Scottish & Southern Electricity Networks

SHEPD High Value Project Reopener:

Special Licence Condition CRC3F

Pentland Firth East Subsea Cable Replacement Project

31 May 2019

Contents

Tables

Figures

Appendices

Confidential Appendices

[redacted]

1 About SSEN

Scottish Hydro Electric Power Distribution plc (SHEPD), is a subsidiary of Scottish and Southern Energy Power Distribution Limited (SSEPD), along with Southern Electric Power Distribution plc (SEPD) and Scottish Hydro Electric Transmission plc (SHE Transmission). SSEPD and its subsidiaries are all members of the SSE plc group (SSE). Scottish and Southern Electricity Networks (SSEN) is a trading name of SSEPD.

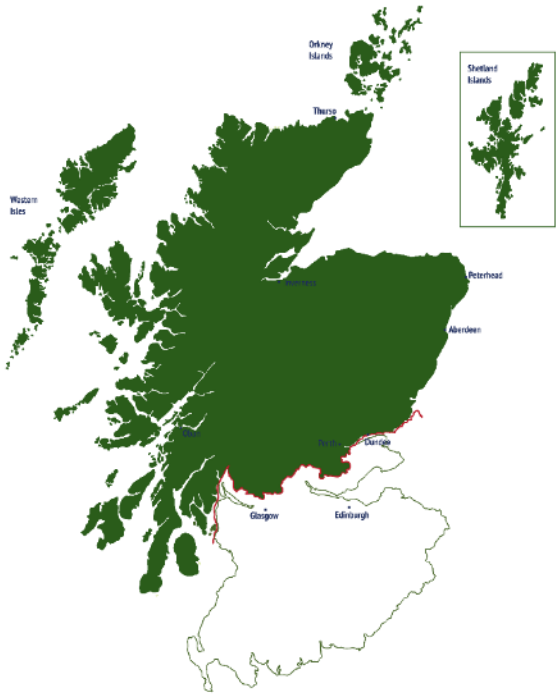
SHEPD is responsible for maintaining the electricity networks supplying over 772,000 homes and businesses across the north of Scotland. The electricity distribution network comprises 9,144 substations and a network length of 49,154km.

As well as distributing electricity to major towns, and the cities of Aberdeen, Dundee, Inverness and Perth, SHEPD also connects customers in remote, rural areas and Scottish islands. It owns and operates over 100 subsea cable links. These subsea cables are generally installed between the mainland and an island but there are also critical links within the island groups themselves.

Due to the nature of SHEPD's distribution network, subsea cable links either form part of an interconnected network or are radial feeds with no alternative means of supply; SHEPD has 36 subsea cables that are a single point, radial feed. The loss of these cables requires local generation to maintain supply to customers and support the network.

SHEPD's subsea cable network offers an essential service to its customers, providing a safe and reliable supply of electricity to homes and businesses and critical links for the export of renewable generation to the GB mainland.

Figure 1: SHEPD's Distribution Service Area



2 Executive Summary

Introduction

In its RIIO-ED1 business plan SHEPD requested an allowance of £44.6m to proactively replace 112km of subsea cables to improve the health and reliability of these assets. Following Ofgem review, the price control determination allowed £36.9m to replace c.85km at an assumed rate of £433k/km.

Following further inspection of 312km of our 454km subsea cable portfolio in RIIO-ED1 and the introduction of the CNAIM asset health and criticality monitoring tool, our understanding of the health of our subsea cables resulted in a modification to the proposed list of cables that we are planning to replace in RIIO-ED1. In our recent submission for the Subsea Cable Protection Reopener we provided evidence that justified the need to replace c.95.2km of the most at-risk subsea cables within the RIIO-ED1 period.

While replacement of the Pentland Firth East (PFE) subsea cable was not in our original RIIO-ED1 business plan, inspections carried out in 2016 and 2017, and subsequent CNAIM assessment showed that this cable also needs to be replaced in RIIO-ED1. Deterioration of the asset has been greater than anticipated and replacement cannot be deferred until RIIO-ED2. This assessment has been further justified following 2 faults on the cable earlier this year.

Due to the value of the project and need for immediate replacement, it was determined that the High Value Project (HVP) reopener mechanism should be triggered to recover the additional and unexpected costs of replacing and protecting the PFE cable in RIIO-ED1.

The Ofgem strategy decision document states that the HVP reopener is intended to cover schemes that were not included in the original price control baseline allowance due to lack of clear outputs, costs or a needs case as well as schemes which were not known about by the DNO at the time of setting the price control allowances. The Pentland Firth East Subsea Cable Replacement Project (PFE) meets this requirement and the criteria set out in Special Licence Condition CRC 3F.

Cable Replacement Project

The PFE subsea cable is a **36.2km** cable connecting Orkney to mainland Scotland. It was installed in 1982. In 2016 the near shore end of the PFE cable was inspected as part of our routine inspection programme. This covered the section of the cable that lies between the shore and approximately 4.5km out to sea. This inspection indicated that there were sections of severe cable armour damage and that an end to end inspection would be required as part of the next annual inspection campaign. In 2017 end to end inspection was carried out and confirmed that the cable is in “critical condition” under standard industry assessment criteria and requires end to end replacement.

The PFE subsea cable is important to the security of supply to the Orkney islands. There are over 13,000 customers on the islands with a maximum demand of approximately 35MW. It is also important for facilitating the export of renewable generation to mainland Scotland. As such it is imperative it is replaced within this price control period.

The HVP consists of six discrete but interrelated elements:

- **Survey** - The sea bed between Murkle Bay in Caithness, where the cable will leave the mainland, and Rackwick Bay on Hoy, where the cable will land, will need to be surveyed.

- **Design** - The survey will be used to inform the design of the new cable route which will consider the topography and composition of the sea bed, any ship wrecks or other debris and items such as unexploded ordnance (UXO) that the cable route will need to avoid.
- **Installation** - Once the route plan has been finalised the cable will be installed. From previous installations we have found the new route is usually 6% longer than the previous installed cable. For the PFE project, there is also a need for micro siting the cable to avoid marine obstacles and to reduce the risk of future damage. We estimate micro siting will require some additional cable taking the total planned installation length to 40km.
- **Burial and Protection** - The introduction of the Scottish National Marine Plan (NMP) in 2015 requires all new subsea cables to be protected either by burial or by other appropriate means. We have designed a Marine Licence CBA methodology that takes into account the views of stakeholders in determining the most appropriate method and level of protection for each cable. For this project, the CBA methodology recommends we bury 5km of the subsea cable in areas of soft sandy sediment and install c.1550 rock bags (every 45m) to stabilise the replacement cable and protect it from movement and scouring in areas of rock and strong current. The method and level of protection will also ensure the safety of the vast number of marine users in the Pentland Firth, giving them confidence in the exact location of our asset and that it is appropriately secured.
- **Decommissioning** - The Pentland Firth is a busy shipping route and fishing area. Because of this and the proximity to three other subsea cables (Pentland Firth West (PFW) electricity subsea cable, BT and Faroe Islands main telecommunication cables) we have determined based on marine licencing objectives that the existing cable will require to be decommissioned for safety and environmental reasons. Following consideration of specific route details, we plan to remove 50% of the existing cable, once the new cable is successfully installed.
- **Associated Electricity Network Infrastructure** - The project also requires work to be undertaken to modify the electricity network infrastructure at either end of the subsea cable. New landfalls are required at both shore ends and 6 km of adjacent overhead line will be replaced and undergrounded (4km at Rackwick Bay and 2km at Murkle Bay). This will help improve network reliability by removing lines from exposure to the corrosive effects of the sea air and damage by severe weather events.

Conclusion

Based on the information we now possess from our RIIO-ED1 inspection campaign, and 2 subsequent faults on the Pentland Firth East subsea cable this year, there is very clear evidence of the need to replace the cable before the end of the current price control period and associated on-land infrastructure. As there is no scope to remove or delay projects within our planned subsea cable replacement programme, this is in addition to our RIIO-ED1 programme provided for in our RIIO-ED1 core allowance. We are therefore seeking to recover **£30.0m (2012/13)** under the HVP Reopener Mechanism provided for in licence condition CRC3F. The benefits associated with delivery of this project are significant and include improved asset health and reliability. We expect the project will provide a reduction in SHEPD's risk score of **453,752** points and will mitigate against the risk of incurring further faults. The project will also deliver additional environmental and safety benefits for marine life and marine users in the area, as determined under the Marine Licence CBA. Planned replacement is currently scheduled for April 2020.

3 Introduction

SHEPD has triggered the reopener mechanism under licence condition CRC 3F; High Value Project Reopener as it has been identified that one of our longest subsea cables in the North of Scotland, Pentland Firth East , needs to be replaced in the current price control period. This was highlighted during our 2016 near shore inspection of the cable which showed that there were sections of the cable in "critical condition". Following further end to end inspection in 2017, it became apparent the full length of the cable needs to be replaced.

In our RIIO-ED1 Business Plan submission we proposed replacing 34 subsea cables, comprising 112km, at a cost of £44.6m. In its final determination Ofgem awarded £36.9m. At an assumed rate of £433k/km this would allow approximately 85km of subsea cables to be replaced.

Following confirmation of this revised RIIO-ED1 allowance SHEPD conducted a review of its planned replacement programme for RIIO-ED1. This review considered additional inspection data obtained through our ongoing inspection campaign and outputs from our CNAIM asset condition monitoring tool. This allowed us to prioritise our replacement programme based on the condition of the cables. We now plan to replace **16 cables**, with a projected length of **95.2km**, at a comparable installation cost to that set out in our RIIO-ED1 Business Plan (excluding protection costs which are subject to a separate reopener mechanism). This list includes 11 projects that were in our original RIIO-ED1 plan and 5 new projects.

A list of the subsea cables that we now plan to replace as part of our RIIO-ED1 proactive replacement programme is provided in Table 1 below, along with details of length, Health and Criticality score prior to replacement. Those projects included in our original RIIO-ED1 Business Plan are shaded blue. Further evidence of their condition and justification of the need to replace them has already been provided to Ofgem as part of the Subsea Cable Protection Reopener submission.

Table 1: RIIO-ED1 Subsea Cable Replacement Programme

Section ID	Circuit ID	Current Length (m)	[redacted]
SHEPD_105	Mull - Coll	15,310	
SHEPD_21	Mainland Orkney - Hoy North (1)	4,427	
SHEPD_26	Sanday – Eday	4,324	
SHEPD_29	Rousay – Egilsay	1,901	
SHEPD_34	Mainland Orkney - Hoy Centre (2)	4,665	
SHEPD_36	Sanday - North Ronaldsay	10,076	
SHEPD_41	Shetland – Whalsay	4,975	
SHEPD_73	Mainland Orkney - Shapinsay	2,900	
SHEPD_74	Carradale - Arran North (1)	6,066	
SHEPD_88	Shetland - West Linga	2,100	
SHEPD_35	Rousay Westray (Replaced)	10,398	
SHEPD_62	Harris Scalpay (Replaced)	770	
SHEPD_43	Mossbank Yell (Replaced)	3,883	
SHEPD_44	Yell Unst 1 (Replaced)	2,130	
SHEPD_61	Yell Unst 2 (Replaced)	1,770	
SHEPD_68	Shapinsay Stronsay (Replaced)	14,640	

As can be seen above, the cables in the programme are all classified as HI5. Replacement is required to maintain reliable supplies to customers in some of the most remote locations on our network. Failure to replace these cables in this price control period would impose an inappropriate level of risk on our customers.

The PFE cable has subsequently been identified in RIIO-ED1 as also being in urgent need of replacement, in addition to our planned replacement programme. In this submission we set out the evidence and justification for this project, including details of the costs associated with individual elements including:

- Subsea cable supply
- Surveying the sea bed to inform the design of the new cable route;
- Design of the cable replacement route to consider the seabed topography, debris, shipwrecks etc;
- Replacement of the current 36.2km cable;
- Burial and protection of the replacement cable as required under Marine Licence;
- Decommissioning of the existing cable following replacement; and
- Replacing and undergrounding sections of associated overhead line and shore ends.

As this project was initiated in 2018, we have already started to design and plan the project. We have secured tenders, evaluated and awarded contracts for the main materials. This has allowed us to provide a clear breakdown of costs and forecasts with supporting evidence and justification. Experience of other subsea cable replacement projects completed in this price control period has also helped inform and give further credibility to forecasts and this submission.

We now plan to replace the existing subsea cable in April 2020.

4 High Value Project Reopener Mechanism

During RIIO-ED1 price control discussions it was recognised, as it had been with other price controls, that there was a need to include uncertainty mechanisms to accommodate either industry wide or specific network events, that could not have been foreseen at the start of the price control or for which costs were uncertain.

Ofgem's RIIO-ED1 Strategy Decision document on Uncertainty Mechanisms states that the purpose of the High Value Project reopener is to allow DNOs to apply for allowances for major projects that:

'*were not included in the original price control baselines due to them failing to have one or more of the following: clear outputs, forecast costs or a need case and schemes which were not known about by the DNO at the time of setting the price control allowances"*.

Special Licence Condition CRC 1A defines Costs as:

'costs incurred, or expected to be incurred, by the licensee on any investment project with respect to its Distribution System that is reasonably forecast to cost the licensee £25 million or more (in 2012/13 prices) during the Price Control Period, and for which clear outputs, a needs case and a statement of costs have been provided to the Authority.'

The Pentland Firth East Subsea Cable Replacement Project meets all these requirements:

- There was no ex- ante allowance for HVP costs for SHEPD as shown in Appendix 1 of Special Licence Condition CRC 3F;
- The project was "not known about at the time of setting the price control allowances" and was not named in our RIIO-ED1 Business Plan;
- It exceeds the materiality threshold set out under Special Licence Condition 3F of £4.54m (12/13 prices);
- While there was an allowance made for subsea cable replacement this has been exceeded with 11 of the original projects named in our business plan and 5 others that have subsequently been brought forward for replacement due to asset health; and
- There is no other mechanism available to fund additional costs associated with the Pentland Firth East Subsea Cable Replacement Project. For instance, the cable is being replaced due to condition and not load requirements therefore the Load Related Expenditure reopener mechanism is not appropriate for this project.

The Subsea Cable Protection Reopener that SHEPD submitted in February 2019 did not contain any of the costs associated with the Pentland Firth East Subsea Cable Replacement Project. This reopener was solely to allow for:

'costs incurred, or expected to be incurred, by the licensee in applying recognised and approved measures to protect cables laid on the seabed beyond laying the cable on the seabed and securing it from the low tide mark as the cable emerges from the water in accordance with licensing requirements imposed by Marine Scotland.'

Protection costs related only to the planned RIIO-ED1 subsea cable replacement programme of work.

In conclusion, the High Value Project reopener is the only mechanism by which SHEPD's allowed revenue can be adjusted to allow for the recovery of justified costs associated with the PFE Project.

5 Meeting Customers Electricity Needs on Orkney

The North of Scotland Hydro Electric Board funded the electrification of most of Orkney starting in 1948. Power was mainly supplied from the diesel generator at Kirkwall (Kirkwall Power Station). This power station was built between 1950 and 1952 by the North of Scotland Hydro Electric Board and replaced a smaller power station in St Magnus Lane, in Kirkwall. The Kirkwall Power Station (KPS) is made up of 4 generator sets, with a connected capacity of 15MW.

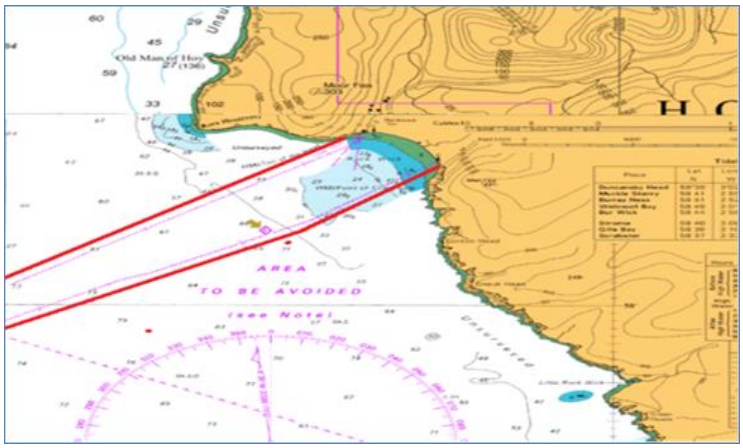
5.1 Subsea Cables

The Pentland Firth East subsea cable (SHEPD_33) was subsequently installed in 1982 as the main source of supply to Orkney. It is a 36.2km, 240mm^2 Single Wired Armour (SWA) 33kV cable rated at 20MW. As demand on Orkney grew, a second 35.5km, 300mm^2 Double Wired Armour (DWA) 33kV subsea cable, Pentland Firth West (SHEPD_95) was installed in 1998 with an operational capacity of 22MW. As shown below, both the East and West cables leave mainland Scotland from Murkle Bay in Caithness (Figure 2) and connect at Rackwick Bay, Hoy (Figure 3). The power is then relayed to mainland Orkney and on to other islands by additional subsea cables. Importantly, both cables provide an essential means to export significant quantities of renewable generation from Orkney to mainland Scotland.

In the event of a fault, or for planned maintenance on the subsea cables, KPS is still required to provide backup supply.

Figure 2: Murkle Bay (Caithness)

Figure 3: Rackwick Bay Hoy (Orkney)



5.2 Orkney Demand and Connected Generation Capacity

Orkney winter peak recorded demand is 34 MW and minimum demand is circa 13MW. In addition, there is a total of 83.2MW of connected generation capacity on Orkney. This generation consists primarily of wind generation (46.7MW) but also comprises gas generation, some connected tidal, and the standby diesel generator at Kirkwall Power Station, owned by SHEPD. 58.9MW of generation is connected on a firm basis with the additional 24.3MW connected through an Active Network Management System (ANM) given export constraints on the island.

The ANM system allows output to be managed as capacity becomes available either through increased levels of demand or other generators reducing their output. The ANM system allows generators to connect while ensuring operational limits of the network are not exceeded and security of supply for customers on Orkney is maintained. This also allows generators to be connected quicker and at lower cost than would otherwise be the case if reinforcement was required.

To meet security of supply requirements there is a need for 2 operational cables connecting Orkney to mainland Scotland. Should only one cable be operational there is a risk that there will not be enough capacity available to meet the demand of customers on the Orkney island group. In the event of high demand or low renewable generation output, backup generation from KPS is required. A second cable is required to meet security of supply requirements and facilitate export of renewable generation.

6 Need for Replacement of Pentland Firth East Subsea Cable

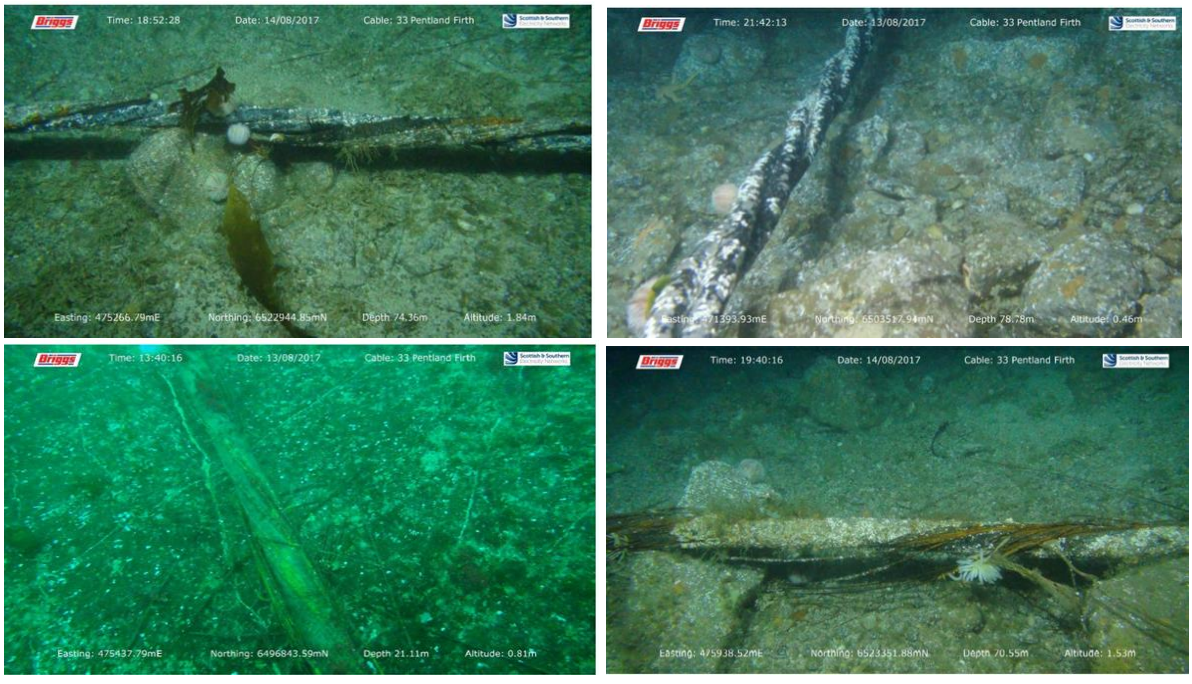
Following on from our RIIO-ED1 Business Plan submission in 2013 and 2014, our proactive RIIO-ED1 inspection campaigns have provided (i) more detailed and (ii) more recent information regarding the condition of our subsea cables. The need for more detailed information has largely been driven by new protection requirements under the new Marine Licensing regime introduced in 2015.

6.1 Inspections

The Pentland Firth East cable has been inspected twice in the RIIO-ED1 period. A near shore inspection was carried out in August 2016 and examined approximately 4.5km of each end of the cable. The results of this inspection identified that the shore end at Caithness had excessive wire amour damage and that further investigation was required. In August 2017 a more detailed inspection of 32.5km was carried out, under our new inspection specification[1] for subsea electricity cables. This identified the cable as having degraded to a greater extent than expected and PFE was reclassified as Asset Health Index category 5 (HI5) i.e. end of serviceable life, replacement required. In locations the armour of the cable has been eroded and some insulation is visible. With the armour being mechanically compromised any force on the cable will be distributed across the insulation and conductors. This can lead to insulation degradation and electrical treeing. SSEN's Submarine Electricity Cables Plan document[2] identifies subsea cables in this condition as needing to be replaced.

A selection of the still photographs captured during the inspection of the cable are presented in the Pentland Firth East Inspection Report (Appendix B). Points of significance along the cable are shown in the Pentland Firth East Points of Interest Report(Appendix C). Examples are shown in Figure 4 below.

Figure 4: Pentland Firth East Inspection Evidence



[1] A new subsea electricity cable inspection specification (SP-NET-CAB-405 – Minimum Requirements for Submarine Electricity Cable - Inspections) was created in RIIO ED1 and has been attached in Appendix D to this submission.

[2] http://news.ssen.co.uk/media/261770/SSEN-Submarine-Electricity-Cables-Replacement-Programme-Booklet.pdf

6.2 Pentland Firth East Investment Decision

SHEPD has an obligation to ensure all network investment is efficient, economic and co-ordinated. Following a review of several replacement options, a 400mm^2 cable option was identified as the preferred solution due to project costs and ability to deliver the required outputs associated with replacing the existing cable. The cable in this option will be rated to a minimum of 30MVA.

6.3 Pentland Firth East Faults

Following a fault on the Pentland First East cable in January 2019, inter-trip arrangements between Scorradale and Thurso ensured there was no interruption to electricity supplies on Orkney. The Active Network Management (ANM) scheme was also reconfigured to operate with Pentland Firth West (PFW) only and to ensure island generation export levels did not exceed the operational rating of the remaining cable (22MVA). Orkney demand was met by the PFW cable and on island generation, including backup power supply from Kirkwall Power Station. Standby generation was also in place as part of SHEPD's contingency plan. The ANM scheme automatically operated to ensure maximum export capacity was made available to island generation, subject to network conditions.

Cable fault location tests were subsequently carried out and the fault was located at Rackwick Bay, Hoy. A repair plan was immediately implemented to replace approximately 8 metres of faulty core. A successful repair was carried out on 10 February 2019 and the subsea cable was re-energised.

A second fault on the cable occurred in March 2019. After further inspection the fault was located approximately 50m below the low water mark from the Rackwick Bay shore end. The repair is currently underway at the time of writing and is expected to be completed in June 2019. In the meantime, security of supply continues to be met as set out above.

7 Introduction of Marine Licences

To undertake the Pentland Firth East Replacement Project, SHEPD must apply for a Marine Construction Licence.

It is essential that the application includes full details of the required pre-application consultation with stakeholders and its outcome; accurate co-ordinates of the location of the works with a chart clearly showing the area the work is to be carried out in (this is particularly important where the cable is to be removed); and details of fishing liaison mitigation action plans which outline how we will undertake work in close proximity to other marine users. Other project specific studies and analysis are required to be submitted to the licensing authority or statutory stakeholders to inform the final Marine Construction Licence determination.

The licences required to replace Pentland Firth East are governed by the marine licensing process which has increased in complexity since the introduction of the Scottish National Marine Plan (NMP) in 2015.

Marine licensing covers activities relating to deposits to and removals from the sea and/or seabed, construction work and use of explosives. The process takes into consideration specific aspects of each proposed development before deciding on whether the development should go ahead and the conditions under which it can proceed.

The licensing of marine activities is designed to ensure that the NMP's General Policies are adhered to. They include supporting economically productive activities, mitigating potential conflicts from interactions with other users, living within environmental limits and delivering climate change objectives.

The NMP recognises that subsea power cables are of vital economic importance and sets out 5 objectives that should be achieved during the installation of new subsea cables:

National Marine Plan Objectives

1. Protect subsea cables whilst achieving successful seabed user co-existence.

2. Achieve the highest possible quality and safety standards and reduce risks to all seabed users and the marine environment.

3. Support the development of a Digital Fibre Network, connecting Scotland's rural and island communities and contributing to world-class connectivity across Scotland.

4. Safeguard and promote the global communications network.

5. Support the generation, distribution and optimisation of electricity from traditional and renewable sources to Scotland, UK and beyond.

The NMP sets out 4 policy statements regarding how cables are to be installed to achieve the objectives set out above. They are:

National Marine Plan Policies

1. Cable owners engage with decision makers early in their planning process to notify of any intention to lay, repair or replace cables.

2. Cables are appropriately routed and protected where feasible.

3. A risk-based approach is taken regarding the removal or otherwise of redundant cables.

4. For the landfall of cables, owners ensure they consider the policies relating to flooding and coastal protection as well as Scottish Planning Policy and Local Development Plans.

To help understand the relative impact on all interest groups, SHEPD led on the development and implementation of a robust Marine Licence Cost Benefits Analysis (CBA) method statement. This was developed through extensive stakeholder engagement and consultation at the beginning of RIIO-ED1, following implementation of the NMP on 27 March 2015.

Cost Benefit Analysis (CBA) Method Statement

The CBA Method statement helps ensure economic and efficient engineering decisions are made around routing, burial, protection and decommissioning of cables whilst ensuring there is not a disproportionate impact on other users, marine wildlife, the environment and electricity consumers. For electricity distribution network projects this ensures a robust, consistent and transparent approach is followed for each project, which sets out the options available and the relative costs and benefits of each in relation to the objectives and policies set out above. Appendices E and F set out our CBA method statement for achieving these objectives.

For Pentland Firth East, the main outcome of the creation of the NMP for SHEPD is that we need to consider cable route and appropriate levels of burial and protection within the project. These include burial in the sea bed or being weighted down with concrete mattresses or rock bags to minimise the possibility that other users of the marine environment could come into contact with the PFE cable resulting in a detrimental impact on their safety or on the marine environment. Appendix G - Pentland Firth East CBA Recommendation sets out our recommendation for method and levels of burial and protection.

8 Pentland Firth East Subsea Cable Replacement

The Pentland Firth East subsea cable is expected to be installed in April 2020 with the full replacement project being completed by August 2020.

Before the Marine Construction Licence application can be submitted, Pre-Application Consultation Events (PAC) must take place. These are scheduled for September 2019. We are planning to engage interested parties such as local communities, environmental groups and local residents. The PACs must run for a minimum of 12 weeks and evidence of compliance must be included as part of the marine licence submission.

The Pentland Firth East project comprises two distinct elements of construction work:

- Offshore works – This includes installation, burial and protection of the new subsea cable and decommissioning of the old cable; and
- Onshore works – This includes modification of the onshore network to connect the new subsea cable to the existing electricity distribution network on Caithness and Orkney and to underground the associated section of the network close to the shore to give added protection.

Offshore works are due to be completed in April 2020 and onshore works are due to be completed in June 2020. Further details are set out below.

8.1 Offshore Works

8.1.1 Subsea Cable Technical System Study

A technical system study was first carried out by SHEPD's system planning team to determine that the proposed 400mm^2 Cu subsea cable, with a maximum route length of 40km, running between mainland Scotland (Caithness) and Orkney (Hoy), has the required technical capability to replace the existing Pentland Firth East (SHEPD_33) 240mm^2 subsea cable. This study also takes into account economic considerations to ensure that overall the least cost option (while meeting technical requirements) is selected. The need for this study was to help inform the replacement cable design and specification for tender to the global market of cable manufacturers. The fully approved system study report for the replacement cable can be found in Appendix H – Pentland Firth East Design Authority Approval.

The full cable procurement process is covered in Section 10 of this document, along with details of the final subsea cable specification that has been used for the procurement of the replacement PFE project. As manufacturing slots are limited, we have secured a slot that will result in cable manufacture being completed in December 2019. The cable will then be stored until it is required for installation by our appointed installation contractor.

8.1.2 Design Development

The policies set out in the NMP mean we have had to significantly change our approach to subsea cable replacement in RIIO-ED1. The NMP policies favour the adoption of the relatively high cost solution of burying cables under the seabed or fully protecting them by other means. Under the NMP it is for the applicant to justify lower levels of burial and protection.

Through our proactive lead in the development of a robust CBA model[3] and methodology[4], supported by extensive stakeholder engagement and industry consultation, we have considered alternatives for

[3] See Appendix I – Pentland Firth East Baseline CBA

[4] See Appendix E - Subsea Electricity Cables Cost Benefit Analysis Model Method Statement Executive Summary and Appendix F - Submarine Electricity Cables Cost Benefit Analysis Method Statement.

installation and protection and analysed these in a robust and transparent manner on a project by project basis. This has ensured replacement decisions are safe, ethical, responsible, economic and efficient. It also ensures appropriate consideration is given to the full impact of our activities on the marine environment and all marine users. This has helped ensure the works we carry out provide appropriate protection and value for money for our customers.

The full CBA analysis for the PFE subsea cable is provided in Appendix G – Pentland Firth East CBA Recommendation. The summary below provides an overview of the key points extracted from the CBA analysis.

The main purpose of the Marine Licence CBA is to provide guidance throughout the design process, inform the final design and ensure engineering considerations cover wider societal and environmental issues. We model different options to consider relevant local circumstances of each subsea cable and determine through the CBA Method Statement and tool what option represents best societal value, represented by the option with the **lowest negative cost in the CBA**, over the investment period. The option with the best societal value (lowest negative cost) then becomes our preferred option for the subsequent and detailed local Marine Scotland Licensing process for individual projects. This process also ensures stakeholders views are considered in the design and licensing process.

In line with the requirements of the NMP there are 3 key phases in all projects which consider routing, method and level of burial and protection:

Phase 1 - Considers the potential level of burial.

Phase 2 – Considers the specific project and risks to determine where additional protection may be required.

Phase 3 – Looks at the sensitivities to identify where designs could be further refined.

Phase 1

In Phase 1 we analysed ability to install the replacement cable using our main burial techniques - Horizontal Directional Drill (HDD), Mass flow Excavation, Trenching and Ploughing. Using information gained from our 2017 subsea cable inspection programme, an option with maximum burial of circa 10.5km, which is both technically feasible and efficient as evidenced by the CBA, was tested. The CBA established that burial of 10.5km would deliver an overall societal impact of **-£20.2m;** this is approximately **£1m** higher than the baseline and lowest installation option of end to end surface lay, which has a societal impact of **-£19.2m** (i.e. lowest net cost).

Phase 2

Under Phase 2, 28 design options (considering specific project risks) were tested in combination under the CBA methodology, to provide a more refined assessment of the optimal solution. Options included up to 10.5km of burial as set out above, utilising HDD for one shore end and installation of protection measures between 3.6km and 36.2km. Options also considered leaving a range of 0.0km to 36.2km of the cable on the sea bed. The cable design options within these ranges of burial, protection, HDD and surface lay had a societal impact of between **-£19.2m (full surface lay) and -£427.2m (full length concrete matressing)**.

Based on inspection information and CBA analysis at the current stage of design, the optimal solution that balances the needs of stakeholders, marine users and customers is determined as a combination

of burial and protection. The CBA insight revealed that utilising 10.5km of burial using Mass Flow Excavation and protection has broadly the same level of societal impact as 5km of burial (Mass Flow Excavation), 4km of rock placement and HDD for one shore end. Therefore, until the depth of burial potential along the length of the new route is confirmed with a route design survey, an option that utilises both burial and protection has been used to forecast costs and for stakeholder engagement. It is viewed as having the additional benefit of delivering protection requirements while also reducing project risk of over reliance on one burial or protection technique.

Phase 3

Following further sensitivity analysis under Phase 3, a further 10 design options were considered including the removal of the existing subsea cable following installation of the replacement cable. Decommissioning and removal of the existing PFE cable was also built into the assumption of the 28 design scenarios tested in Phase 2, so a sensitivity analysis was carried out to look at this aspect in isolation. The results identified that an increase in overall societal value of c.£1.3m could potentially be delivered (through reduced expenditure) if 100% removal after decommissioning is not carried out. As we are only proposing to remove 50% of the existing cable this means the societal impact would be capped at £0.65m. Given the level of risk removed we consider this to be proportionate. Within the CBA analysis the case to decommission and remove the existing PFE is also supported by an increase in societal benefit of c.£0.8m, gained from returning the existing sea bed to a natural state.

In conclusion, we currently plan to decommission 50% of the existing cable immediately after the replacement cable is installed to deliver safety and environmental benefit.

8.1.3 Survey and Subsea Cable Route Corridor

The exact subsea cable route design for the replacement of the PFE subsea cable will be determined following a detailed route survey by the installation contractor, in accordance with our cable survey specification[5]. This will be completed by October 2019. Following the introduction of the NMP in RIIO-ED1, the approach we now adopt for subsea cable replacement project pre-lay surveys has changed significantly. For instance, the installation contractor, when appointed, must now verify installation data and assumptions before commencing work. They must also check that any route design changes imposed by the Marine Licence are achievable and collect data for the optimisation of the overall cable route.

To ensure the required burial and protection activities and obligations can be discharged and full Marine Licence compliance is achieved, the pre-lay survey must now complete the following:

- Collect specific information on debris, obstructions and other irregularities along the installation routes;
- Locate and map in-service and abandoned cables or pipelines, and provide a detailed description of conditions in areas where cables or pipelines cross;
- Acquire all necessary data regarding sea currents, critical wave and wind directions in relevant areas; and
- Undertake any necessary Unexploded Ordnance (UXO) surveys and inspections.

For the PFE route design the cable protection requirements present a particular engineering difficulty e.g. due to adverse seabed conditions such as moving sediment, steep slopes, UXO, removal of out-

[5] A new subsea electricity cable survey specification (SP-NET-CAB-406 – Minimum Requirements for Submarine Electricity Cable – Rouse Survey) was created in RIIO ED1 and has been attached in Appendix J to this submission.

of-service cables crossing the route and removal of boulders along the route. This is expected to require additional investigations and associated licences, including high resolution bathymetry surveys, sub-bottom profiling and video inspections.

To support the design of the final cable route and burial and protection requirements, we have established a minimum set of criteria to ensure a robust, proportionate, transparent and consistent approach is taken for each project, including PFE, under the NMP and marine licensing regime. The relevant criteria contained within our route survey specification are:

- Cables must be installed within initial and/or consented corridors, unless engineering constraints dictate otherwise;
- Comply with conditions set out in the Marine Works Licence;
- Comply with all relevant environmental regulations and legislation;
- Consider the total cable length and installation costs while not undermining cable properties/engineering considerations or increase risk to the subsea cable asset;
- Seek to achieve a low risk route;
- Seek to reduce lifetime system/ route maintenance;
- Seek to reduce or avoid environmental impact or disturbance;
- Seek to avoid areas of archaeological value and other sites of special interest;
- Seek to avoid unstable/steep slopes;
- Propose cable protection design and methodology with supporting risk analysis.

8.1.4 Subsea Cable Installation

To meet the criteria set out in our specification, a replacement subsea cable length of **40km** is required. This is based on the existing cable length of PFE which is 36.2km, adjusted to allow the installation contractor to accommodate:

- Micro siting around currently known obstructions such as ship wrecks, UXOs, archaeological features etc.;
- Route deviations due to topographical features i.e. rock peaks and/or deep crevices;
- Crossing other previously installed cables (known telecoms cables);
- “Pull ins” at the shore ends (such as threading through HDD ducts/onshore trenches); and
- Lengths for jointing through terminal joint pits at each of the shore ends.

The planned replacement cable of 40km is 110% of the existing cable length. Our experience from replacing other subsea cables is that they are, on average, 106% longer than the cable they replace.

A further 4km of cable has been allocated to the project for strategic spares, in line with industry practice. Following the recent faults on the existing PFE subsea cable, it has been confirmed that cable manufacturers do not prioritise orders for short cable lengths. Also, the standard procurement timescale for cables of this specification is circa 18 months. To protect security of supply going forward and to minimise fault costs, strategic spares are an essential component of the replacement programme.

8.1.5 Confirming Design Parameters

At the time of writing, this project is at the design stage. Further detailed route surveys are to be carried out in August 2019. However, the current design description provides a robust overview of what we plan to propose in our Marine Construction Licence application, to be submitted in December 2019. Forecasts have been based on similar subsea cable replacement projects completed over RIIO-ED, providing a useful benchmark for forecasts. While PFE is longer than comparable projects the

percentage of proposed burial 12.5% (5km) is shown to be in line with projects recently completed. For example, Shapinsay Stronsay included 7% Burial, while Rousay Westray included 17% burial. Both projects were completed in June and July 2018 respectively. The sea bed conditions of these two projects also exhibit similarities to PFE, including a soft sandy seabed type which facilities the ability to bury the cable, in line with the NMP, to a safe operational depth, to reduce the risk of third-party interventions. Shapinsay Stronsay and Rousay Westray also required rock bags to be placed along the full length of the cable to prevent the strong tides in these areas from moving the cable, causing wire armour damage and increasing the risk of third-party interaction.

To provide additional evidence in support of our design and proposed approach for burial and protection, in advance of the Marine Licence application, a Stability Assessment Study was commissioned for the PFE project. Details of the study were published in April 2019 and are included in Appendix K – Pentland Firth East Cable Stability Assessment. This was commissioned to further evaluate and support the level of protection proposed in tender negotiations, looking at engineering stability requirements. Table 2 provides a summary of the analysis completed for protection based on an installation length of 40km.

Table 2: Pentland Firth East Required Rock Bag Quantities

Water Depth	Route Length	Rock Bag Spacing	No of Rock Bags
0 – 20m	1,000m	10m	100
20 – 70m	14,000m	20m	700
70 – 80m	3,000m	40m	75
60 – 70m	6,000m	35m	172
70 – 80m	12,000m	40m	300
70 – 20m	2,000m	20m	100
20 – 0m	1,100m	10m	110
Totals:	**39,100m**		**1557**

In summary, the length and depth of the PFE subsea cable, combined with specific seabed, tidal and marine conditions, supports a Marine Licence application requiring permanent deposits of up to **1,560 rock bags along the 40km 33kV subsea cable, along with 5km of burial**.

8.1.6 Percentage of removal after decommissioning

The National Marine Plan also sets out detailed requirements for subsea cable decommissioning and removal, stating:

'A risk-based approach should be applied by network owners and decision makers to the removal of redundant submarine cables, with consideration given to cables being left in situ where this would minimise impacts on the marine historic and natural environment and other users.'

The removal of redundant cables represents a step change from the previous practice of leaving the cables in situ once they are no longer operational.

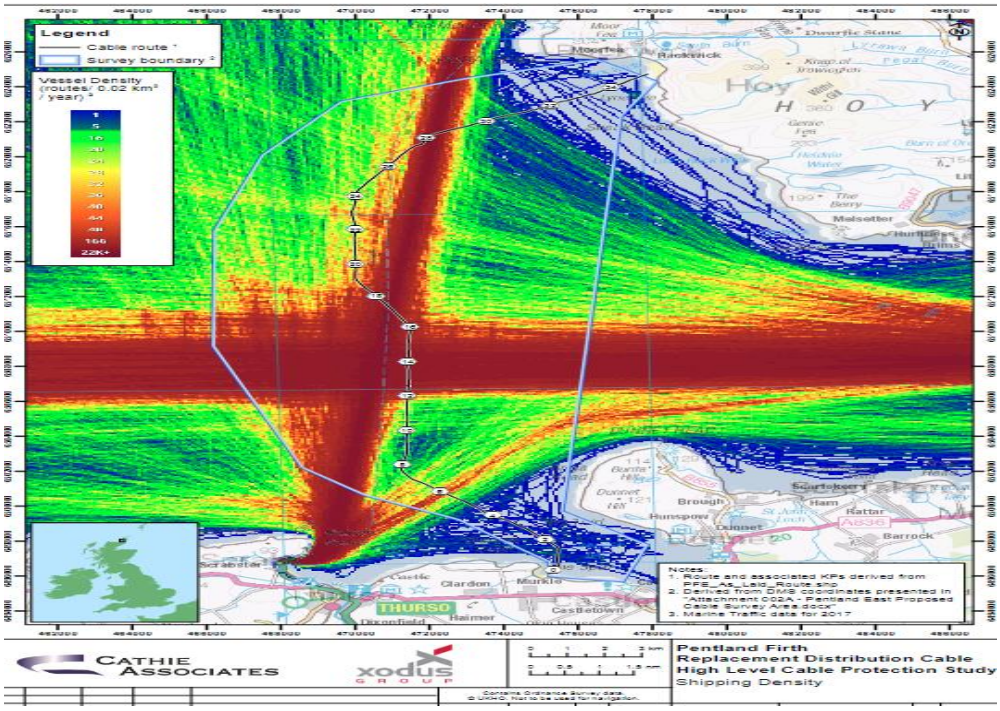
SHEPD's experience to date under the marine licensing regime, is that there continues to be significant debate between stakeholders about the benefits of removing subsea cables once they have been replaced. On the one hand there is a strong argument that removal of subsea cables greatly enhances safety within the marine environment, by removing a snagging hazard, but the counter argument is that subsea cables have been in the marine environment for a significant period of time, and in most cases pose limited additional risk. In some cases, they can form an important part of the marine habitat. As such the removal of each cable needs to be assessed on a case by case basis. As set out

above, the CBA has been developed to ensure all costs and benefits are taken into consideration in determining if decommissioning is appropriate on a cable by cable basis.

Following review of the PFE cable inspections (Appendix L – Pentland Firth East Inspection Overview) we plan to remove **c.18km (50%)** of the current subsea once it is decommissioned. The focus will be on removing areas that are not buried and currently have significant suspensions over rocky ground and therefore post the greatest risk. The decision to remove 50% of the existing cable balances the financial cost to electricity customers with the safety and environmental impact on other marine users associated with not removing the existing cable.

Strong stakeholder feedback in support of decommissioning and removal was provided during the development of the Marine Licence CBA and focused on two key impacts: '***Impact 1****: Decreased health and safety risk to marine vessel operators from cable snagging and* ***Impact 4****: Decreased damage cost to marine vessel operators from cable snagging'*. Based on the feedback from stakeholders and the marine traffic density in the Pentland Firth area (see Figure 5 below - Red being High Activity and Blue being Low Activity) appropriate consideration needs to be given to the risk of cable snagging.

Figure 5: Marine traffic density (Appendix M)



The Marine (Scotland) Act in 2010 also delivered new powers to protect habitats and species of national and international importance through the designation of Marine Protected Areas (MPAs). The current PFE cable is located in or in close proximately to two important areas at Rackwick Bay and Murkle Bay. As a result, the need to operate sensitively in these two designated areas is fundamental to any decision to remove the existing cable.

For the Rackwick Bay area (Hoy) the subsea cable is predominately buried in the sand. Therefore, interaction or contact with the cable requires it first to be excavated. It is therefore proposed that, following review of environmental considerations, the existing subsea cable should be left in this environment. Although the Murkle Bay cable is located out with the nearby environmentally sensitive area, the cable is covered with a greater level of vegetation and thus consideration needs to be given to the impact on the overall marine ecosystem if the cable was removed. Although detailed analysis

will be carried out as part of the final design phase, based on the inspection report (Appendix B) and Inspection Overview (Appendix L), it is planned that the cable will be removed as much as possible on the approach to Murkle Bay as the existing cable crosses with two telecommunications cables.

From an economic and efficiency point of view, ongoing negotiations with installation contractors have informed cost forecast for the removal of the decommissioned cable directly following the installation of the replacement PFE cable. Costs are based on the same installation vessel carrying out installation and removal activities. With appropriate planning this would deliver savings with a unit rate of [redacted] (see Appendix A).

In summary, there is no operational need to retain the existing PFE cable in the subsea environment after the installation of the replacement cable and compelling safety and environmental reasons to remove sections. We have evidence from inspections that sections of the cable are buried, and the CBA provides quantified arguments that for these areas of burial and other environmentally sensitive areas, there is a higher societal benefit associated with leaving the cable in situ. However, for remaining sections, a balanced societal view dictates removals of sections not in sensitive areas or secured by burial. We plan to remove 18km of cable that meet the relevant criteria. When delivered with the main replacement programme this is forecast to deliver savings [redacted].

8.2 Onshore network modification

As part of this replacement project, additional underground cable works will be required to connect the new subsea cable into the existing network at both Rackwick Bay, Hoy and at Murkle Bay, Caithness.

8.2.1 Caithness Modifications

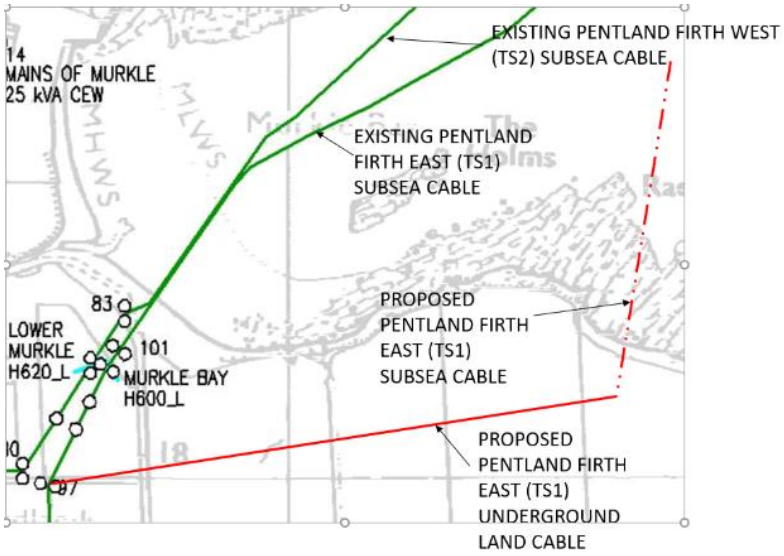
Currently both Pentland Firth East and Pentland Firth West subsea cables make landfall in Murkle Bay. Due to close proximity of the existing live cables it is unsafe to consider installation of a third cable alongside, on the beach at Murkle Bay. For this reason, we are planning to bring the cable ashore at a location to the east of Murkle Bay. The landfall here consists of sub-vertical cliffs with solid rock ground conditions. The best installation method here is Horizontal Directional Drilling (HDD). HDD is a guided drilling technique in which a borehole is drilled along a predetermined path. It is typically required where the sharp change in topography and/or ground conditions dictate that a trenchless technique would be more practical than deep open cut excavation methods. The final route of the subsea cable will be designed in conjunction with the Survey Design and Installation (SDI) contractor but installing the cable by this method reduces exposure to the tides and therefore reduces the risk of the replacement cable becoming exposed on the beach and being damaged by rocks and other debris moving in the inter tidal zone.

We will install approximately 2km of underground cable to join the subsea cable from the subsea joint pit to the existing overhead line. This work will result in a short section of overhead line becoming redundant. This will be decommissioned and removed.

Figure 6 below provides a Geographical Information System (GIS) map of the onshore overhead line area showing the existing route of the Pentland Firth East cable and the proposed new onshore cable route.

[6] To remove the PFE subsea cable, after the installation vessel has demobilised from site, a fully inclusive decommission rate of £256k/km has been quoted for the process.

Figure 6: Murkle Bay, Caithness

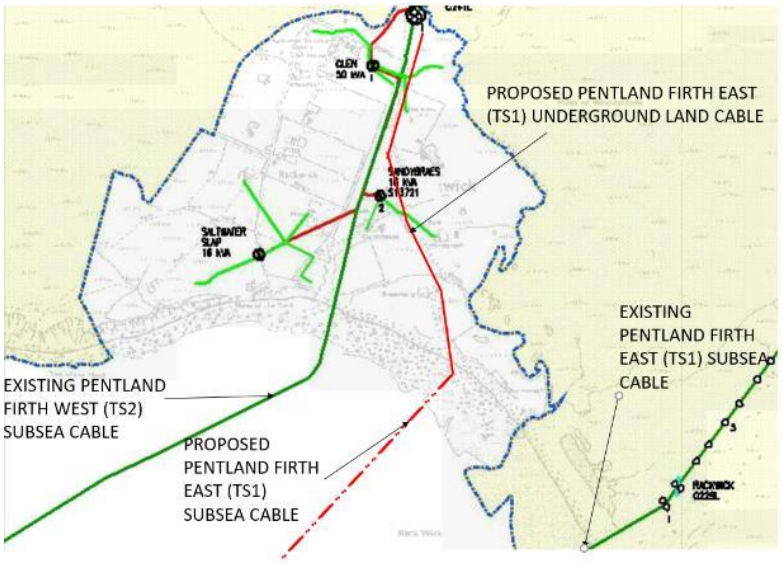


8.2.2 Island of Hoy Modifications

On the island of Hoy, the replacement subsea cable is currently planned to be installed between the positions of the existing east and west cables. Modifications at the shore ends will protect against future movement of the sand and uncovering of cable, which once exposed is subject to damage, particularly from the strong tides and moving rocks in the intertidal area. Prior to 2010, sections of the existing cable on the shore have been protected by cement bagging. After 2010 cast iron mechanical protectors have also been used to prevent the cable from being damaged. These issues will be avoided in the new location as highlighted in Figure 7. The replacement cable will be installed within a channel of harder bedrock which will protect the cable and reduce the risk of exposure.

Figure 7 provides an illustration of where the existing subsea cable is currently installed in relation to Rackwick Bay and the Pentland Firth West Cable. It also provides a view of where the new cable will be installed and how the new landing point will be connected to the existing distribution network.

Figure 7: Rackwick Bay, Hoy

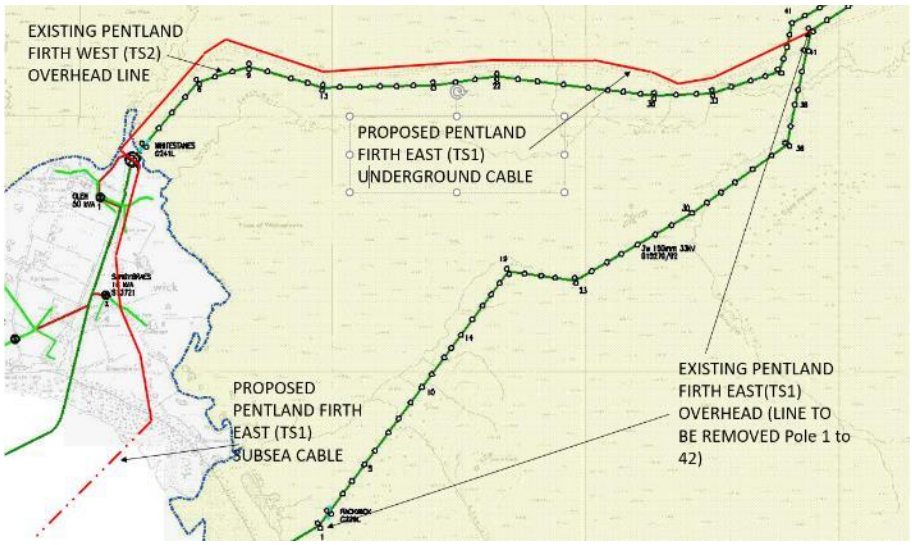


The onshore modifications also include the installation of a further 4km of underground cable on land, removing overhead lines in an environmentally sensitive Special Protected Area on Hoy. The new circuit will connect at pole 42 (Figure 8). After the new connection has been completed the redundant overhead line and associated infrastructure will be decommissioned and removed.

The current overhead line suffers from corrosion associated with close proximity to the sea. To prevent damage and failure of the cable, routine maintenance is carried out to clean the salt deposits off the equipment. The new shore end locations will improve access for inspections and maintenance and provide safer working conditions.

The new route will be installed through heathland adjacent to the existing public highway and moves the cable away from its original route which runs through an environmentally sensitive area. It will follow a similar on shore route to the PFW cable. Operational access to the buried cable would be infrequent but avoid the need to obtain permissions to gain access to these sensitive environments.

Figure 8: Rackwick, Hoy Proposed Onshore Cabling



9 Efficient Expenditure: Pentland Firth East Replacement Costs

We forecast the costs associated with the replacement of the Pentland Firth East subsea cable, including protection, decommissioning and removal to be **£30.0m**. This includes actual costs incurred to date and forecast costs for the remainder of the project. Forecasts are derived from a combination of tender returns and analysis of costs incurred in subsea cable replacement projects completed in the last year. A full breakdown of the costs is presented for each activity in Appendix A – Pentland Firth East Project Cost. A summary is provided in Table 3 below.

Table 3: Pentland Firth East subsea cable replacement costs (2012/13 prices)

Activity	**Total**	Spend Profile in RIIO-ED1 (£m)		
		2018/19	2019/20	2020/21
Indirect Costs	[redacted]	[redacted]	[redacted]	[redacted]
Regulatory consent and Engineering	[redacted]	[redacted]	[redacted]	[redacted]
Plant and materials	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Total	**30.0**	0.2	14.0	15.8

As outlined in Table 3, PFE High Value Project costs can be separated into four distinct areas:

- **Indirect Costs** [redacted]
  These include actual and forecast internal and external project management costs, including travel, to support the end to end replacement of the PFE cable.

  As this project is in addition to our planned RIIO-ED1 replacement programme activities and costs are ring-fenced and directly associated with a specific team, established in April 2018[7]. The team will be required through to the end of July 2020, to fully support installation, decommissioning and removal. The team will also help ensure all project risks are identified, mitigated and managed.

  The project also includes external project management resource for specific tasks and periods as required. This provides greater flexibility and efficiency as dedicated resource can be secured quickly and stepped down as required. A core SHEPD team will manage external resource and provide an interface to SHEPD teams. This will also help ensure any specific knowledge is retained in the core project. Project resource requirements, and overall indirect project costs will be monitored throughout the project life cycle to ensure quality and efficiency of delivery.

[7] It is forecast that the PFE team will need to be in place for a period of over two years from April 2018 to July 2020. This is based on an April 2020 installation date.

- **Regulatory consent and Engineering** [redacted]
  As part of the PFE replacement project there is a need to employ third-party service providers to carry out key regulatory consenting and support activities. This support will include carrying out technical studies, providing legal opinions and preparation of specific project evidence to ensure necessary consents are achieved on time to meet project deadlines and ensure compliance. The assessment of activities and support required in these areas is based on experience of delivering other subsea cable projects over RIIO-ED1, including requests for information from key stakeholders including Marine Scotland, Scottish Natural Heritage (SNH), Historic Scotland, Crown Estate, Planning Authorities, Harbour Authorities, marine users (including Fishing Associations) and electricity customers on the islands.

  This category also includes payments of licencing fees (Marine Licences), agent fees and compensation payments to allow the installation to progress.

- **Plant and Materials** [redacted]
  Within the PFE replacement project, there are several items of plant and material that we have already procured specifically for the project due to long manufacturing and delivery lead times such as the subsea cable which represents [redacted] of the total Plant and Material costs. Another component of Plant and Materials is subsea cable accessories, required to connect the replacement cable via the transition cable joints onto the existing distribution electricity network. The cable accessories will be compatible with the manufacturing specification for the new subsea cable and are included as part of the cable tender and contract award. It can be difficult securing manufacturing slots for distribution network subsea cables due to the high demand from offshore windfarms. Because of this we placed our order in an available slot that will mean the cable will be ready for collection in December 2019. Storage will be required until all consents can be secured, and an appropriate weather window is available. Therefore, storage costs are also included in this cost category.

- **Construction** [redacted]
  The construction cost category of the PFE replacement project is divided into two related work sections - Construction Onshore and Construction Offshore.

  - **Construction: Onshore Works** [redacted]
    The final design and route of the onshore works will be determined by the final subsea cable route design. However, the project team in conjunction with statutory stakeholders and other interested parties has developed a credible option. This has been used to forecast the costs to complete the required work, using unit rates from similar completed projects. Forecast diesel generation costs have also been included to ensure security of supply during the energisation of the replacement PFE subsea cable. Details of our onshore works have already been provided in Section 8.2 above including development maps (Figures 6 to 8).

  - **Construction: Offshore Works** [redacted]
    The main element of the offshore construction works is the Survey, Design and Install part of the PFE replacement project which has been tendered with global installation contractors. The target contract award date is July 2019. The contractor will be a key partner responsible for the installation of the replacement PFE cable safely, economically and efficiently.

- The aim of the tender is to appoint an installation contractor who will carry out the route survey and design for the offshore project works. SHEPD will ensure the appropriateness and compliance with key project parameters such as length, cost, route, depth and technical requirements. Once a detailed design has been agreed, offshore works will commence in early 2020. The current tendered cost for survey, design and install (excluding burial and protection) is [redacted] The tender process in support of this is detailed in Section 10. Our approach of using the same contractor drives efficiencies and helps reduce overall project risk[8]. SHEPD will be responsible for approving final design, installation, burial and protection methodologies.

- After installation the contractor will complete the required burial and protection as required by our Marine Licences. The additional cost of burial and protection [redacted] was informed by our marine licence CBA analysis and tendered framework unit rates. The forecast evidence for the burial and protection costs, including unit rates and references are included in Appendix A.

- To discharge our marine licence conditions, the installation contractor will also undertake a post lay survey to provide evidence of installation. The conditions are focused around our ability to clearly inform other marine users where our subsea cable has been installed and the type and volume of protection that has been deposited on the seabed. The final element of the offshore construction works will be the removal of 50% of the existing PFE subsea cable after decommissioning. The forecast costs of [redacted] has been informed by stakeholder engagement and tendered unit rates. The calculations for these costs are included in Appendix A.

[8] The contract will be awarded in two stages to ensure the most economic rates are achieved based on the best available information.

10 Our Approach to Procurement

As a regulated business we are required to comply with the Utilities Contracts (Scotland) Regulations 2016 (UCSR). To meet these requirements and ensure value for money, work associated with this project has been competitively tendered. This section sets out details of that competitive process and associated contractual arrangements.

Two options were considered for the initial procurement strategy as detailed below:

Option 1: Identify and procure the main materials (Subsea Cable) and services (Survey, Design and Installation) individually from distinct contractors.

Option 2: Identify a preferred supplier who would develop a turnkey package including Cable Manufacture, Survey, Design and Installation.

The strategy adopted for the first stage of the project was Option 1. However, following further review, Option 1 was refined to a two-contract delivery model, combining Survey activities with the Design and Installation contract. This is expected to improve efficiency and reduce delivery risk as the contractor selected for design and installation also has responsibility for survey works, ensuring greater focus and accountability throughout the end to end process.

The subsea cable is being procured separately to allow an installation date of April 2020 to be met. The critical path for procurement of cable in this case takes into account the lead time for cable manufacture.

10.1 Procurement Work Packages

Following further review as set out above the work packages for the project are as follows:

- Work Package 1 – Cable Manufacture and Supply[9]
- Work Package 2 – Survey, Design and Installation[10]

10.1.1 Work Package 1 – Cable Manufacture and Supply

This package includes cable manufacture and supply, including storage. While the total length of cable being procured under the tender is 50km, this length of cable will not be utilised by the Pentland Firth East Replacement Project. The current forecast route length for PFE is 40km, as set out above, with an additional 4 km for strategic spare. This leaves 6km to be utilised and allocated to our planned RIIO-ED1 replacement programme, for the SHEPD_34 Mainland Orkney Hoy project.

[9] The cable manufacture contract also includes subsea cable accessories and temporary storage of the cable until the subsea cable installer ready to collect the cable for installation.

[10] The installation contractor will also be responsible for burial and protection of the replacement cable and decommissioning of the existing cable. This was however not included in the initial works information to allow a cost comparison to be carried out on known activities. The costs of burial, protection and decommission are based on inspection data currently and will be confirmed after the route survey has been conducted in summer 2019 and prior to submission of the marine licence.

Pre-Qualification and Invitation to Tender (ITT) Process

As the anticipated value of the goods (Subsea cable) required for the replacement PFE project exceed the European Union award threshold the goods need to be tendered in accordance with the Utilities Contract (Scotland) Regulations 2016. The first stage of this procurement process is to carry out a prequalification review of suppliers. This was carried out using Achilles an intermediary company used by SSE Group to pre-qualify suppliers. This was followed up with an Invitation To Tender (ITT), issued to all relevant suppliers who passed prequalification.

Achilles Criteria

Within the Achilles system the product code: *'3.7.21 Subsea cables'* was identified as the main category for the manufacture of the PFE subsea cable. Through the prequalification and ITT process potential suppliers were identified and assessed using a tender evaluation process. The initial assessment was performed using the standard criteria within Achilles. From this process a shortlist of [redacted] potential suppliers was identified; [redacted] subsequently decided to tender for the manufacture and supply of the PFE subsea cable. Following evaluation of submissions, [redacted] progressed to the ITT stage:

[Redacted]

Following receipt of tenders from the [redacted] suppliers, [redacted] was selected as the preferred supplier based on their tender submission and delivery timetable. The contract was awarded in May 2019 (see Table 4) with a delivery date of December 2019.

Our tender management system Emptoris has been used to manage the end to end tender process, to ensure transparency, consistency and fairness throughout the process and compliance with the EU procurement regulations. The delivery of the [redacted] subsea cable contract will now be managed through our contract management system (Sypro) by the project Contract Manager and Quantity Surveyor to ensure economic and efficient delivery of the cable.

10.1.2 Work Package 2 – Survey, Design and Installation

Work Package 2 includes the survey of the route corridor, design of the cable route and installation of the replacement subsea cable. To protect electricity customers, financially, this contract will be awarded in two parts which will be run consecutively. Part A includes only the route survey and route design elements and Part B includes all associated works for the subsea cable installation. This two-stage contracting approach has been successfully implemented by SHEPD on previous subsea cable projects and ensures greater certainty of project scope, liabilities and financial outcome.

To obtain project certainty Part A of the contract will be completed first and the survey route and route design output will be used to refine the final installation project scope (Part B). The installation project scope will include all offshore elements including laying the cable on the seabed and installation of all required burial and protection requirements. The decommissioning and removal of the existing PFE cable will also be included and contracted under Part B.

Pre-Qualification and Invitation to Tender (ITT) Process

Similar to the subsea cable supply contract, the anticipated value of survey, design and install works will exceed the European Union contract value threshold of £312k and thus the works have been tendered in accordance with the Utilities Contract (Scotland) Regulations 2016. The first stage of this procurement process is to carry out a prequalification review of potential suppliers through Achilles. An ITT was then issued to all relevant suppliers who passed prequalification.

Achilles Criteria

Within the Achilles system the product code: *'4.2.16 Subsea Cable Services-Subsea Cable Installation'* was identified as the main category for the design and installation of the PFE replacement subsea cable. Through the prequalification and ITT process potential suppliers were identified and scored according to the tender evaluation process and criteria within Achilles. A shortlist of [redacted] suppliers was identified and from this [redacted] were selected to participate in the ITT as set out below:

[Redacted]

Of the [redacted] suppliers set out above, [redacted] were already on our subsea cable framework contract - Boskalis, Global Marine and Briggs Marine. An assessment matrix was developed as part of the overall tender process, setting our model questions and answers. Following completion of this process [redacted] of the [redacted] contractors have been shortlisted to participate in a "*Best and Final Offer"* round. The companies shortlisted are:

[Redacted]

Based on the latest stage in the process for both Part A and Part B, further analysis of submissions by potential contractors will be carried out and used to identify the preferred supplier, with a planned contract award targeted for July 2019.

10.2 Contract Award Status

The procurement programme through to contract award for the two work packages (Work Package 1 – Cable Manufacture and Supply and Work Package 2 – Survey, Design and Install) are outlined in Table 4.

Table 4: Progress of main procurement contracts

Procurement stage	**Work Package 1 Cable Manufacture and Supply**	**Work Package 2 Survey, Design and Install**
PQQ issued	26/04/18 (complete)	11/07/18 (complete)
PQQ returned	14/05/18 (complete)	02/08/18 (complete)
PQQ scored and notified to applicants	23/05/18 (complete)	11/09/18 (complete)
Invitation to Tender issued	05/09/18 (complete)	29/11/18 (complete)
Tender return	12/10/18 (complete)	31/01/19 (complete)
Tender evaluation complete	25/01/19 (complete)	[redacted]
Contract award	15/05/19 (complete)	[redacted]

10.2.1 Work Package 1 - Subsea Cable Manufacture Contract Cost (Nominal Value)

In reaching a final signed contract with [redacted] on the 15 May 2019 a total saving of [redacted] has been achieved by SHEPD relative to the highest priced tender. A competitive global market tender, clear specification and rigorous assessment process has all ensured an efficient contract price.

[Redacted]

Full details of the subsea cable specification (Appendix N) and subsea cable costs [redacted] from [redacted] are attached. The financial information also included in support of this reopener (Appendix A – Pentland Firth East Project Cost) only reflects the Pentland Firth East proportion of the overall contract value.

10.2.2 Work Package 2 – Survey, Design and Install Contract Cost (Nominal Value)

As this work package is currently under refinement and evaluation, the final contracted price for survey, design and installation works (excluding burial and protection and decommissioning) is yet to be determined. To date we have received three tender prices.

[Redacted]

In support of our forecast in Section 9, a full cost breakdown of the lowest price to carry out Survey, Design and Install (excluding burial, protection and decommissioning) has been provided in [redacted]

11 Outputs

As outlined in Section 3, for a project to be considered for funding under the High Value Project reopener mechanism, it must include clear outputs which demonstrate the cost benefit case, and which will allow the performance of the project to be assessed at the end of the price control period. Similar to our planned replacement programme for RIIO-ED1, the main output and benefit that will be delivered through the Pentland Firth East subsea cable replacement project is a reduction in Risk Index points of **453,752**.

11.1 Risk Index Points

Risk Index is designed to allow DNO's to demonstrate the overall condition of their network assets, on an asset by asset basis. The Risk Index is made up of two variables, Health Index and Criticality Index:

- **Health Index** represents the condition of the asset and in turn its Probability of Failure.
- **Criticality Index** represents the criticality of the asset to the distribution network and in turn its Consequence of Failure.

Therefore, the level of risk on the network can be assessed across all asset types to ensure the investment in the network delivers the required level of risk reduction.

The Risk Index is calculated as set out below. Volume is calculated in metres (m) of addition or disposal of asset.

Risk Index points = Volume x Probability of Failure (Health Index) x Consequence of Failure (Criticality Index).

The Criticality Index consists of four bands, C1 being low criticality and C4 being very high criticality. Assets are categorised based on the relative magnitude of the consequence of failure compared to the average consequence for the relevant asset category. The PFE subsea cable has been categorised as C2 – average criticality predominately based on the number of customers which would be affected if there was a failure.

The probability of failure is assessed using the Health Index as outlined in Common Network Asset Industry Methodology (CNAIM)[11]. In summary, the Health Index is a method for collecting information relating to Asset Health to derive its Probability of Failure. The Health Index consists of five bandings, HI1 covering a 'New or As New' asset to HI5 covering assets at 'End of Serviceable life, intervention required'. The Pentland Firth East subsea cable was categorised as HI5 following the results of the end to end inspections in August 2017. During these visual inspections it was identified that the cable's external wire armour was in critical condition. The inspection report for PFE is contained in Appendix B.

More information about the Risk Index methodology can be found in the DNO Common Network Asset Indices Methodology[12].

11.1.1 Risk Index Point Calculation

Table 5 below sets out details of Risk Index points produced using CNAIM for every metre of Extra High Voltage (EHV) subsea cable. For example, if a metre of HI5 C1 EHV subsea cable was removed,

[11] CNAIM is a common framework of definitions, principles and calculation methodologies, adopted across all GB Distribution Network Operators, for the assessment and forecasting of asset risk.

[12] The DNO Common Network Asset Indices Methodology (CNAIM) - https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

this would deliver 9,853 points. However, this must be netted off with the value of subsea cable that it is replaced with i.e. 985 points for an EHV subsea cable rated HI1 C1. This means a net reduction of 8,868 points per metre could be achieved.

Table 5: Extremely High Voltage (EHV) Subsea Cable Risk Index (per metre)

EHV Subsea Cable Risk Index Point Matrix					
	HI1	**HI2**	**HI3**	**HI4**	**HI5**
C1	985	1,467	2,594	4,201	9,853
C2	1,408	2,096	3,705	6,001	14,076
C3	2,111	3,144	5,558	9,002	21,114
C4	3,519	5,239	9,264	15,003	35,190

The corresponding calculation for the PFE replacement project is set out in Table 6 below. This takes account of the length of cable to be removed and the length of replacement cable. It also takes into account the respective Health Index and Criticality Index.

Table 6: Reduction in Risk Index points

Cable Name	**Length (m)**	**Risk Point Index**	**Total Risk Points**
Pentland Firth East (SHEPD_33)	36,237	HI5 C2 (14,076)	510,072
Pentland Firth East Replacement	40,000	HI1 C2 (1408)	56,320
Risk Index Reduction Output			**453,752**

As illustrated in Table 6 when the current PFE cable (SHEPD_33) is removed in April 2020, it will reduce the overall risk on our distribution network by 510,072 points. However, following installation of the replacement cable, the change in Risk Index Points will be 453,752. This is driven by the new cable being rated as HI1 C2. The Criticality Index will stay the same as the network configuration will not change.

11.2 Customer Interruptions/ Customer Minutes Lost Benefit

The current network arrangement for the Orkney Islands has the two Pentland Firth cables (SHEPD_33 and SHEPD_95) providing the P2/6 compliant security of supply level. In the event of a failure of one of the cables two cables, Kirkwall Power Station is available to meet the excess demand. In the event the PFE cable was not replaced, the network arrangement would be altered. The Pentland Firth West subsea cable and KPS would need to operate in conjunction to meet all demand. The impact of any fault on the remaining Pentland Firth West subsea cable would therefore be significant, particularly as Kirkwall Power Station is only intended as a backup generator given its age and environmental considerations.

For instance, with maximum demand on the islands has reached 34MW. If Pentland Firth West (PFW) with an operational capacity of 22MW was to fail the island would be wholly reliant on KPS with a capacity of 15MW. The shortfall would need to be met by other means. There are several renewable

generators connected on the islands but due to their intermittent nature they could not be considered as a reliable contingency option. Any alternative solution would be needed to keep the lights on at times of peak demand.

There are two options that could be considered in the event of a failure of the PFW cable. Firstly, Mobile Diesel Generation (MDG) could be sourced and kept on the islands, on a permanent basis, to meet demand should it be required. This would incur a standby cost and running costs. These costs would be in addition to the diesel costs incurred by KPS to run its 4 diesel generators. Should there be a cable fault then it is possible there would be no CI/CMLs incurred as the MDG could potentially meet demand very quickly.

A second approach would be to mobilise MDG to the islands following a fault on the PFW cable. It could be expected to take a minimum of 48-hours for the generation sets to be moved to the islands and connected to the island network. If this approach was taken, then KPS could not be relied upon to meet demand all potential demand. If a fault was to occur at a time of peak demand, the CI/CML impact could be expected to be 7,742CIs and 22,297,783CMLs in the 48-hour period until MDG could be used to meet demand.

11.3 Other benefits

There are also other benefits to the replacement of the Pentland Frith East subsea cable that cannot be fully quantifiable at this time but provide further strength to the need for this High Value Project.

11.3.1 Constrained Generation Export

On Orkney there is 67.7MW of connected generation not including Kirkwall Power Station. At a time of minimum demand (approximately 13MW), and maximum generation on the islands it is possible that both Pentland Firth cables could export their full capacity (42MW) to the mainland and demand would still be met. If there was only one Pentland Firth cable in operation, output would have to be constrained at times of high generation. This could have an economic impact on island generators and community windfarms on the Orkney islands.

11.3.2 Environmental Impact

Kirkwall Power Station operates as a backup generator to meet demand on Orkney in the event of one of the subsea cables not being in operation. As this is a diesel generator there is an environmental imperative to keep its operation to a minimum to avoid the production of Greenhouse Gases. If KPS was required to run at increased levels output would be balanced against the levels of renewable generation on the island but there would still be a considerable increase to SHEPD's carbon footprint and a wider environmental impact.

12 Cost Recovery Arrangements for the Reopener

As set out in the Introduction, licence CRC 3F sets out a mechanism:

'(a) to specify the basis on which the licensee's opening levels of allowed expenditure on uncertain cost activities, as specified in Table 1, can be revised; and

(b) to determine any appropriate revisions to PCFM Variable Values for the licensee relating to uncertain cost activities and the Regulatory Years to which they relate, for the purposes of the Annual Iteration Process for the ED1 Price Control Financial Model '

The Price Control Financial Model is already set up to allow the recovery of relevant High Value Project costs through the MOD value.

Table 7 below summarises the relevant Pentland Firth East High Value Project costs incurred to date and forecast costs for the remainder of the RIIO-ED1 period (in 2012/13 prices).

Table 7: Pentland Firth East HVP Costs (Duplication of Table 3)

Activity	**Total**	**Spend Profile in RIIO-ED1 (£m)**		
		2018/19	2019/20	2020/21
Indirect Costs	[redacted]	[redacted]	[redacted]	[redacted]
Regulatory consent and Engineering	[redacted]	[redacted]	[redacted]	[redacted]
Plant and Materials	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Total	**30.0**	0.2	14.0	15.8

The established process of adjusting the MOD value each year, for future Regulatory Years, means that given the timescale for this reopener, we would expect an Ofgem determination towards the end of 2019 to feed into the 2020/21 Regulatory Year, but given the notice period for changes to Distribution Use of System (DUoS) charges, the 2020/21 MOD values would not be reflected in tariffs until 2022/23. As with other reopeners, we would expect adjustments to be profiled in line with the expenditure profile set out above. Appropriate adjustments will require to be made to take account of:

- The time value of money;
- SHEPD's RIIO-ED1 capitalisation rate; and
- Adjustments to SHEPD's opening RAV for RIIO-ED2.

13 Conclusion

Special Licence Condition CRC 3F sets out the requirements of a High Value Project. This submission has demonstrated that all of these have been met.

In its RIIO-ED1 Business Plan, SHEPD did not apply for any funding for High Value Projects. However, inspection of the Pentland Firth East cable in 2016 and in 2017 demonstrated the need for the full replacement of the asset.

This cable is integral to providing security of supply to SHEPD's customers on Orkney. It also allows renewable energy to be exported to the Scottish mainland. At times of low generation on the island, the absence of a dual cable connection between Orkney and mainland Scotland means the full demand of the archipelago cannot be satisfied. Any shortfall needs to be met by Kirkwall Power Station. This is not an appropriate means of providing long term security of supply. The absence of a second cable can also lead to constraints in export of generation at times of high generation output and low demand.

This submission sets out the expenditure required to replace the existing Pentland Firth East subsea cable to maintain security of supply. It shows replacement costs including protection, decommissiong and removal are both economic and efficient.

Since the beginning of RIIO-ED1 SHEPD has proactively installed 25km of subsea cable and within the next few months it plans to energise a further 15km. The successful project delivery evidences a strong track record of delivering subsea cable projects under the rigorous marine licensing regime developed since the introduction of the Scottish National Marine Plan in March 2015. Although the replacement of the PFE subsea cable will be the single largest project undertaken by SHEPD, at **£30.0m,** the dedicated project team supported by a globally recognised cable manufacture and vastly experienced installation contractor give confidence that the project will be delivered on budget and on time.

The progression of the PFE project through our stringent Large Capital Project governance process has ensured that a robust challenge of costs and project scope has been undertaken and this challenge has been provided in the evidence to support this submission.

In summary, this submission seeks to recover the costs of £30.0m (2012/13 prices) associated with the replacement of critical SHEPD infrastructure, namely the Pentland Firth East Subsea Cable in RIIO-ED1 at a cost of **£30.0m (2012/13).** The main benefits associated with the project include retaining security of supply and delivery of **453,752** risk index points.