Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan T2BP-EJP-0007

Transmission Substation SCADA Replacement

Engineering Justification Paper

1 Executive Summary

This Engineering Justification paper sets out the need for a supervisory control and data acquisition (SCADA) replacement program due to SHE Transmission's ongoing strategy of reducing operational risk. This driver requires that all SCADA which is at the end of its life or has become obsolete must be replaced in order to maintain operational integrity during and beyond the RIIO-T2 period.

SHE Transmission has outlined the following replacements for this approach;

- Replacement of 13 Remsdaq Remote Terminal Units (RTUs) due to space and wiring constraints.
- Replacement of C10 Schneider RTUs at 16 sites and SAS2000 RTUs at 4 sites which are at end of operational life span.
- HMI (Human Machine Interfaces) and Network replacement is required; standardising the HMI platform on the Copadata Zenon system due to cyber security risk and spares inefficiencies.
- Network switch replacements
- RTUs installation at generations sites where currently shared with customers.

More technical details on these devices is provided throughout the paper.

The cost to deliver the preferred option is £11.93m. This cost is based on previous expenditure for similar tasks and would be delivered (as an ongoing roll-out of project works throughout the T2 period (between 2021 and 2026).

Upon project delivery there are several benefits relating to the RIIO-T2 business goals which have been listed below:

- New operating systems and software with enhanced cyber security. Operational cybersecurity will reduce risk from cyber-attacks and will contribute to our goal to aim for "100% network reliability for homes and businesses", a goal outlined in the "Network for Net zero" Business plan.
- Removal of obsolete RTUs and replacement with new units which are supported and have readily available spares which allows faster response to failures.
- Enhanced connectivity options to promote further / more accurate data collection. This data collection will give SHE Transmission greater insight and control of substations.

This scheme is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

Name of Scheme/Programme	Substation SCADA Replacement
Primary Investment Driver	Resilience
Scheme reference/ mechanism or category	SHNLT2040
Output references/type	NLRT2SH2040
Cost	£11.93m
Delivery Year	2021 - 2026
Reporting Table	Reported in table C2.25_Op_Prot_Meas_&_IT_Capex
Outputs included in RIIO T1 Business Plan	No

2 Introduction

This Engineering Justification Paper sets out our plans to undertake SCADA Replacement work during the RIIO-T2 period (April 2021 to March 2026).

The Engineering Justification Paper is structured as follows:

Section 3: Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the "need".

Section 4: Optioneering

This section presents all the options considered to address the "need" that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

Section 5: Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

Section 6: Conclusion

This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

Section 7: Price Control Deliverables and Ring Fencing
This section provides a view of whether the proposed scheme should be ring-fenced or subject to other funding mechanisms.

Section 8: Outputs included in RIIO-T1 Business Plan

This section identifies if some or all the outputs were included in the RIIO-T1 Business Plan and provides explanation and justification as to why such outputs are planned to be undertaken in the RIIO-T2 period.

Section 9: References

3 Need

In order to monitor, process and act in real time to control the operation of the transmission network we use a supervisory control and data acquisition (SCADA) system. This is a package of automated hardware and software elements that gather data and issues commands. As with most computing technology, the useful life of SCADA system components is short, typically less than 10 years. Technological improvements are rapid, so obsolescence occurs before the end of physical asset life. The speed of change also limits the opportunity for cost-effective repair and availability of spares.

This document describes the proposal for RIIO-T2 submission for SHE Transmission substation-based SCADA systems, in line with our Substation SCADA Equipment Replacement Policy. Substation SCADA systems generally consist of on-site Remote Terminal Units (RTUs), local communications systems and Human Machine Interfaces (HMIs) for local control and monitoring of plant. RTUs take alarms (e.g. protection operated, CB open) and other information from plant and pass back to the control system (Poweron) and to local HMIs. RTUs also process controls from the control system to plant.

3.1 Age/Obsolescence

Useful life of substation systems is estimated 20 years for RTU IO cards, and 10 years for RTU controller / CPUs. Prior to this we can expect fault rates to start increasing towards the end of their lives. RTUs will often be unsupportable due to unavailability of spares. In this case we would rely on our own holdings, but the numbers of systems, and the costs and resources required to replace and recommission equipment render this unsustainable and means we cannot manage this end of life period to maintain SCADA availability.

3.2 Cyber Security

The useful life of HMIs and network switches is 10 years. Obsolescence of these items is faster than RTUs due to issues such as operating system and application software support and security issues. Operating Systems or software can become obsolete or introduce Cyber Security vulnerability.

[redacted]

3.3 Legacy Issues

Finally, there is also the need to address legacy issues at five sites all of which belong to one of our customers where they provide SCADA facilities via the use of shared RTUs. The information from these is currently taken back to our “PowerOn” System via an Inter Control Centre Protocol (ICCP) link.

4 Optioneering

When reviewing our options in this area, we produced a three-tier approach to our development, in addition to a "Do Nothing" option:

- ***Minimum Requirements***
    - The bare minimum required to "keep the lights on" & maintain legal/regulatory compliance
- ***Responsible Operator***
    - A more resilient network for longer term customer benefit
- ***Progressive Network Enabler***
    - An adaptable, sustainable and flexible network providing enhanced value to current and future customers

4.1 Do Nothing

This option would retain existing SCADA equipment and carry out no SCADA replacement works in RIIO-T2. Though this is a zero-cost option, it does not address the following concerns:

- Fault rates will increase towards the end of life. The existing RTUs will be at an age where some platforms are at, or approaching, obsolescence and we will have to rely on spares to maintain the SCADA systems. This will lead to circuit unavailability.
- Complete RTU replacements are time consuming for replacing wiring and commissioning. If a phased replacement programme is not planned and designed, then this will likely lead to further unplanned outages over an extended time period.
- Existing RTUs are unable to meet the requirements and demands of a modern electrical network; integrated monitoring would not be supported, and we would be unable to comply with STCP requirements.
- Obsolete HMIs and unsupported Operating Systems introduce unnecessary Cyber Security Risks.

On this basis, this option is not taken forward for detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

4.2 Minimum Requirements

This approach includes the replacement of a number of RTUs, associated HMIs and, Transmission RTUs would be added at several customer sites. This approach removes the threat of an unsecure and obsolete operating system, removes the complexities introduced by a lack of standardisation, improves time synchronisation accuracy, data transfer speeds and capability of future expansion, as well as removing the legacy issue which restricts mobility and control of some substation assets.

However, this option does not address IEC 61850 development on any of these sites. IEC 61850 is the new Ethernet based international standard for communication in power generation facilities and substations. Therefore, in the future, further works would be required to implement this new standard, increasing capital expenditure requirements and additional outages.

On this basis, this option has not been taken forward for detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

4.3 Responsible Operator

This option expands on the "Minimum Requirements" approach but mitigates against the risk by including for IEC 61850 development. The scope of works required is as follows:

- Replacement of 13 Remsdaq RTUs. The costing allows for establishing new RTU cubicles and rewiring all the existing equipment. Consideration will be given to upgrading along with protection upgrades at sites. Where an HMI exists – this work will be done at the same time to avoid repeat commissioning works.
- Replacement of Schneider C10 RTUs at an estimated 16 sites. These will be approaching the end of the useful life as the controller contains the power supply and the C10 is unable to provide communications to Intelligent Electronic Devices (IEDs).
- Replacement of the combined fleet of Schneider RTU C10 electronics with a suitable retrofit solution. This will extend the useful life of the RTU cabinets and wiring.
- Replacement of the remaining four SAS2000 RTUs. Discussions with the manufacturer to provide an economic means of life extension have not proved fruitful. Support for the system will be withdrawn shortly after the end of RIIO-T2.
- Replacement of HMIs and associated network equipment with modern equivalents, allowing communication with IEC 61850 systems and all existing protocols. It could allow further benefits such as gateway functionality (removal of RTU), OPC links (for example condition monitoring) or interfacing with the central system. Upgrade of existing HMI Operating Systems where Copadata Zenon is already used.
- Installation of GPS clocks to improve time synchronisation accuracy.

- Network switch replacements at IEC61850 sites are also proposed – this will be done where possible with other substation works. Replacement switches will increase cyber security and allow remote management to improve fault response.

- Installation of RTUs at five customer sites.

On this basis, this option has been taken forward for detailed analysis.

PROGRESSED TO DETAILED ANALYSIS

4.4 Progressive Network Enabler

In addition to the replacement works outlined in the "Responsible Operator" approach, this also included for the replacement of RTUs at all sites. It would also ensure all substations meet the IEC 61850 requirements to such a degree that they would need no further intervention in this area for several years. This does, however, pose delivery difficulties and introduces the risk that technology and associated protocols may develop beyond these capabilities and require additional investment. It should be noted that this option was only considered after the Stakeholder Engagement event described in Section 5.2 had been completed. However, it does introduce the following concerns:

- The increased technology level offered by the new generation of RTUs may not be required at all sites.

- Additional resource is required to carry out these replacements

On this basis, this option has been taken forward for detailed analysis.

PROGRESSED TO DETAILED ANALYSIS

A summary of the above optioneering is shown in Table 1, below.

	Do Nothing	Minimum Requirements	Responsible Operator	Progressive Network Enabler
Manage Age/Obsolescence	✗	✓	✓	✓
Mitigate Cyber Security Issues	✗	✓	✓	✓
Manage out Legacy Issues	✗	✓	✓	✓
Alignment with IEC 61850	✗	✗	✓	✓

Table 1 - Optioneering Summary

5 Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. It examines three comparative factors in order to determine the preferred option:

- Risk,
- Stakeholder Requirements, and
- Cost.

5.1 Risk and Benefit Analysis

Due to the nature of this project, risks and benefits involved are not easily quantifiable and are not suitable for traditional Cost Benefit Analysis.

In order to demonstrate the benefits of delivering this project, we have carried out a Risk and Benefit Analysis. For each option taken forward to Detailed Analysis, it looks at the existing risks, the likelihood of these risks being realised, and the severity should that happen. The likelihood and severity combine to give an overall Unmitigated Risk Rating.

Mitigation actions delivered by each option are then identified, and the likelihood and severity are reappraised, resulting in a Mitigated Risk Rating.

This exercise was carried out for these proposals. As can be seen in Table 2, the Unmitigated Risk Rating is "Severe". Once all the mitigations are taken into account, the Mitigated Risk Rating falls to "Medium" for both options. Both potential options derive similar amounts of improvement to the risk rating. The full Risk & Benefit Analysis is contained within Appendix A.

				Responsible Operator	Progressive Network Enabler
Risk ID	**Risk Title**	**Risk**	**Unmitigated Overall Risk Rating**	**Mitigated Overall Risk Rating**	**Mitigated Overall Risk Rating**
1	Age and Obsolescence	Assets are reaching end of life and spares procurement is difficult; unable to manage end-of-life to maintain availability. Will lead to asset failure and reduced circuit availability	Severe	Medium	Medium
2	Cyber Security	Unsupported operating systems introduce cyber security vulnerabilities	High	Medium	Medium
3	Business Separation	Legacy issues mean that some SCADA facilities are shared with customers. Asset data could be accessed by customers.	Severe	Medium	Medium
		OVERALL	**Severe**	**Medium**	**Medium**

Table 2 - Risk and Benefit Analysis Results

5.2 Stakeholder Engagement

On 5 March 2019, SHE Transmission hosted a stakeholder workshop, aimed at gathering feedback from its stakeholders on its approach to network resilience and reliability for the RIIO-T2 plan. A total of 46 stakeholders attended the workshop, representing 31 organisations.

Stakeholders favoured the Responsible Operator option in this area. The average score slightly increased once stakeholders were made aware of the costs, as can be seen in Figure 1. It is important to note that there was no 'Progressive Network Enabler' option at that time, which means that stakeholders ranked it as highly as they were able to.

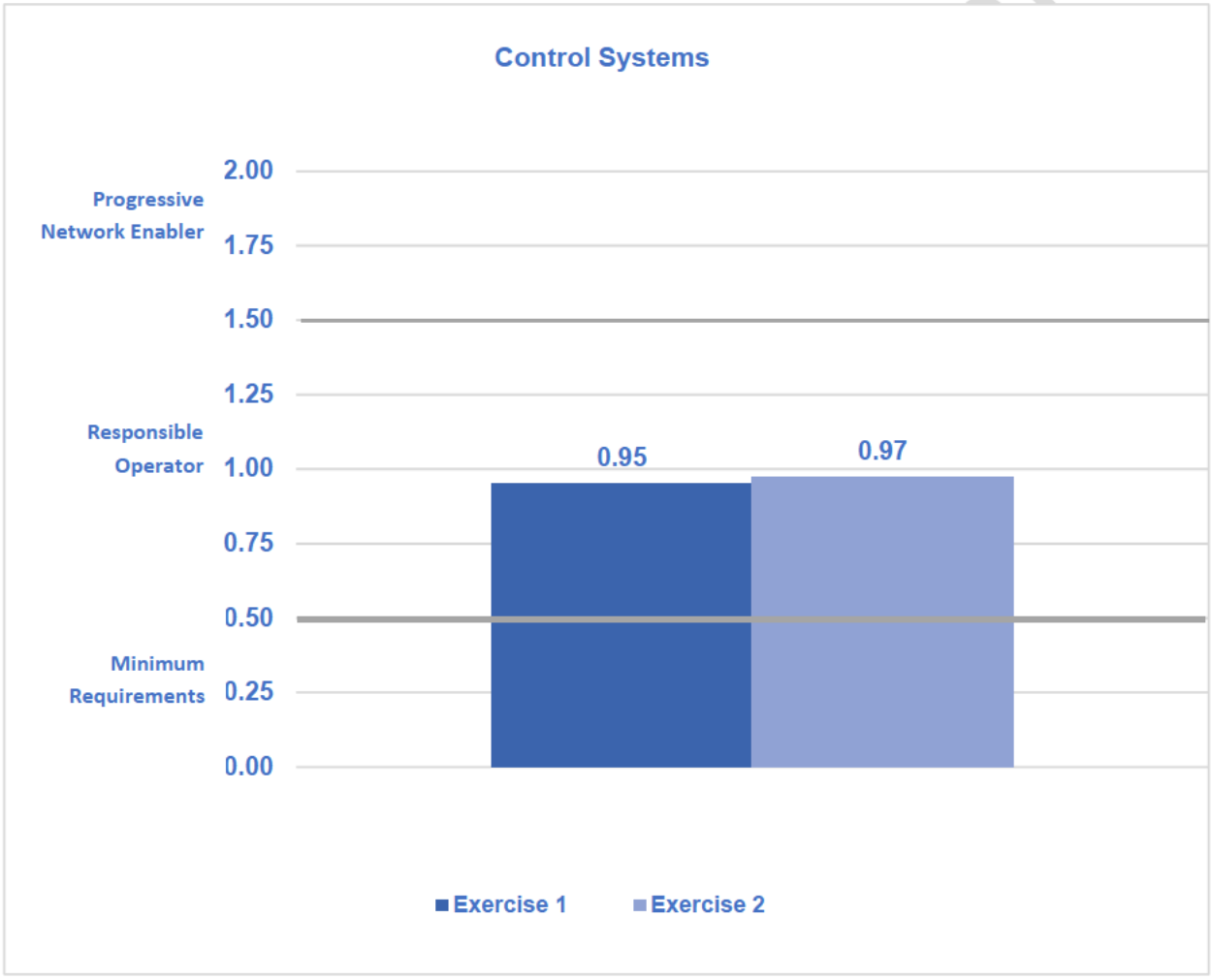

Figure 1 - Stakeholder Feedback

Stakeholders were unanimous in their support for our proposals, as they believed it was vital to keep up with emerging technologies in this area. However, this decision was given with the caveat that the implications of IP connected equipment for cyber security had been duly considered.

5.3 Costs – Responsible Operator

As laid out in

Remsdaq RTU Replacement	[redacted]	[redacted]
SAS RTU Replacement	[redacted]	[redacted]
HMI Replacement	[redacted]	[redacted]
HMI Clock Replacement	[redacted]	[redacted]
Schneider RTU Replacement	[redacted]	[redacted]
Schneider C10 CPU Replacement	[redacted]	[redacted]
IEC61850 Network Replacement	[redacted]	[redacted]
RTU Switch Upgrade	[redacted]	[redacted]
IEC61850 Development	[redacted]	[redacted]
Separation of Shared RTUs	[redacted]	[redacted]
OS Upgrades	[redacted]	[redacted]
On Costs	[redacted]	[redacted]
Risk & Contingency	[redacted]	[redacted]
TOTAL	£11,929,498	£23,344,193

Table , costs for this option are £11.93m over the course of RIIO-T2.

5.4 Costs – Progressive Network Enabler

As laid out in

Remsdaq RTU Replacement	[redacted]	[redacted]
SAS RTU Replacement	[redacted]	[redacted]
HMI Replacement	[redacted]	[redacted]
HMI Clock Replacement	[redacted]	[redacted]
Schneider RTU Replacement	[redacted]	[redacted]
Schneider C10 CPU Replacement	[redacted]	[redacted]
IEC61850 Network Replacement	[redacted]	[redacted]
RTU Switch Upgrade	[redacted]	[redacted]
IEC61850 Development	[redacted]	[redacted]
Separation of Shared RTUs	[redacted]	[redacted]
OS Upgrades	[redacted]	[redacted]
On Costs	[redacted]	[redacted]
Risk & Contingency	[redacted]	[redacted]
TOTAL	£11,929,498	£23,344,193

Table 3, costs for this option are £23.34m over the course of RIIO-T2.

	Responsible Operator	Progressive Network Enabler
Remsdaq RTU Replacement	[redacted]	[redacted]
SAS RTU Replacement	[redacted]	[redacted]
HMI Replacement	[redacted]	[redacted]
HMI Clock Replacement	[redacted]	[redacted]
Schneider RTU Replacement	[redacted]	[redacted]
Schneider C10 CPU Replacement	[redacted]	[redacted]
IEC61850 Network Replacement	[redacted]	[redacted]
RTU Switch Upgrade	[redacted]	[redacted]
IEC61850 Development	[redacted]	[redacted]
Separation of Shared RTUs	[redacted]	[redacted]
OS Upgrades	[redacted]	[redacted]
On Costs	[redacted]	[redacted]
Risk & Contingency	[redacted]	[redacted]
TOTAL	£11,929,498	£23,344,193

Table 3 - Option costs for all approaches

The table above outlines a summary of the costs required for the "Responsible Operator" and "Progressive Network Enabler" options.

The cost sheet included with this justification has been developed with respect to previous installation experience as well as costs associated with the appropriate contractors. For each replacement scheme there is an associated cost for the hardware required including the RTU CPU, Control and data input cards, cablings, filters, enclosures, consumable materials and a welfare facilities van for the installers.

5.5 Proposed Solution

We have examined each of the options in terms of three comparative factors:

- Cost
- Risk Reduction
- Stakeholder Requirements

From our analysis the "Responsible Operator" option is proposed as it addresses the identified need, is the least cost option and does not require significant additional resource. It provides significant benefits in terms of resilience and operational risk reduction and it aligns with stakeholder feedback.

Most of the benefits of the Progressive Network Enabler option are delivered at a much-reduced cost.

6 Conclusion

This Engineering Justification paper sets out the need for a SCADA replacement program due to system obsolescence and the introduction of IEC 61850.

The paper investigated SCADA replacement and determined a need based on several RTU assets that had approached the end of their operational life and determined that sourcing spares was becoming untenable. In addition to this there was a risk to cyber security due to software used on HMI's that was no longer supported by the developers and would no longer be protected from security threats should the station be upgraded to allow for IP control.

An optioneering assessment took place which investigated 4 options, two of which were taken forward for detailed analysis.

During the detailed analysis review, specific RTU models and quantities were outlined for replacement along with upgrades to the HMIs and network switches and achieving substation network IEC 61850 compliance.

This approach is supported by the response from stakeholders at an engagement session that took place on the 5th of March 2019 at the International Conference Centre in Edinburgh.

The cost for the preferred option stands at £11.93m. This cost is based on previous expenditure for similar tasks and includes a yearly breakdown of that cost (throughout the T2 period) as well as an indication of the individual component cost and the associated personnel costs.

The project will be delivered over the RIIO-T2 period between 2021 and 2026 and will have the following associated benefits relating to the RIIO-T2 business goals:

- New operating systems and software with enhanced cyber security. Operational cybersecurity will reduce risk from cyber-attacks and will contribute to our goal to aim for "100% transmission network reliability for homes and businesses", a goal outlined in the "Network for Net zero" Business plan.
- Removal of obsolete assets by using RTUs with readily available spares which allows faster response to failures. This also contributes to the above goal.
- Enhanced connectivity options to promote further / more accurate data collection. This data collection will give SHE-Transmission greater insight and control of substations and will help to achieve the goal of "£100 million in efficiency savings from innovation" stated in the "Network for Net Zero" Business plan.

This scheme is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

7 Price Control Deliverables and Ring Fencing

As set out in our Regulatory Framework paper (section 1.12 and Appendix 3) we support a key principle from Citizens Advice – one that guarantees delivery of outcomes equivalent to the funding received - to ensure that RIIO-T2 really deliver for consumers. At the project level this means that if we don't deliver the output, or a materially equivalent outputs, we commit to returning the ex-ante allowance for the output not delivered.

This means that if the funding for Transmission Substation SCADA Replacement should be ring-fenced and if it does not go ahead, we will return the allowances of £11.93m in full (minus any justified preconstruction expenditure).

It also means that we commit to delivering the output specified above for the costs of £11.93m. If we do not deliver the output, or a materially equivalent output, we commit to returning a proportion of the ex-ante allowance. The detailed methodology should be decided at when developing the Close Out methodologies but should apply the same principles of uncertainty mechanisms - that any under delivery should be material.

8 Outputs included in RIIO T1 Plans

There are no outputs associated with this scheme included in our RIIO-T1 plans.

9 References

- RTS Substation SCADA Equipment Replacement Policy.
- IEC 61850

Appendix A

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Project Risk and Benefit Matrix - Responsible Operator

Risk ID	Risk Title	Risk	Unmitigated Risk Likelihood	Unmitigated Risk Impact	Unmitigated Overall Risk Rating	Mitigation Action	Mitigated Risk Likelihood	Mitigated Risk Impact	Mitigated Overall Risk Rating	Benefits
1	Age and Obsolescence	Assets are reaching end of life and spares procurement is difficult, unable to manage end-of-life to maintain availability	Likely	Major	Severe	Replace identified RTUs/HMIs and associated network equipment	Hardly Ever	Major	Medium	Reduces risk of failure Also provides better value for the consumer as it makes optimal use of outages
2	Cyber Security	Unsupported operating systems introduce cyber security vulnerabilities	Possible	Major	High	Replace identified network switches	Almost Never	Major	Medium	Increased cyber security
3	Business Separation	Legacy issues mean that some SCADA facilities are shared with customers	Almost Certain	Major	Severe	Install RTUs at customer sites	Almost Never	Major	Medium	Removal of legacy issue

Figure 2 - Risk & Benefit Matrix – Responsible Operator

Scottish & Southern Electricity Networks TRANSMISSION

Project Risk and Benefit Matrix - Progressive Network Enabler

Risk ID	Risk Title	Risk	Unmitigated Risk Likelihood	Unmitigated Risk Impact	Unmitigated Overall Risk Rating	Mitigation Action	Mitigated Risk Likelihood	Mitigated Risk Impact	Mitigated Overall Risk Rating	Benefits
1	Age and Obsolescence	Assets are reaching end of life and spares procurement is difficult, unable to manage end-of-life to maintain availability	Likely	Major	Severe	Replace RTUs at all sites and Indentified HMIs and associated network equipment	Almost Never	Severe	Medium	Reduces risk of failure Ensure all substations meet the IEC 61850 requirement
2	Cyber Security	Unsupported operating systems introduce cyber security vulnerabilities	Possible	Major	High	Replace identified network switches	Almost Never	Major	Medium	Increased cyber security
3	Business Separation	Legacy issues mean that some SCADA facilities are shared with customers	Almost Certain	Major	Severe	Install RTUs at customer sites	Almost Never	Severe	Medium	Removal of legacy issue

Figure 3 - Risk & Benefit Matrix – Progressive Network Enabler

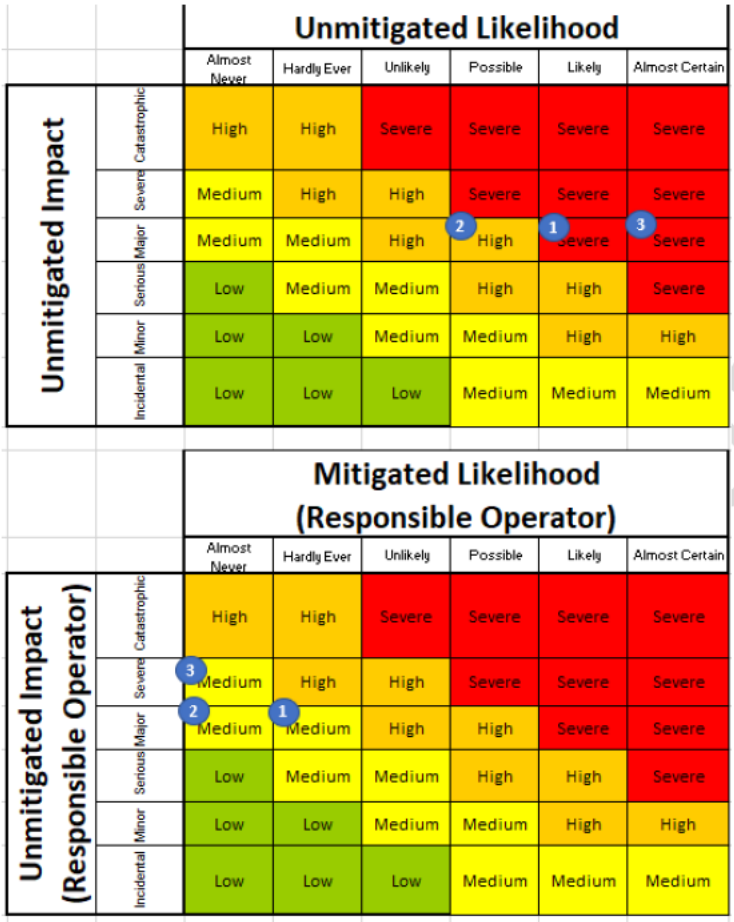

Figure 4 - Risk Heat Maps for Preferred Option