SSEN OTN ROLLOUT

ENGINEERING JUSTIFICATION PAPER

RIIO-ED2

Scottish & Southern Electricity Networks

1. SUMMARY TABLE

Summary table for OTN Rollout			
Name of Scheme/Programme	OTN Rollout		
Primary Investment Driver	Asset Health (pilot cables) / Net Zero / BT21CN		
Scheme reference/ mechanism or category	422/SSEPD/OT/OT2_OTN_ROLLOUT		
Output references/type			
Cost	£98.60m+		
Delivery Year	RIIO ED2/ED3		
Reporting Table	CV11		
Outputs included in RIIO ED1 Business Plan	No		
Spend apportionment	ED1 £3.50m	ED2 £43.73m	ED3+ £51.37m+

2. EXECUTIVE SUMMARY

The secure operation of a power system relies on the prompt and reliable exchange of information between electrical installations and decision platforms. Facilities are generally spread over a wide geographic area and may include various economic and technical feasibility contexts leading to a network implemented through multiple technologies. The overall telecommunication network must constitute a well-coordinated, maintainable, stable and highly reliable infrastructure delivering a predictable and secure communication service for the operational mission critical applications of the power system. The on-going “smart” evolution of the power grid further requires the network to facilitate open-data while assuring optimal operation of legacy systems during the long phase of migration.

The increased uptake of Low Carbon Technologies and Intelligent Electronic Devices is placing new demands on our networks and greatly increasing the availability of, and need for, operational data. In order to support our Digital Strategy, it is essential that the underlying communications infrastructure is in place. This is to cater for the volume of data to be collected but also the ubiquity of the requirement to collect this from all key sites. The expansion of the underlying digital communications network to all our primary substations during ED2 and ED3 will be required in order to deliver the base layer upon which our Digital Vision will be delivered.

This preferred option described below in section 4.3 will cost £43.7m in ED2. This is based on previous expenditure for similar tasks and would be delivered as an ongoing roll-out of project works throughout the ED2 and ED3 periods. In ED2, this would encompass 442 sites at an average cost of £98.9k per site to fully implement and realise. This option would also adopt a blended and “opportunistic” best value approach where SSEN would own physical infrastructure between sites only where available or deployed during other works (e.g. cable laying). Where ownership of physical infrastructure between sites is not immediately possible, an approach of renting services from the telecoms providers would then be used to realise benefits now and allow for easy transition to SSEN assets in future when cost effective.

Upon project delivery, we will mitigate unacceptable risks to corporate business values caused by the existing telecommunication infrastructure and will address requirements related to the ED2 business goals, such as:

- Having a secure, resilient communications network that will allow us to remotely access various plant and accommodate system monitoring elements to support long-term Risk Based Asset Management Strategy.

- Providing high speed and high bandwidth data connections to each of our substation sites will enable and accelerate our wider digital strategy.

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4. INTRODUCTION

This Engineering Justification Paper sets out our plans to undertake Distribution Communication upgrades work during the RIIO-ED2 period (April 2023 to March 2028).

The Engineering Justification Paper is structured as follows:

Section 4: 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 5: Optioneering

This section presents all the options considered to address the "need" that is described in Section 4 Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 6.

Section 6: 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 7: 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.

5. NEED

5.1 ADDRESSING RELIABILITY CHALLENGES

Reliability refers to the extent to which customers have a continuous supply of electricity. As electricity cannot be easily stored, a reliable supply of electricity requires generators to produce electricity and the transmission and distribution networks to transport the electricity to customers in real time. As a result, a reliable supply of electricity to customers requires adequate planning, capacity, and maintenance of all components of the electricity supply chain to ensure electricity can be delivered to customers when it is required.

Distribution networks are an important component of the electricity supply chain. Distribution networks transport electricity to end customers and increasingly also provide the network access point of connection for smaller Distributed Generation providers who are vital in the move to a sustainable low carbon energy network. Distribution networks also play a key role in maintaining the safe and secure operation of the electricity system. Given these roles, an outage on the distribution network could cause widespread and severe disruptions to the supply of electricity. As a result, distribution networks are designed and built to provide a high level of reliability to ensure that the number of unplanned outages is low.

- Protection services – Reliable and fast Telecoms services play an integral part in the complex protection schemes that provide protection against faults and disconnect affected sections of the network to protect life and minimise customer interruptions. Modern protection scheme design - utilising high-speed differential relays and complex acceleration, blocking and intertripping arrangements are very sensitive to even minor disruption in telecoms circuit provision. Poor performance of the telecoms system in the event of a fault can, and has, led to much wider areas of impact than the initial faulted circuit being tripped – with multiple circuit trips or cascading circuit trips possible. A vast majority of existing protection services still utilise copper pilots today as the communication medium. These copper pilots are degrading and require replacement. Such cables often run through our towns and cities and replacement costs are very high. Modern protection relays tend to use fibre optic based communications and we already have systems operating over switched fibre circuits. The next step is to use the data network provided by the OTN for protection services. Trials and testing of protection services over the OTN are due to complete prior to the start of ED2. Protection services over the OTN should commence during ED2. This then negates the need for point to point pilot cables for protection services. The OTN provides us the ability to provision a communications circuit from any point on the OTN to any other point on the OTN.

- Scada services – Currently across our network Remote Terminal Units (RTUs) are commonly connected serially via legacy copper pilot cables, microwave or other radio technologies. Serial communications are unreliable because if one of the devices loses communications the rest do also, resulting in a large-scale failure with the loss of operations centre visibility. Recent fault experience with radio technologies impacted by adverse atmospheric conditions during the winter months of 2020 has highlighted the severity of this issue. Reliable IP connectivity offers a solution to this and subsequently boosts reliability, reducing faults.

- Third Party Products End of life impact- Currently we rely on a Public Switched Telephone Network (PSTN) service for over 800 PSTN lines to provide communications connectivity to network Assets. PSTN services are planned to be ceased by British Telecommunications (BT) in 2025 and no suitable alternative is being offered for a substation deployment by BT which remains resilient to long duration power failure. To enable the replacement of this service one alternative is VoIP (Voice Over IP). Utilising our proposed Operational Technology Network, an IP voice service can be provisioned. However, there must be an appropriate bearer circuit connection to provide the IP connectivity required at each substation site. This is discussed further in 419_SSEPD_OT_Personnel Communications.

5.2 INCREASED DIGITALISATION

Our network is undergoing significant changes in both the quantity of system data available and the way that information is collated; with increasing levels of data capture and transfer for both existing and new power system monitoring and IP based networks equipment to support the various dependent functions shown below,

- Active Network Management (ANM) and transition to Digital System Operator (DSO) – Providing customers the ability to connect and participate in ANM schemes cost effectively is now a primary offering. Expanding our communication network closer to customer connections will facilitate their connections while increasing system functionality and reliability.

- Enabling the Digital Strategy for Distribution – The enhancement of the telecommunications network in our regions is a fundamental element in the strategy to build platforms to optimise network investment via the digital evolution.

- Integrated Condition & Performance Monitoring – Made possible by deploying a data network presence to each of our substation sites.

New procedures agreed with the System Operator and the modernisation of our protection systems are both placing a significant and increasing demand on information transfer capacity and reliability. To fully support this digitalisation, we require a communications network that is high speed (low latency), high bandwidth, secure and reliable to ensure the integrity of protection, control, and monitoring of the distribution system.

5.3 SECURITY

As systems like ANM and network digitalisation enhance our network for the benefit of our customers, new threats need to be mitigated alongside more traditional ones. The rollout of high-speed secure communications enables controls for traditional and evolving threats.

- Cyber Security – Increased bandwidth at sites is required to enable use of security technologies that require to transfer security related data over the communications network to a central location e.g. Intrusion detection or additional low-level firewalling.

- Physical Security – Remote CCTV monitoring and alarming deployed as standard alongside a high speed and secure comms rollout would enhance our existing physical monitoring and alarming.

- Availability – Ensuring the availability of the network ensures the availability of all services transported over it. Our communications network underpins all services that traverse it and having a network that responds and is available at all times is critical to our success for our customers.

5.4 INTERDEPENDENCIES

The works identified in this paper are interlinked with and support the following programmes of work described in other Engineering Justification Papers:

- Refurbishment of protection systems, which is replacing ageing protection relays and modernising the technologies used to ensure they still perform as required given the changes on the network with the integration of large amounts of renewable energy. An example of this is the replacement of fault throwers with teleprotection. (424_SSEPD_NLR_PROTECTION)
- Substation SCADA Upgrades will deploy modern RTUs which enable IP communications, enhance power flow monitoring and facilitate Active Network Management and integrated condition and performance monitoring. (420_SSEPD_OT_SCADA)
- Personnel Voice Communications which outlines the requirement for the implementation of a Voice over Operational Technology Network (VoOTN). (419_SSEPD_OT_PERSONNEL_COMMS)
- Physical Security. (320_SSEPD_NLR_LEGAL)
- A_10_Cyber Resilience OT Plan
- A_05_Digital Investment Plan.

Successful implementation of these projects is dependent on the provision of a reliable and high capacity communications network between our assets and our control centres.

Where the opportunity arises, we will install fibre optic cables with all cables at EHV and above, along with all overhead tower lines where we are replacing the earthwire. These activities provide direct fibre optic telecommunications into our substations at least cost and disruption and provide the best possible telecommunications medium. The works in this paper therefore also seek to coordinate with:

- Load reinforcement.
- Non-load asset replacement.

6. OPTIONEERING

When reviewing our options, we looked at ownership options as well as deployment options. A three-tier approach to the communications requirements was considered, 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 with improved reliability and ease of connectivity for customer benefit within the ED2 period .
- Progressive Network Enabler
    - An adaptable, sustainable and flexible network providing enhanced value to current and future customers.

6.1 OWNERSHIP OPTIONS

It is possible to minimise capital expenditure by leasing telecommunication services from third party providers. Or we can build, own and operate our own systems. We have focused on minimising the total cost of ownership over a lifetime of 25 years, whilst maintaining the resilience and security that we require. This has led to a mixed approach to asset ownership.

When considering the overall cost/ benefit analysis of the network rollout, two cost components must be reviewed:

1. Configuration and choice of equipment within the substation
    - The key to a successful rollout of the network is standardisation, with all substations having the same telecommunication devices, connected using a standard configuration and only varying based on the required resilience of the substation. This arrangement provides a well understood total cost model with limited variations.
    - The substation configuration must include batteries to ensure availability of the technology for 72 hours in event of a total loss of power (known as a black-start scenario[1]).
    - Over ED1 we are running numerous proof of concept projects to demonstrate the capabilities of the data network operating on the OTN and to maximise synergies with other asset management projects. Such projects have included establishing metering, CCTV, voice communication, Corporate data services and protection on the OTN. In particular, we can ensure that every substation is ready for an Active Network Management scheme, enabling flexible connections as business-as-usual.
2. Providing the physical connections to the substation and what ownership model that connection should follow

[1] ENA Engineering Recommendation G91: Substation Blackstart Resilience

- Each substation must be connected to the network with either one or two fixed links, dependant on the resilience requirements. Telecommunication resilience is designed to match the resilience of the power circuits.[2] Generally, the cost of these links is dependent on the delivery medium, the length of the connection and the bandwidth required. For remote substations therefore, the cost of the fixed link is the dominant variable component within the overall cost of network delivery. Operational Technology has therefore examined the following options to optimise the cost/ benefit analysis for the network delivery:

a) Operational Technology build and own the whole network

- Within this option, the complete network would be constructed by OT by installing fibre optic cable (overhead, underground and subsea) to enable the fixed link connections to all substations. Given the remoteness of the substations, the cost of construction would be excessive and therefore a positive cost/ benefit case is unlikely to be achieved.

b) Outsource the fixed link element to Telecommunications Operators

- This option is to outsource the connection to the substations to external Telecommunications Operators (e.g. BT, Vodafone etc). This is less desirable as monitoring and control traffic will traverse an external 3rd party's core network which may present cybersecurity, resilience and optimal routing risks. Again, it is unlikely that Operators will have network close to all substations and additional construction costs will be likely.

c) Build a hybrid network

- This option requires planning to ensure that an optimal design can be created using both elements of Operational Technology network build and other Telecommunications Operators networks. By examining the connection requirements for each substation, an optimal solution can be realised which delivers the network benefits at an acceptable cost whilst minimising the risks from utilising 3rd party networks.

Option c is the delivery model that we consider provides the best value for our customers; only owning the bearer circuit where installation costs can be shared with other planned investments.

It has been recognised that some substations, due to their challenging geographic location and low customer numbers, presently do not have a positive business case for installing the OTN. We are keen to ensure that no-one is left behind in the transition to Net Zero and we will work with other partners to look for opportunities to share infrastructure to reduce the costs of installation of the OTN. Particular opportunities may arise using the fibre which is now installed as standard within our subsea cables; if we can identify a partner to share the costs of connecting to these fibres, better serving our customers by using the fibre to extend or improve broadband services to the community. This is discussed further as a Consumer Value Proposition within our Business Plan.

[2] ENA Engineering Recommendation P2/6: Electricity Distribution Network Planning

6.2 DO NOTHING

This option would entail no expansion or reinforcement of our Operational Communications Network over the course of RIIO-ED2, even where other capital works were being carried out. This does not address any of the following risks:

- Faults would increase over time due to the ageing of current telecommunications legacy pilot cables that are end of life, difficult to repair or quantify ongoing costs for and ageing communications hardware.
- We would be exposed to third-party product end of life decisions for those SCADA, Protection and PSTN circuits provided by a 3rd party over a mixture of infrastructure.
- In addition, there would be an inability to innovate in the cyber security area, as most technologies required an IP connection of a moderate bandwidth to be able to send and receive security data.
- After 2025 there would be no black start communications method available to substation sites via the PSTN due to the end of life of BT PSTN services.
- As a result of BT ceasing the PSTN service there will be an impact on over 800 SSEN existing WLR network connections.
- An operational data connection will be required at sites requiring a voice over IP service.

On this basis and due to the significant operational risk of "doing nothing", this option has not been deemed feasible under licence conditions.

NOT RECOMMENDED

6.3 MINIMUM REQUIREMENTS

The minimum requirements options would be a reactive approach to deployment of upgraded communications services driven by either new customer need or failures in legacy plant, e.g. pilot cables that become uneconomical to repair during ED2. SSEN has trialled this approach alongside the responsible operator approach detailed in 5.3 below.

We have found that the average cost per site to implement solutions under this minimum requirement scenario rollout, can cost significantly more and take almost twice as long to deliver as a working solution for our customers. The average additional cost per site under this option is estimated at an additional £10,000, with a vastly increased lead-time to deliver due to not building on efficiencies of iterative geographical rollouts.

This scope of works will only provide piecemeal additions to our telecommunications infrastructure and will not provide an underlying secure and robust telecommunications platform to support our Digital Strategy. It would also not provide ubiquitous or targeted access to ANM connectivity for our customers. Additional costs to connect to these ANM systems could then be prohibitively high for our customers when connecting to our electrical network.

This option would limit IP network presence to a very select number of sites, it would not provide a common platform across the majority of the remaining sites for the following services.

- Enhanced Cyber security – Innovative products that require an IP connection to enable the transfer of information back to our operations centre could not be utilised
- IP telephony in our substations as a replacement for the existing PSTN service – PSTN service is due to be ceased by British Telecom in 2025. Currently over 800 PSTN lines are utilised in our substations to provide a range of services, including substation external comms & CCTV security capability.
- Risk based Asset Management – This is not possible without an IP network presence.
- Active network management – Ease of connection for our customers is not improved during ED2 and could still lead to high connection charges for our customers.

The estimated cost for this option is £18.90m based on tendered framework quotations received from our current framework contractor. This would cover reactive works at 182 sites, including 62 sites with known pilot cable issues during ED2, at an average cost per site of £103.87k per site. This option is deemed deliverable within the RIIO-ED2 period; however, it would be unable to deliver our requirements to be a responsible operator.

RECOMMENDED FOR DETAILED ANALYSIS

6.4 RESPONSIBLE OPERATOR

The Responsible Operator option would enable us to proceed with a proactive coordinated geographical expansion of our communication network during ED2. This would encompass all key substations within each geography being connected back to a core network. This enables a standard set of services to be deployed at all sites with the communication network upgrade e.g. access to ANM functionality for our customers. It also enables lower average costs for installation and rollout per site ~£10k per site less expensive than a minimum requirement option type approach. These comms would be deployed in a non-resilient way (unless being used for resilient protection purposes). Alongside the minimum requirement option this approach has been fully trialled and further detail of the trial can be found in section 6.

A site by site cost/ benefit calculation is completed for all sites. The Responsible Operator option then progressing an OTN installation at all sites with a positive return within 10 years. This is based on conditional information of existing plant e.g. pilot cables, protection, RTUs, fault throwers and additional benefits of providing targeted *local* access to ANM for SSENs customers, increased reliability and functionality.

This option would include the installation of IP/Data network hardware & network connectivity during ED2 to enable:

- Mitigation for aging and difficult to practically repair (and quantify repair costs for) copper pilot cables
- Enhanced Cyber security – The most up to date, best in market solutions could be utilised with less concern over bandwidth availability.
- Active network management – Ubiquitous access for our customers to access ANM services at the closest point for them, resulting in significant savings for customers.
- Mitigation of the impact on our sites of the PSTN end of life decision by BT Openreach
- Voice – A replacement voice over IP service could be implemented, providing a resilient secure voice communications medium that would be available during a black start scenario.
- Security – Provision of CCTV capability at all sites and migration of any existing services to our network to return a saving for each migration. A secure communication network deployment would also aid in the deployment of electronically controlled access to sites (e.g. a proximity access control "PAC" system) and site alarms.
- Digital substation – Enabling secure and reliable access would allow for greater monitoring and collecting of substation information, to allow SSEN to monitor assets in more detail and share this information with our customer.
- Ready for the future – Having secure, reliable and scalable solution for our needs and our customer needs will allow SSEN to accommodate any foreseeable communications requirements for a significant time to come.

The cost for this option is £43.73m based on tendered framework pricing received from our current framework contractor. The Responsible Operator option would see the deployment of the SSEN comms network to 442 sites, including 62 sites with known pilot cable issues at an average cost of £98.94k per site. This option is deemed deliverable within the RIIO-ED2 period and enables complete compliance with required IP services while offering readily available connectivity at key sites for ANM services.

RECOMMENDED FOR DETAILED ANALYSIS

6.5 PROGRESSIVE NETWORK ENABLER

The progressive network enabler option expands on the responsible operator option and would see the OTN rolled out to all primary substations and grid supply point sub stations. This would make our network entirely ready from a communications point of view ready for a transition to DSO. Due to this expanded footprint SSEN would also look to add diverse connections to 132kV sub stations found within our SEPD region to enhance their communications resilience.

Cost benefit for additional sites on top of those highlighted in the "responsible operator" option shows a reduced cost benefit analysis, although this ubiquitous availability of reliable and secure comms would significantly reduce customer connectivity costs when utilising an ANM scheme.

This would also provide a significantly higher level of reliability to key substations regardless of voltage, with two separate diverse low latency communications paths being available for protection and control services. In addition to this, very high bandwidth would be available at all sites.

The step up to the progressive network enabler option from the responsible operator option would require additional hardware at some core SSEN sites and the expansion of the existing SSEN core network in order to provide enhanced network availability.

The estimated cost for this option is £95.10m based on tendered framework pricing received from our current framework contractor. This option would see the deployment of the SSEN comms network to 979 sites, including 62 sites with known pilot cable issues at an average cost of ~£97.14k

There are several risks highlighted that critically question the deliverability of this option within the 5-year RIIO-ED2 period.

RECOMMENDED FOR DETAILED ANALYSIS

7. DETAILED ANALYSIS

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

- Risk and benefits analysis,
- Stakeholder engagement,
- Detailed studies and trials; and
- Costs.

7.1 RISK & BENEFIT ANALYSIS

Data capture and risk quantification:

We confirmed the current communication services used at each site and if using an SSEN asset, their condition (e.g. pilot cables); historical fault records and test records were used to analyse the reliability of the communication service. We then looked at which electrical assets utilise those services and grading risks based on their impact on our ability to operate the electrical network. For example, a protection service on an unhealthy pilot cable is higher risk than a CCTV service on a modern IP service leased from a 3rd party.

Copper pilot cable testing undertaken during ED1 has highlighted a number of legacy copper pilot cables that are highly likely to have issues in the short to medium term. It is likely the failing copper pilot cables will need repairs and/or replacement on an ad hoc basis at specific sites when faults occur. Due to the random occurrence of faults within the legacy copper pilot cable network, it isn't always viable to incorporate these fault occurrences within the planned OTN network rollout.

In addition to quantifying the risks we have also captured the existing costs of maintaining and providing todays communications services.

Future requirements:

We have then reviewed known future requirements that will mandate change in the way communication services are delivered to site, e.g. PSTN switch off requiring new telephony and metering services to be deployed.

Alongside this we have also captured highly likely requirements that will be appear within the ED2 period, e.g. deployment of communications to support planned electrical network reinforcement (fault thrower replacement), alongside average costs for our customer to connect to ANM schemes. We also project that almost all possible future communication requirements within the substation can be provided by or will require IP network connectivity of some kind.

Business Benefit and savings:

We have then compared the three options progressed to detailed analysis by completing a cost benefit analysis for each option using the information gathered. Savings can be shown where existing services are supplied via 3rd party or disparate networks. Benefits are accrued where we can support other projects along with more readily available connectivity.

7.2 STAKEHOLDER ENGAGEMENT

A specific engagement session was held with Telecommunication suppliers in January 2021 to test the validity and deliverability of our plans. We used the feedback to streamline our proposals.

7.3 DETAILED STUDIES AND TRIALS

SSEN are conducting trial projects to evaluate the most efficient approach from those detailed above that will return the highest benefits for our customers.

All trials were undertaken using an identical approach. The first stop for all trials is data capture:

- Catalogue all existing telecommunication services into substation sites (including services that may not be utilised currently, e.g. fibre optic cables)
- Cataloguing all existing business services using telecommunication services in each sub station
- Identify all desired business services requiring telecommunication services before the end of the ED2 period
- Confirming all costs to maintain all telecoms services
- Quantifying the risk of current services by reviewing telecoms fault levels through ED1 and benchmarking this with similar services over our area
- Confirming all costs to maintain all services.

Following the data capture we then applied the following principles to aid in identification for the preferred solution:

- A high preference for the utilisation of existing assets and infrastructure (e.g. SSEN fibres previously deployed)
- Potential solutions must ensure predictable costs for both capital and operational expenditure
- Rationalisation of the telecommunications footprint physically on site in terms of space and power
- Any deployed solution must be scalable to meet our business and customer requirements beyond ED3
- Repeat visits to sites and geographies must be eliminated or kept to a minimum to ensure maximum efficiency
- A positive cost/ benefit.

We typically deploy fibre optic cables with new electrical cable installs (at 33kV and above). An “opportunistic” approach was taken to avoid significant capital costs that may only provide additional benefits for a limited number of years, e.g. rental of a service from a telecoms supplier for 5 years may have a small capital cost and medium annual charge, but SSEN can obtain the benefit of the improved telecoms service for five years, then cease the service at no cost and move to a newly deployed SSEN fibre. This approach avoids “paying twice” for any civil works which can be significant and would be excessive once our own fibre is available. This approach also allows SSEN to gain advantages through improved communication services, while allowing for easy migration and lowering operational costs over the long term, as new SSEN fibre assets are deployed through future ED periods.

We are also continuing to investigate the deployment of a single fully converged telecoms platform at each site. This would result in significant reduction in physical footprint and power requirements, while increasing the number of services available at all sites and enhance cyber security of operational comms. This approach has also made it possible for SSEN to trial the deployment of a completely standard operational technology (OT) equipment panel to all sites.

Using the OT panel deployment model would allow SSEN to deploy at scale and maximum cost efficiency, while improving the telecoms provision to all sites connected.

SSEN is now trialling this standard approach at 97 sites over different geographies: 43 of these sites are being fully deployed in ED1 to confirm the approach and findings of the studies during the trial. The remaining 54 sites have been fully designed and costed in preparation for delivery within the ED2 period. The findings from these trial rollouts have enabled us to forecast the cost and deliverability of each approach below with a high degree of confidence.

7.4 COSTS

Note on costs in CV7b:

The OTN rollout can replace the function of our existing pilot cables, by providing a data platform to enable a communications link from any substation with the OTN to any other substation with the OTN. However, the OTN does not physically replace pilot cables. The km unit rate in CV7b is therefore not appropriate.

The sites where the legacy copper pilot cables were more likely to fail during ED2 based on ED1 analysis, were included in the CV7b asset replacement cost calculations. This was because the failure of the existing pilot cable asset was the primary driver for the upgrade of the existing comms to the site. The site list in appendix A lists the sites where pilot cable issues are the primary driver under CV7b.

7.5 COSTS – MINIMUM REQUIREMENTS (MR)

As described in detail above, this option would be the replacement of legacy telecommunications equipment and services that go end of life, e.g. PSTN affecting voice and metering service. Any additional rollout would be carried out in a reactive fashion where assets completely failed to the point of being unusable. Surveys of existing pilot cables during ED1 have provided information on a significant number of pilot cables at high risk of failure during ED2. Repair/replacement of these assets has been included as a minimum requirement activity. This is forecast to cost £18.90m as noted in Figure 2.

7.6 COSTS – RESPONSIBLE OPERATOR (RO)

As described in detail above, this option would be the replacement of legacy telecommunications equipment and services that go end of life, e.g. PSTN. Surveys of existing pilot cables during ED1 have provided information on a significant number of pilot cables at high risk of failure during ED2. Repair/ replacement of these assets has been included as a requirement during ED2. Provision of IP/ Data network hardware and feature rich and secure connectivity to 442 substations. This is forecast to cost £43.73m, as noted in Figure 2.

7.7 COSTS – PROGRESSIVE NETWORK ENABLER (PNE)

As described in detail above, this option would be the replacement of legacy telecommunications equipment and services that go end of life, e.g. PSTN. Surveys of existing pilot cables during ED1 have provided information on a significant number of pilot cables at high risk of failure during ED2. Repair/ replacement of these assets has been included as a requirement activity during ED2. Provision of IP/ Data network hardware and feature rich & secure connectivity to 979 substations. This would also enhance connectivity of 132kV substations in our SEPD area to add resilient diverse connectivity to them. This is forecast to cost £95.10m, as noted in Figure 2. A breakdown of substation numbers and costs for the SEPD and SHEPD regions for the various options are shown in table 3.

Figure 1 – Site implementations

Category for OTN deployment	**MR**	**RO**	**PNE**
+ ve Business Case (sites)	120	380	917
Pilot cable issues (sites)	62	62	62
	182	**442**	**979**

Figure 2 – Option Costs

Category	**MR**	**RO**	**PNE**
NPV (45 years)	-£2.82m	-£8.00m	-£49.53m
OPEX* (ED2 period 5 years)	£4.27m	£8.20m	£20.9m
OPEX* (CBA period 10 years)	£11.34m	£23.91m	£55.70m
Total Capex (ED2)	**£18.90m**	**£43.73m**	**£95.10m**

(*Based on 20% of the total number of sites being installed each year during ED2 for each option)

Figure 3 – Costs & DNO CV11 vs CV7b breakdown

DNO	CBA	Category for OTN deployment	MR Sites	MR Cost(m)	RO Sites	RO Cost(m)	PNE Sites	PNE Cost(m)
SEPD	CV11	+ ve Business Case (sites)	118	£12.21	266	£26.51	518	£50.64
SEPD	CV7b	Pilot cable issues (sites)	57	£5.90	57	£5.68	57	£5.57
SHEPD	CV11	+ ve Business Case (sites)	2	£0.23	114	£11.05	399	£38.41
SHEPD	CV7b	Pilot cable issues (sites)	5	£0.56	5	£0.49	5	£0.48
			182	**£ 18.90**	**442**	**£ 43.73**	**979**	**£ 95.10**

Figure 4 – Responsible Operator Volume/CAPEX & DNO CV11 vs CV7b breakdown*

DNO	CBA	Category	Volume 2023/4	Cost £ (k) 2023/4	Volume 2024/5	Cost £ (k) 2024/5	Volume 2025/6	Cost £ (k) 2025/6	Volume 2026/7	Cost £ (k) 2026/7	Volume 2027/8	Cost £ (k) 2027/8
SEPD	CV11	+ ve Business Case	12	1,196	53	5,283	67	6,677	67	6,667	67	6,677
SEPD	CV7b	Pilot cable issues	11	1,096	11	1,096	12	1,196	12	1,196	11	1,096
SHEPD	CV11	+ ve Business Case	13	1,261	23	2,230	26	2,521	26	2,521	26	2,521
SHEPD	CV7b	Pilot cable issues	1	97	1	97	1	97	1	97	1	97
		TOTALS	37	3,650	**88**	8,706	106	10,491	106	10,491	105	10,391

*Capex figures rounded for clarity

Figure 5 – Responsible Operator Volume/OPEX & DNO CV11 vs CV7b breakdown*

DNO	CBA	Category	Volume 2023/4	Opex £ (k) 2023/4	Volume 2024/5	Opex £ (k) 2024/5	Volume 2025/6	Opex £ (k) 2025/6	Volume 2026/7	Opex £ (k) 2026/7	Volume 2027/8	Opex £ (k) 2027/8
SEPD	CV11	+ ve Bus Case	12	43	65	462	132	939	199	1,415	266	1,891
SEPD	CV7b	Pilot cable	11	39	22	156	34	242	46	327	57	405
SHEPD	CV11	+ ve Bus Case	13	46	36	256	62	441	88	626	114	811
SHEPD	CV7b	Pilot cable	1	4	2	14	3	21	4	28	5	36
		TOTALS	**37**	**132**	**125**	**889**	**231**	**1,642**	**337**	**2,396**	**442**	**3,143**

*Opex figures rounded for clarity

7.8 PROPOSED SOLUTION

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

- Cost,
- risk reduction; and
- progress to Net Zero.

Although the Minimum Requirements option offers the best NPV, the CBA approach does not place a value on the establishment of a coordinated IP Network to facilitate progress to Net Zero. This approach would also increase the risks and build technical debt around copper pilot cable estate as these will need to be replaced at some point.

The Responsible Operator option is to be preferred, as it delivers the functionality to enable IP based services to a greater number of existing substations, mitigates better against remote legacy asset failure and therefore provides greater risk reduction. The Responsible Operator approach offers the best balance between cost, risk, and investment to aid our progression to Net Zero via deployment of an Operational Communications Network, that provides a more intelligent and responsive platform for the distribution network.

In addition, the Responsible Operator option is deliverable within the RIIO-ED2 time period whereas the Progressive Network Enabler option would carry significant risk in this regard due the volume of work required.

Looking ahead we would review the progressive network enabler option for RIIO-ED3 consideration. The Responsible Operator option during RIIO-ED2, will equate to roughly half of our estate receiving improved communications and would cover strategic sites. RIIO- ED3 could then expand this deployment to achieve a best-in-class scenario. We believe that this in conjunction with our opportunistic approach to using rented telecoms circuits as a medium-term solution, is a sensible and incremental approach providing best value to our customers in the long term.

Further detail on sites and costings can be found in Appendix A and B.

8. CONCLUSION

The significant changes to the distribution network and the increasing levels of data capture and transfer, along with the wider deployment of IP based equipment, has placed higher demand on our communications network. It requires a medium which is high speed, high bandwidth, secure and reliable to ensure the integrity of protection, control, monitoring and the enhanced security of the distribution system. Providing standard access to active network management systems is also a key deliverable to which we are committed within the RIIO-ED2 period. These factors are driving the need to replace legacy communications technologies (e.g. copper pilot cables) with a secure and reliable fibre optic based connection/ service to each substation.

We have determined a need to increase the quantity of data that can be received from our assets and a way that data can be used within internal systems to more accurately recognise asset operation and condition. This data can then be used for failure prediction and better real time monitoring for the Distribution Control Centre and the System Operator.

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

During the detailed analysis review, specific substations and circuits were highlighted for replacement. The project scope also outlined upgrades required to perform local network enhancements at each substation.

Given the preceding information, a decision has been made to deploy the Responsible Operator option, which will ensure at least one high speed communications bearer or equivalent service is made available to each of the 442 selected substations, in addition to local network enhancements at each site. This will be achieved by the installation of our approved communications hardware stack plus associated equipment. The cost forecast for this project following the proposed responsible operator option is £43.73m.

Option	Expenditure type	Cost (£m) (ED2)	Benefits over 10 years (£m)	NPV (10 years) (£m)	NPV (45 years) (£m)
Responsible Operator	CAPEX	43.73	59.17	-2.90	-8.00
Responsible Operator	OPEX	8.20			

9. APPENDIX A – SITE LISTING

SEPD Site List

TYPE	SITE NAME	SUBSTATION CODE	OFGEM RO
Supergrid	AMERSHAM MAIN	AMEM	RO Site
Primary	ARBORFIELD	ARBO	RO Site
Primary	BOWERDEAN	BOWE	Pilot site
Grid	BURGHFIELD	BURG	Pilot site
Primary	CAVERSHAM	CAVE	RO Site
Grid	CIPPENHAM	CIPP	RO Site
Primary	CROWTHORNE	CROW	Pilot site
Primary	CHURCH ROAD	CHUR	RO Site
Primary	EASTHAMPSTEAD	EHAM	RO Site
Primary	CLARENCE ROAD	CLAR	RO Site
Primary	COKES LANE	COKL	RO Site
Primary	COPLEY DENE	COPD	RO Site
Primary	FLACKWELL HEATH	FLAH	Pilot site
Primary	FRYERS LANE	FRYL	RO Site
Grid Primary	HIGH WYCOMBE	HIGW	RO Site
Primary	FARNHAM ROYAL	FARR	RO Site
Primary	HIGH WYCOMBE TOWN	HIWT	RO Site
Primary	KINGSCLERE	KING	RO Site
Primary	GRASSINGHAM ROAD	GRAR	RO Site
Primary	GREENFORD	GREE	RO Site
Primary	HARVARD LANE	HARL	RO Site
Primary	KNOWL HILL	KNOH	RO Site
Primary	LITTLE HUNGERFORD	LITH	RO Site
Primary	HILLINGDON	HIIN	RO Site
Primary	IRONBRIDGE	IRBR	RO Site
Grid	LOUDWATER	LOUD	Pilot site
Primary	KENTWOOD HILL	KENH	Pilot site
Primary	KIDMORE END	KIDE	RO Site
Primary	MORTIMER	MORT	RO Site
Primary	NUFFIELD	NUFF	RO Site
Supergrid	LALEHAM	LALE	Pilot site
Primary	PANGBOURNE	PANG	RO Site
Primary	LITTLE MARLOW	LITM	RO Site
Primary	SOUTHCOTE	SCOT	Pilot site
Primary	SOUTHFIELD ROAD	SOUR	RO Site
Primary	STOKENCHURCH	STOK	RO Site
Primary	NORTH FELTHAM	NFEL	Pilot site
Primary	NORTH HYDE 11kV	NHYD	RO Site
Grid Primary	THATCHAM	THAT	Pilot site
Primary	NORTHOLT	NOHO	RO Site

Primary	TRASH GREEN	TRAG	RO Site
Primary	VICARAGE FARM ROAD	VIFR	RO Site
Primary	WATLINGTON	WATL	RO Site
Primary	PETERSFIELD AVENUE	PETA	Pilot site
Primary	RIVERSIDE	RIVE	RO Site
Grid Primary	WOKINGHAM	WOKI	RO Site
Primary	WYCOMBE MARSH	WYCM	Pilot site
Primary	ST JOHNS	STJO	Pilot site
Primary	ALRESFORD	ALRE	RO Site
Grid Primary	ALTON	ALTO	RO Site
Primary	SUNBURY CROSS	SUNX	RO Site
Grid	AMESBURY	AMES	RO Site
Primary	THEALE	THEA	Pilot site
Primary	THREE VALLEYS	THRV	Pilot site
Primary	ANDOVER EAST	ANDE	Pilot site
Grid	ARNEWOOD	ARNE	RO Site
Primary	BARTON STACEY	BARS	RO Site
Primary	BEENHAM	BEEN	RO Site
Primary	WILSON ROAD	WILR	Pilot site
Primary	BEMERTON	BEME	RO Site
Primary	WOODCOTE	WOCO	RO Site
Primary	BEVOIS VALLEY	BEVV	RO Site
Primary	YIEWSLEY	YIEW	RO Site
Grid	ACTON LANE	ACTL	Pilot site
Primary	ALDERNEY	ALDN	RO Site
Primary	ALDERTON	ALDE	RO Site
Primary	BICESTER	BICE	RO Site
Primary	BIRDHAM	BIRD	RO Site
Primary	ALTON LOCAL	ALTL	RO Site
Primary	BITTERNE	BITT	RO Site
Primary	BORDON	BORD	RO Site
Primary	ARGYLE ROAD	ARGR	Pilot site
Supergrid Grid	BOTLEY WOOD	BOTW	RO Site
Primary	ASHLING ROAD	ASHR	RO Site
Primary	ASHTON PARK	ASHP	RO Site
Supergrid	AXMINSTER	AXMI	RO Site
Grid Primary	BOURNE VALLEY	BOUV	Pilot site
Primary	BASSETT	BASS	RO Site
Primary	BROCKHAMPTON	BROC	RO Site
Primary	BROOK STREET	BROS	Pilot site
Grid Primary	CAMBERLEY	CAMB	Pilot site
Primary	CHANDLERS FORD	CHAN	RO Site
Grid Primary	BICESTER NORTH	BICN	RO Site
Primary	BILLINGSHURST	BILL	RO Site

Primary	BILSHAM	BILS	RO Site
Primary	BINSTEAD	BINS	RO Site
Primary	CHARMINSTER	CHMI	RO Site
Primary	BISHOPS WALTHAM	BISW	RO Site
Grid Primary	CHICHESTER	CHHE	Pilot site
Primary	BLANDFORD	BLAN	RO Site
Supergrid Grid Primary	CHICKERELL	CHIC	RO Site
Primary	BOSCOMBE DOWN	BOSD	RO Site
Primary	CHINEHAM	CHNM	RO Site
Grid	CIRENCESTER	CIRE	RO Site
Primary	BOURTON	BOUR	RO Site
Primary	BRADFORD ON AVON	BRAA	RO Site
Supergrid	BRAMLEY	BRLE	RO Site
Primary	BRANDON ROAD	BRAR	RO Site
Primary	CIRENCESTER TOWN	CIRT	RO Site
Primary	BROCKHURST	BRHU	Pilot site
Primary	BROMHAM	BROM	RO Site
Primary	CORFE MULLEN	CORM	RO Site
Primary	BUSHEY	BUSH	RO Site
Grid Primary	COWLEY LOCAL	COLO	Pilot site
Primary	CARTERTON	CART	RO Site
Primary	CENTRAL	CENT	Pilot site
Grid Primary	CHALVEY	CHAL	Pilot site
Grid Primary	COXMOOR WOOD	COXW	RO Site
Primary	CREEKMOOR	CREE	RO Site
Primary	CROOKHAM	CROO	RO Site
Grid	DENHAM	DENH	Pilot site
Primary	CHILTON CANTELO	CHTC	RO Site
Primary	DORCHESTER	DORT	RO Site
Grid Primary	CHIPPENHAM	CHIP	RO Site
Primary	DOWN GRANGE	DOWG	RO Site
Grid	DRAYTON	DRAY	Pilot site
Primary	CODFORD	CODF	RO Site
Primary	EASTLEIGH NORTH	EASN	RO Site
Primary	COTTISFORD	COTT	RO Site
Primary	COVE	COVE	Pilot site
Grid Primary	COWES	COWE	RO Site
Supergrid	COWLEY	COWL	RO Site
Primary	ELMS ROAD	ELMR	RO Site
Primary	ENFORD	ENFO	RO Site
Grid	FAREHAM	FARE	Pilot site
Primary	CROCKERTON	CROC	RO Site

Primary	FARNBOROUGH	FABO	RO Site
Primary	DEDDINGTON	DEDD	RO Site
Primary	FERNDOWN	FEDO	RO Site
Primary	DEVIZES	DEVI	RO Site
Primary	DIMCO	DIMC	RO Site
Grid	FERNHURST	FERN	RO Site
Primary	FIVE OAKS	FIVO	RO Site
Primary	DRAKES WAY	DRAW	Pilot site
Primary	FLETCHWOOD	FLET	RO Site
Primary	DUNBRIDGE	DUNB	RO Site
Primary	EAST HOWE	EHOW	RO Site
Primary	FORDINGBRIDGE	FOIN	RO Site
Primary	EASTNEY	EAST	RO Site
Primary	ELECTRIC HOUSE	ELEH	Pilot site
Grid	FORT WIDLEY	FWID	Pilot site
Primary	EMSWORTH	EMSW	RO Site
Primary	HARESTOCK	HAST	RO Site
Grid	HAVANT	HAVA	Pilot site
Primary	FARLINGTON	FARL	RO Site
Grid Primary	HEADINGTON	HEAD	Pilot site
Primary	FARNHAM	FARN	RO Site
Supergrid	FAWLEY	FAWL	RO Site
Primary	FELTHAM	FELT	RO Site
Primary	HERRIARD	HERR	RO Site
Primary	HINTON MARTELL	HINM	RO Site
Primary	HITCHES LANE	HITL	RO Site
Primary	HOMINGTON	HOMI	RO Site
Primary	HORNDEAN	HORN	RO Site
Primary	HOUNDMILLS	HOUN	RO Site
Primary	FRATTON PARK	FRAP	RO Site
Primary	FRESHWATER	FRES	RO Site
Primary	FRIMLEY	FRIM	RO Site
Grid Primary	FROME	FROM	RO Site
Primary	GABLE HEAD	GABH	RO Site
Primary	GAMBLE ROAD	GAMR	RO Site
Primary	GODALMING	GODA	RO Site
Primary	GORDON ROAD	GORR	RO Site
Primary	GORING	GORI	RO Site
Primary	GROVE	GROV	RO Site
Primary	HAMBLE	HAMB	RO Site
Grid Primary	HAMWORTHY	HAMW	RO Site
Grid Primary	HUNSTON	HUNS	Pilot site
Primary	HASLEMERE	HASL	RO Site
Primary	HASLINGBOURNE	HABO	RO Site

Primary	HURSTBOURNE TARRANT	HURT	RO Site
Primary	HAWLEY	HAWL	RO Site
Primary	HAYES	HAYE	RO Site
Grid Primary	LANGLEY	LANG	RO Site
Primary	LANGLEY COURT	LANC	RO Site
Primary	HILSEA	HILS	RO Site
Primary	HINCHESLEA	HINC	RO Site
Primary	HINDHEAD	HIND	RO Site
Primary	LEIGH PARK	LEIP	RO Site
Supergrid	LOVEDEAN	LOVE	RO Site
Primary	HOEFORD	HOEF	RO Site
Primary	LYNES COMMON	LYNC	RO Site
Primary	HOOK	HOOK	RO Site
Grid	LYTCHETT	LYTC	RO Site
Primary	MARCHWOOD	MAWO	RO Site
Primary	MARLBOROUGH SOUTH	MARS	RO Site
Primary	MELKSHAM TOWN	MELT	RO Site
Primary	JAYS CLOSE	JAYC	RO Site
Primary	KENNINGTON	KENN	RO Site
Primary	KIDDINGTON	KIDD	RO Site
Primary	KINGS RIDE	KINR	Pilot site
Primary	LABURNUM ROAD	LABU	Pilot site
Primary	MIDDLE WALLOP	MIDW	RO Site
Primary	MILFORD ON SEA	MILS	RO Site
Primary	LARKHILL	LARK	RO Site
Primary	LEAFIELD	LEAF	RO Site
Primary	LEE ON SOLENT	LEOS	RO Site
Primary	MILL LANE	MILA	RO Site
Primary	MILTON	MILT	RO Site
Primary	LYMINGTON	LYMI	RO Site
Grid Primary	NETLEY COMMON	NETC	RO Site
Primary	NEW MILTON	NEWM	RO Site
Primary	MANCHESTER ROAD	MANR	RO Site
Grid	NORRINGTON	NORR	RO Site
Primary	MARKET	MARK	RO Site
Primary	NORTH BADDESLEY	NBAD	RO Site
Primary	MAYBUSH	MAYB	RO Site
Supergrid	MELKSHAM	MELK	RO Site
Supergrid	NURSLING	NURS	RO Site
Primary	MEYRICK ROAD	MEYR	RO Site
Primary	OAKRIDGE	OAKR	Pilot site
Primary	MIDHURST	MIDH	RO Site
Primary	MILFORD	MILF	RO Site
Primary	OXFORD	OXFO	RO site
Primary	PARK GATE	PARG	RO Site

Primary	PARKSTONE SOUTH	PARS	Pilot site
Supergrid	MINETY	MITY	RO Site
Primary	NETHERHAMPTON	NETH	RO Site
Primary	PETERSFINGER	PETF	RO Site
Primary	PLAISTOW	PLAI	RO Site
Primary	NEWPORT	NEWP	RO Site
Primary	NORMANDY	NORM	RO Site
Primary	POOLE	POLE	RO Site
Primary	POOLE 132KV	POOL	RO site
Primary	NORTH FAREHAM	NFAR	RO Site
Primary	PORTLAND	PORT	RO Site
Grid Primary	PORTSMOUTH	PORP	Pilot site
Primary	OLD ROAD	OLDR	Pilot site
Grid Primary	OSNEY	OSNE	Pilot site
Primary	OVERTON	OVER	RO Site
Primary	PORTWAY	POWA	Pilot site
Primary	PRESTON CANDOVER	PREC	RO Site
Primary	PARKSTONE NORTH	PARN	RO Site
Primary	PULHAM	PULH	RO Site
Primary	PETERSFIELD	PETE	RO Site
Primary	PURBROOK	PURB	RO Site
Primary	PIDDLETRENTHIDE	PIDD	RO Site
Grid Primary	REDHILL	REHI	RO Site
Primary	PLESSEY TITCHFIELD	PLET	RO Site
Primary	REDLYNCH	RELY	RO Site
Primary	ROSE GREEN	ROSG	RO Site
Primary	PORTCHESTER	POCH	RO Site
Primary	ROWDEN	ROWD	RO Site
Primary	ROWNER PARK	ROWP	RO Site
Grid	ROWNHAMS	ROWN	RO Site
Primary	PRESSED STEEL SWINDON	PRSS	Pilot site
Grid	SALISBURY	SALI	RO Site
Primary	SALISBURY CENTRAL	SALC	RO Site
Grid Primary	SHAFTESBURY	SHAF	RO Site
Grid Primary	PYESTOCK	PYES	Pilot site
Primary	QUEENSMEAD	QUEE	Pilot site
Primary	SHRIPNEY	SHRI	Pilot site
Primary	REDLANDS	REDL	RO Site
Primary	SOUTH BERSTED	SBER	RO Site
Primary	RISSINGTON	RISS	RO Site
Primary	ROMSEY	ROMS	RO Site
Primary	ST CROSS	STCR	Pilot site
Primary	ROSE HILL	ROSH	Pilot site
Primary	STAPLEFORD	STAP	RO Site

Grid Primary	STRATTON	STRA	RO Site
Grid Primary	SWINDON	SWIN	Pilot site
Primary	RYDE	RYDE	RO Site
Primary	THRUXTON	THRU	RO Site
Primary	TITCHFIELD	TITC	RO Site
Primary	SANDHURST	SAND	RO Site
Primary	SANDOWN	SADO	RO Site
Primary	SELSEY	SELS	RO Site
Grid Primary	TOOTHILL	TOOT	RO Site
Primary	SHALFLEET	SHAL	RO Site
Primary	SHANKLIN	SHAN	RO Site
Primary	SHERBORNE	SHER	RO Site
Primary	SHIPTON OLIFFE	SHIO	RO Site
Grid Primary	UPTON	UPTO	Pilot site
Primary	SHROTON	SHRO	RO Site
Primary	SILKSTEAD	SILK	RO Site
Primary	WELL END	WELE	RO Site
Primary	SOMERFORD	SOME	RO Site
Grid	WEST GRAFTON	WGRA	RO Site
Primary	SOUTHBOURNE	SBOU	RO Site
Primary	SPARKFORD	SPAR	RO Site
Primary	WESTBOURNE	WBOU	RO Site
Primary	STANDLAKE	STLA	RO Site
Primary	WESTERN ESPLANADE	WESP	RO Site
Primary	WEYMOUTH	WEYM	RO Site
Primary	SWANAGE	SWAN	RO Site
Primary	WHITELEY	WHLE	RO Site
Grid	WINCHESTER	WINC	RO Site
Primary	TEFFONT	TEFF	RO Site
Primary	TETBURY	TETB	RO Site
Primary	WINTON	WINT	RO Site
Grid	WITNEY	WITN	RO Site
Primary	TONGHAM	TONG	RO Site
Primary	WOODSTOCK	WOOD	RO Site
Primary	TOTTON	TOTT	RO Site
Primary	TOWNHILL PARK	TOWP	RO Site
Primary	TRADING ESTATE	TRAE	Pilot site
Primary	TROWBRIDGE TOWN	TROT	RO Site
Primary	UNION STREET - 33/11KV	UNIS	Pilot site
Primary	WOOLSTON	WOOL	RO Site
Primary	VENTNOR	VENT	RO Site
Primary	VERWOOD	VERW	RO Site
Grid	WAREHAM	WARE	RO Site
Primary	WAREHAM TOWN	WART	RO Site

Primary	WARMINSTER	WARM	RO Site
Primary	WATERLOOVILLE	WATE	RO Site
Grid	WOOTTON COMMON	WOOC	RO Site
Grid Primary	YEOVIL	YEOV	RO Site
Primary	WEST GRAFTON VILLAGE	WGRV	RO Site
Primary	WESTON	WEST	RO Site
Primary	WHITEWAY	WHWA	RO Site
Primary	WIMBORNE	WIMB	RO Site
Primary	WINCANTON	WICA	RO Site
Primary	WINDRUSH PARK	WINP	RO Site
Primary	WINSMORE LANE	WINL	Pilot site
Primary	WINTERBORNE KINGSTON	WIBK	RO Site
Primary	WINTERBOURNE ABBAS	WINA	RO Site
Primary	WITNEY TOWN	WITT	Pilot site
Primary	WOOTTON BASSETT	WOOB	RO Site
Primary	WRECCLESHAM	WREC	RO Site
Primary	WROUGHTON	WROU	RO Site
Grid Primary	YARNTON	YARN	RO Site
Primary	YETMINSTER	YETM	RO Site
Primary	ZETLAND ROAD	ZETR	RO Site

SHEPD Sites

Substation Name	Site code	OFGEM RO
Dalneigh Primary	713	Pilot site Not in MR
Dunoon Primary	363	MR site
Lochside Primary	083	MR site
Oban Primary	307	Pilot site Not in MR
Rothesay Primary	362	Pilot site Not in MR
Tummel Bridge Primary	260	Pilot site Not in MR
Abernethy Primary	242	RO site
Aboyne Primary	801	RO site
Alyth Primary	258	RO site
Annat Primary	702	RO site
Ashgrove Primary	458	RO site
Balbeggie Primary	255	RO site
Ballater Primary	806	RO site
Balmedie Primary	807	RO site
Balnagask Primary	808	RO site
Banchory Primary	810	RO site
Battery Point Primary	652	RO site
Bilbohall Primary	499	RO site
Blairgowrie Primary	257	RO site
Brechin Primary	073	RO site
Brodick Primary	370	RO site

Brora Primary	550	RO site
Bruchag Primary	365	RO site
Buckie Primary	462	RO site
Burghead Primary	454	RO site
Callander Primary	210	RO site
Campbeltown Primary	312	RO site
Carnoustie Primary	064	RO site
Charles Avenue Primary	062	RO site
Clayhill Primary	826	RO site
Commerce Street Primary	827	RO site
Craigagoul Primary	381	RO site
Crosshills Primary	551	RO site
Culloden Primary	712	RO site
Culter Primary	836	RO site
Cumming Street Primary	457	RO site
Dalrulzion Primary	259	RO site
Denburn Primary	841	RO site
Dingwall Primary	515	RO site
Dufftown Primary	461	RO site
Dunblane Primary	209	RO site
Ellon Primary	849	RO site
Errol Primary	254	RO site
Fochabers Primary	487	RO site
Forres Primary	452	RO site
Fraserburgh Primary	853	RO site
Friockheim Primary	089	RO site
Fyvie Primary	856	RO site
Glendevon Primary	273	RO site
Goodlyburn Primary	249	RO site
Greyfriars Primary	861	RO site
Hastigrow Primary	582	RO site
Hatton Primary	863	RO site
Haudagain Primary	865	RO site
Hayton Primary	867	RO site
Hilton Primary	750	RO site
Hume Street Primary	067	RO site
Huntly Primary	869	RO site
Insch Primary	871	RO site
Invergordon Primary	559	RO site
Inverlochy Primary	724	RO site
Inverness Primary	726	RO site
Inverurie Primary	875	RO site
Kames Primary	366	RO site
Keith Primary	464	RO site
Kemnay Primary	881	RO site
Kepculloch Primary	205	RO site

Kilchrenan Primary	323	RO site
Kingseat Primary	884	RO site
Kinloss Primary	453	RO site
Kirkwall Primary	677	RO site
Lhanbryde Primary	488	RO site
Lochdonhead Primary	317	RO site
Lochgilphead Primary	308	RO site
Lossiemouth Primary	455	RO site
Lunanhead Primary	082	RO site
Macduff Primary	406	RO site
Mallaig Primary	731	RO site
Marnoch Primary	401	RO site
Maryton Primary	084	RO site
Maud Primary	901	RO site
Midmar Primary	907	RO site
Mill Rd Primary Montrose	075	RO site
Milnathort Primary	251	RO site
Mintlaw Primary	909	RO site
Mossat Primary	911	RO site
Nairn Central Primary	723	RO site
Newtonhill Primary	914	RO site
Oldmeldrum Primary	921	RO site
Peterhead Grange Primary	928	RO site
Peterhead North Street Primary	929	RO site
Pinegrove Primary	734	RO site
Pitlochry Primary	263	RO site
Port Ellen Primary	331	RO site
Queens Lane North Primary	932	RO site
Raigmore Primary	735	RO site
Redford Primary	066	RO site
Redgorton Primary	270	RO site
Redmoss Primary	935	RO site
Rothes Primary	459	RO site
Ruthrieston Primary	939	RO site
Salen Primary	315	RO site
Sanday Primary	685	RO site
Scone Primary	271	RO site
Skene Primary	941	RO site
Springhill Primary	943	RO site
St Machar Primary	956	RO site
St Nicholas Primary	958	RO site
Stonehaven Primary	945	RO site
Strachur Primary	382	RO site
Strathdon Primary	951	RO site
Strontian Primary	751	RO site
Tain Primary	546	RO site

Thimblerow Primary	248	RO site
Tumblin Primary	790	RO site
Turriff Primary	964	RO site
Uig Primary	640	RO site
Whitehouse Primary	981	RO site
Whitestripes Primary	982	RO site

10. APPENDIX B – COST MODEL

Detailed analysis of costs associated with circuit deployment during ED1, both CapEx and OpEx along with hardware and service pricing from suppliers were used to establish the cost and benefit figures utilised in producing the cost benefit analysis input. The figures below are summarised supplier costs/ quotes. The cost/ benefit input is shown in the related cost benefit analysis document.

ED1 Hardware/service costs & benefits

SEPD OTN Circuit cost (per end)

Description	Unit			Cost (£)
SEPD OTN circuit average RO circuit price	per site			£30,633

SHEPD OTN Circuit cost (per end)

Description	Unit	Cost (£)
SHEPD OTN circuit average RO circuit price	per site	£27,933

OT Panel

Description	Unit			Cost (£)
Complete Panel + Delivery to site	1			£31,127

Labour cost per OTN site deployment

Description	Labour			Cost (£)
OT Engineering costs - Labour 11 days @£350 (3 design, 4 PM, 4 RTSD / site)	11			£3,850
OTN Deployment 3rd party costs - Labour	1			£14,490
Total Labour costs OT deployment /site	**1**			**£18,340**

DC Requirements

Description	Unit			Cost (£)
DC System				£10,540
DC System transport cost (standard rate for 2 units per site)				£2,520
DC Installation Cost				£4,000
Misc DC site reconfigurations/changes				£2,500
Complete Charger + Installation	1			£19,560

Average ED2 site OPEX

Description	Unit			Cost (£)
SHEPD/SEPD circuit (OPEX)	Per site			£4,556
OTN Node Hardware (OPEX)	Per site			£2,560
Total OPEX per site	**1**			**£7,116**

Existing service cost actual/assumed/derived

Description	Unit			Cost (£)
PSTN Line OPEX	1			£597
CCTV CAPEX	1			£2,460
CCTV OPEX	1			£597
PABX extension OPEX	1			£597
Metering line OPEX	1			£597
Non OTN solution for Metering - CAPEX	1			£2,460
Non OTN solution for Metering - OPEX	1			£597

Future service deployment cost at non OTN site

Description	Unit			Cost (£)
Voice capability via Fixed PMR (Site based)	1			£7,000
CCTV/Security - leased service CAPEX	1			£10,000
Voice & security non OTN solution (subtotal)				£17,000

Anticipated Benefit due to OTN deployment at site

Description	Unit	Per year	ED2/3 total (10 year)	Potential Saving (£)
Voice -VOIP via OTN	1	£597	£5,970	£5,970
CCTV/Security/PAC - via OTN (1/2 day per month per site visit saving)	1	£3,000	£30,000	£30,000
Migration from Fault Throwers (Based on 2 FT /site & 50% change)	1		£30,000	£30,000
Meter line - provided via OTN - 3rd party cct avoided	1	£597	£5,970	£5,970
Improved SCADA reliability (6-man days per year)	1	£1,800	£18,000	£18,000
Remote Access Available (1/2 day per month per site)	1	£1,800	£18,000	£18,000
Wi-Fi Enabled on site (saving 2 hours /month/site)	1	£900	£9,000	£9,000
Reduction in failure of automation due to comms (1 /year- 60 min) (1 feeder out of average of 12 per sub x number of customers/feeder)	1			£30
Known Issue with pilot cable failure avoided (10% cost shown/site)	1			£50,000
Future Issue with pilot cable failure avoided (5% cost shown/site) (sites with a pilot cable test score of 1 or 2)	1			£5,000
Future Issue with pilot cable failure avoided (3% cost shown/site) (pilot cable exists 'E' but current condition unknown)	1			£3,000
ANM Functionality (To be everywhere by end of ED3)	1			£10,000
Protection work ED2 Synergies (RTU change and OTN deployed)	1			£30,000