-T3	9.68	£	68,200.65	Deferred in preference to Devol Moor due to non-lead asset condition
LONGANNET 275kV	LOAN275ACBM80	RIIO-T2	10.69	£	56,653.91	
LONGANNET 275kV	LOAN275ACBM70	RIIO-T2	10.60	£	55,256.34	
LONGANNET 275kV	LOAN275ACBM20	RIIO-T2	10.54	£	54,492.82	
LONGANNET 275kV	LOAN275ACBM30	RIIO-T2	10.54	£	54,492.82	
TORNESS 400/132kV	TORN400GCBX320	RIIO-T2	11.70	£	53,537.08	
TORNESS 400/132kV	TORN400GCBX820	RIIO-T2	11.70	£	53,537.08	
ECCLES 400/132kV	ECCL400GCBX805		9.40	£	51,094.37	Historical SF6 leakage has driven the EoL due to the model using a 5-year window. Included in scheme SPNLT20140 for intervention should there be recurrence of leakage..
WINDYHILL 275kV	WIYH275ACBL35	RIIO-T2	10.17	£	49,862.28	
WINDYHILL 275kV	WIYH275ACBL25	RIIO-T2	10.17	£	49,862.28	
HUNTERSTON 400kV	HUER400ACBX420	RIIO-T2	10.93	£	49,828.83	
GALASHIELS 132/33kV	GALA132OCB120	RIIO-T3	10.26	£	48,976.58	
HUNTERSTON 400kV	HUER400ACBX105	RIIO-T2	10.93	£	42,384.60	
HUNTERSTON 400kV	HUER400ACBX705	RIIO-T2	10.93	£	42,384.60	
HUNTERSTON 400kV	HUER400ACBX220	RIIO-T2	10.93	£	42,384.60	
HUNTERSTON 400kV	HUER400ACBX620	RIIO-T2	10.93	£	42,384.60	
TORNESS 132kV	TORN132GCB230	RIIO-T2	11.46	£	34,408.42	
TORNESS 400/132kV	TORN400GCBX420	RIIO-T2	9.33	£	28,938.68	

TORNESS 400/132kV	TORN400GCBX720	RIIO-T2	9.24	£	28,185.09	
HUNTERSTON 132kV	HUER132ACB590	RIIO-T2	10.04	£	23,884.32	
HUNTERSTON 132kV	HUER132ACB290	RIIO-T2	10.04	£	23,884.32	
HUNTERSTON 132kV	HUER132ACB890	RIIO-T2	10.04	£	23,884.32	
HUNTERSTON 132kV	HUER132ACB710	RIIO-T2	10.00	£	23,632.67	
HUNTERSTON 132kV	HUER132ACB390	RIIO-T2	10.00	£	23,632.67	
HUNTERSTON 132kV	HUER132ACB490	RIIO-T2	10.00	£	23,632.67	
HUNTERSTON 132kV	HUER132ACB610	RIIO-T2	10.00	£	23,632.67	
HUNTERSTON 132kV	HUER132ACB990	RIIO-T2	9.96	£	23,392.16	

5.2 Transformers

Transformer Asset ID	Substation Name	Asset Description	Intervention Period	EoL	Risk	Comment
14220749	SALTCOATS 25KV RailwaySub	SACO025TRXT2C	RIIO-T2	11.84	£ 3,527,986.04	
14178450	SHRUBHILL 275/33kV	SHRU275TRXSGT1	RIIO-T2	10.31	£ 3,048,727.43	
14171384	MARSHALL MEADOWS 132kV	MARM132TRXT1	RIIO-T2	12.50	£ 2,625,365.08	Load-related disposal in RIIO-T2
14164772	GRANGEMOUTH 275/33kV	GRMO275TRXSGT1	RIIO-T2	10.40	£ 2,435,907.73	
14236965	TORNESS 400/132kV	TORN400TRXSGT1	RIIO-T2	9.34	£ 2,086,264.14	
14238049	TORNESS 400/132kV	TORN400TRXSGT2	RIIO-T2	9.34	£ 2,086,264.14	
14198931	CARNTYNE SUBSTATION 132/33kV	CATY132TRXT1B	RIIO-T2	10.12	£ 1,455,681.40	
14198951	CARNTYNE SUBSTATION 132/33kV	CATY132TRXT2B	RIIO-T2	10.12	£ 1,455,681.40	
14152065	DEVOL MOOR 132/33kV	DEVM132TRXT2A	RIIO-T2	9.82	£ 1,434,111.85	
14159758	INVERKEITHING 132/33kV	INKE132TRXT2	RIIO-T2	10.42	£ 1,366,704.42	
14256107	NEILSTON 275kV	NEIL275TRXSGT1	RIIO-T2	10.04	£ 989,296.97	
14242737	WINDYHILL 275kV	WIYH275TRXSGT3	RIIO-T2	10.23	£ 986,710.42	
14156329	PARTICK 132/33kV	PART132TRXT1	RIIO-T2	10.00	£ 873,510.01	
14157670	PARTICK 132/33kV	PART132TRXT2	RIIO-T3	10.00	£ 873,510.01	Refurbishment in early RIIO-T3 to co-ordinate with site rationalisation project
14134865	GIFFNOCK 275/33kV	GIFF275TRXSGT2	RIIO-T3	10.12	£ 809,730.73	Delivered in early RIIO-T3
14134889	GIFFNOCK 275/33kV	GIFF275TRXSGT1	RIIO-T2	10.12	£ 809,730.73	
14237902	CLYDESMILL 275/33kV	CLYM275TRXSGT2		9.21	£ 680,531.17	
14184872	WISHAW 275/33kV	WISH275TRXSGT7		8.64	£ 641,907.18	
14374775	GORGIE 132/33kV	GORG132TRXT1		9.47	£ 616,714.16	
14184020	WISHAW 275/33kV	WISH275TRXSGT6		8.64	£ 576,530.71	
14256947	EAST KILBRIDE 275/33kV	EKIL275TRXSGT2		8.97	£ 560,130.25	
14163414	KENDOON 132/11kV	KEOO132TRXT2	RIIO-T2	10.89	£ 487,074.44	Intervention is necessary due to very poor condition
14168285	CUMBERNAULD 132/33kV	CUMB132TRXT2		8.73	£ 407,317.33	
14161607	GLENLUCE 132/33kV	GLLU132TRXT2		9.17	£ 351,178.24	
14146578	PAISLEY 132/33kV	PAIS132TRXT2		8.86	£ 319,870.63	

5.3 Conductors

Overhead Line Route	Intervention Period	EoL	Risk	Comment
SP-XJ	RIIO-T2	9.72	£ 40,073,220.70	Included in uncertainty due to load related interaction - intervention planned
SP-ZS	RIIO-T2	9.40	£ 35,903,548.38	
SP-ZT	RIIO-T2	9.34	£ 26,165,154.04	
SP-ZP	RIIO-T2	9.40	£ 17,599,676.53	
SP-ZO	RIIO-T2	10.81	£ 10,755,217.98	
SP-BL	RIIO-T2	10.21	£ 10,680,968.47	
SP-ZA	RIIO-T2	11.99	£ 10,504,482.24	
SP-ZF	RIIO-T2	9.40	£ 7,820,413.49	
SP-XH	RIIO-T2	8.50	£ 7,617,584.30	Included in uncertainty due to load related interaction - intervention planned
SP-ZCS	RIIO-T2	8.53	£ 6,902,884.74	
SP-XX	RIIO-T3	10.56	£ 5,911,867.96	Deferred to align with Wider Works project in RIIO-T3
SP-XZ	RIIO-T2	8.86	£ 4,128,183.16	
SP-XF	RIIO-T2	10.23	£ 2,912,259.13	
SP-AY	RIIO-T2	9.96	£ 2,889,277.95	
SP-BU	RIIO-T2	8.92	£ 2,742,372.48	
SP-ZR	RIIO-T2	10.81	£ 2,286,695.62	
SP-ZE	RIIO-T2	8.77	£ 1,925,649.72	
SP-YQ	RIIO-T2	8.53	£ 1,231,540.50	
SP-AL	RIIO-T2	9.89	£ 1,202,599.60	
SP-ZCN	RIIO-T2	8.53	£ 1,197,474.70	
SP-AT	RIIO-T3	9.93	£ 708,673.42	Deferred to align with generation-triggered reinforcement in RIIO-T3
SP-BC	RIIO-T2	10.39	£ 687,315.55	
SP-AC	RIIO-T2	9.76	£ 325,034.48	
SP-BM	RIIO-T2	9.93	£ 56,436.42	

5.4 Fittings

Overhead Line Route	Intervention Period	EoL	Risk	Comment
SP-ZP	RIIO-T2	11.06	£ 589,499,665.16	
SP-ZF	RIIO-T2	13.74	£ 287,352,758.69	
SP-S	RIIO-T2	14.75	£ 267,660,608.41	
SP-ZS	RIIO-T2	8.94	£ 180,741,544.86	RIIO-T2 Spacer Replacement project SPNLT2019 (categorised as Conductor in the Transmission Glossary) will manage fittings issues on this route
SP-ZO	RIIO-T2	11.60	£ 146,532,824.14	
SP-ZCS	RIIO-T2	10.60	£ 142,028,809.86	
SP-R	RIIO-T2	14.31	£ 104,800,444.36	
SP-XF	RIIO-T2	14.45	£ 95,923,208.85	
SP-ZA	RIIO-T2	13.15	£ 92,420,857.93	
SP-ZE	RIIO-T2	11.58	£ 50,345,946.70	
SP-XD	RIIO-T2	13.38	£ 44,881,517.08	
SP-ZCN	RIIO-T2	10.60	£ 27,129,444.39	
SP-G	RIIO-T2	15.00	£ 23,780,426.76	
SP-AT	RIIO-T2	13.08	£ 7,390,900.91	Load Related Intervention
SP-U	RIIO-T2	13.38	£ 6,521,694.27	Load Related Intervention
SP-N	RIIO-T2	12.78	£ 5,707,694.79	Load Related Intervention

5.5 Cables

Circuit	Intervention	EoL	Risk
POOB-SHRU-SMEA-1	RIIO-T2	8.26	£ 14,811,755.63
POOB-SHRU-SMEA-2	RIIO-T2	8.26	£ 14,496,318.48
CURR-GORG-TELR-1	RIIO-T2	10.58	£ 11,426,181.25
CURR-GORG-TELR-2	RIIO-T2	10.58	£ 11,381,087.40
DEVM-ERSK-BRAP	RIIO-T2	8.60	£ 3,278,163.94
BRAP T1-ERSK-1	RIIO-T2	8.60	£ 2,947,686.73
GALA-HAWI	RIIO-T2	10.17	£ 1,793,870.28