Cost Benefit Analysis Model

The Final Cost Benefit Analysis (CBA) Recommendation

The **Final Recommendation** for the 11kV submarine electricity cable **Mull - Coll** is Option 1F:

- Cable surface laid on the seabed – Approximately 9.50km
- Split pipe protection carried out at shore ends – Approximately 0.56km
- Burial via post lay Jetting – Approximately 5.4km
- No decommissioning carried out on the existing cable
- New cable is decommissioned at end of economic life

This was deemed to be the best value solution based on the available information:

The **Final CBA Recommendation** scenario has an overall societal value of **minus £16,699,682.** This includes consideration of impacts on health and safety, socio-economic, environmental, and wider economic and engineering impacts.

It should be noted that the **Project Description**, **Cable Burial Risk Assessment (CBRA)** and final engineering design may not fully reflect the CBA recommendation which is developed to inform the design process and highlight where societal value is impacted. The granularity of the CBA model does not permit modelling of exact lengths of protection and stabilisation which may have been identified in the project description and therefore the results output provides indicative results of similar install scenarios.

The final recommendation is the preferred installation method, given the information available at the time of modelling the CBA from the cable route engineering processes and when considering the National Marine Plan. The preferred option has a lower value to society that some of the other options, but based on the information available at the point of modelling allows for protection & stabilisation of the cable and includes shore end protection which has been determined to be essential for the mechanical protection of the cable in prolonging cable life, although it does have an impact on the societal value of the solution. This solution also takes into consideration views of stakeholders.

The CBRA will inform the final design regarding protection measures, including the potential for rock placement, in areas where burial may not be achievable and there is evidence of fishing activity on the seabed. Rock placement has therefore been allowed for as an option within the Project Description and Marine Licence application. However, at the time of modelling the CBA there is significant uncertainty regarding any requirement and related costs for this and as such a scenario for this has not been included. If rock placement is required, then the CBA may need to be updated to reflect this.

Areas where stabilisation is required will be defined in the OBS On-Bottom Stability (OBS) study. The OBS study will define how much the cable is predicted to move under storm conditions using DNV approved software, if the cable is predicted to move by more than 10 x its Outer Diameter then it is considered to be unstable. Where the cable is shown to be unstable, Rock Bags, concrete mattresses, burial or similar methods may be proposed in addition to the CBA recommendation in order to stabilise the cable.

Introduction

The Mull - Coll submarine cable has been identified as being in a Critical condition during SHEPD submarine cable inspections. Various options have been considered to rectify the critical conditioned cable including attempting a future piece in repair should the cable fault or replacement prior to such an event, with the latter being deemed the only viable option for this specific cable.

As such this CBA model has been developed to help in selecting how the replacement submarine electricity cable will be installed in the marine environment. The model was designed to help identify the best value method of cable installation, burial, protection, inspection, and maintenance which satisfies all current legislation. It allows modelling of the perceived material risks and impacts at this point in the project.

Background

SHEPD collaborated with stakeholders to develop the CBA model. The model helps SHEPD understand the impacts that different engineering decisions around cable installation can have on the safety of mariners, energy costs for communities we serve, on local and national economic activity and on the natural environment[1].
The CBA Model allows us to make informed judgements guided by a clear set of values - ensuring that every decision is as ethical, responsible, and as balanced as it can be. The CBA model assigns financial values across the following key categories for each cable installation method and design[2]:

- Health and safety
- Socio-economic
- Environmental
- Wider economic and engineering

These values are then aggregated to estimate the **'societal value[3]'** of each solution. The best value[4] solution becomes the option that we recommend in this summary.

Approach taken to arrive at the final recommendation

The starting point for the CBA process is Scotland's National Marine Plan (NMP) (2015) which highlights the following policies, in Chapter 14, which need to be considered on a case by case basis for reaching a decision regarding the development and activities involved in installing a submarine electricity cable:

- Cables should be suitably routed to provide sufficient requirements for installation and cable protection.
- New cables should implement methods to minimise impacts on the environment, seabed, and other users, where operationally possible and in accordance with relevant industry practice.

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[1] For details of why and how the Cost Benefit Analysis Model was created see http://news.ssen.co.uk/media/266234/CBA-Model-Statement-Executive-Summary.pdf
[2] The Submarine Electricity Cables Cost Benefit Analysis Method Statement can be found here: https://www.ssen.co.uk/CBAFULL/
[3] Societal value is the cost or benefit to society which includes the private costs / benefits plus any external costs / benefits. Private costs / benefits in the CBA model would be regarded as the Economic and Engineering category and the external costs would be noted as the Health and Safety, Socio-economic and the Environment categories.
[4] We define best value as the method(s) of installation which satisfy all current legislation and provides a sustainable balance of economic, safety and wider social and economic impacts, but which is not always lowest cost.

- Cables should be buried to maximise protection where there are safety or seabed stability risks and to reduce conflict with other marine users and to protect the assets and infrastructure.
- Where burial is demonstrated not to be feasible, cables may be suitably protected through recognised and approved measures (such as rock or mattress placement or cable armouring) where practicable and cost-effective and as risk assessments direct.
- Consideration of the need to reinstate the seabed, undertake post-lay surveys and monitoring and carry out remedial action where required.

Based on the need to comply with the Scotland's National Marine Plan the following three phases of work with regards to the CBA model have been carried out as part of this marine licence application.

Phase one:

This looks at the parameters which permit different types of installation. Each scenario is developed based on the installation methods permitted by the seabed type and depth of sediment. At this point only one method is applied within each section of the model.

Phase two:

Hybrid solution(s) are then modelled which include elements of both burial and protection that are feasible. A process of engagement is then conducted to identify if these scenarios are practicable, cost effective.

Phase three:

Hybrid solution(s) are refined and then entered the CBA model to obtain estimated societal value. During the phase three analyses a sensitivity analysis is carried out on key assumption to understand how the value of impacts may vary.

The **Final CBA Recommendation** will then be made for the scenario which represents the overall best value solution.

Modelling Mull - Coll

16 different CBA models, including the baseline, have been developed across the three phases to identify the best value solution. Recent survey data indicates that there is potential to bury some of the cable along the proposed route although actual burial depths that may be achieved are likely to vary with ground conditions.

The baseline option is of the current installation which is approximately 150m shorter than the new proposed route.

Mull - Coll: Phase one

The input to phase one of the CBA analysis was standalone burial installation assessments for the Mull - Coll cable. This involved 6 scenarios. Based on the initial outputs of the route surveys it has been determined that there is sufficient sediment depth to allow for burial along sections of the proposed subsea cable. The route is more fully described in the Project Description.

Onsite investigation has confirmed that split pipe protection will be required on both shore ends of the cable. Therefore, all models, excluding the baseline and option 1A, have the same level of split pipe protection applied.

Table 1 Standalone protection method evaluation

Option	Scenario Methods	Total Societal Value	Net change (£)	Net Change (%)
Base	Baseline Surface lay 100% (the installation method used for the cable we are replacing)	-£10,503,823	£-	
1A	Surface lay 100%	-£10,675,019	-£171,197	1.6%
1B	Split pipe protection 3.63%, Surface lay 96.37%	-£12,600,679	-£2,096,857	20.0%
1C	Jetting 37.19%, Split pipe protection 3.63%, Surface lay 59.18%	-£17,011,003	-£6,507,181	62.0%
1D	Jetting 41.07%, Split pipe protection 3.63%, Surface lay 55.30%	-£17,507,238	-£7,003,415	66.7%
1E	Jetting 43.66%, Split pipe protection 3.63%, Surface lay 52.71%	-£17,855,542	-£7,351,719	70.0%
1F	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45%	-£16,699,682	-£6,195,859	59.0%

Mull - Coll: Phase two

Phase two of the analysis then sought to identify scenarios beyond the initial assessment scenarios (Phase 1 output) where single burial scenarios only were considered, by adding additional protection which may be practicable, cost-effective and address marine user risk.

Table 2 provides an overview of the 6 scenarios that were considered in this phase of the analysis.

Table 2 Practicable and cost-effective protection scenarios

Option	Scenario Methods	Total Societal Value	Net change (£)	Net Change (%)
Baseline	Baseline Surface lay 100% (The installation method used for the cable we are replacing)	-£10,503,823	£-	
2A	Jetting 34.92%, Rock Bagging 2.59%, Split pipe both shore ends 3.63% & Surface lay 56.59%	-£19,069,638	-£8,565,815	81.5%
2B	Jetting 34.92%, Rock Bagging 2.26%, Split pipe both shore ends 3.63% & Surface lay 56.92%	-£18,791,026	-£8,287,203	78.9%
2C	Jetting 34.92%, Rock Bagging 3.88%, Split pipe both shore ends 3.63% & Surface lay 55.30%	-£20,184,085	-£9,680,263	92.2%
2D	Jetting 34.92%, Rock Bagging 2.26%, Mattressing 2.59%, Split pipe both shore ends 3.63% & Surface lay 54.33%	-£21,010,503	-£10,506,680	100.0%
2E	Jetting 34.92%, Rock Bagging 2.59%, Mattressing 2.26%, Split pipe both shore ends 3.63% & Surface lay 54.33%	-£21,029,312	-£10,525,490	100.2%

2F	Jetting 34.92%, Rock Bagging 1.82%, Mattressing 2.26%, Split pipe both shore ends 3.63% & Surface lay 54.98%	-£20,472,089	-£9,968,266	94.9%

^The net change is compared to the baseline assumption of the existing cable.

Within the six scenarios considered in Table 2, no scenarios provided a reduction in the societal value of the baseline installation or when considered against option 1F which is the preferred option from Phase 1 of analysis. Following on from detailed design investigation it has been confirmed that split pipe protection will be required on both shore ends to protect the cable from damage due to abrasion. Additionally, this split pipe will stabilise the cable.

Stakeholder consultation has also informed this process, this feedback has been summarised within the *Pre-Application Consultation Report*.

The **Scenario** which is deemed the most suitable for installation was:

Option	Scenario methods
1F	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45%

Mull - Coll: Phase three

The best solution(s) are refined and challenged to identify the best value solution using the societal value as an indicator of value before a **Final CBA Recommendation** is made.

Sensitivity analysis was conducted to help identify the key variables which have a major influence on the cost and benefits of a submarine electricity cable project. These are:

- Age: Life expectancy of the cable
- Full life cycle costs
- Social costs
- Decommissioning costs
- Health and safety risk

The sensitivity scenarios took the scenario which is deemed the most suitable for installation from Phase 1 & 2 and then applied variances in the predicted lifecycle of the new cable as well as considering decommissioning of the existing install.

Table 3 shows the impact of an increase in the life expectancy and the effects of decommissioning the existing cable against the baseline. Currently any protected section of cable is predicted to last 45 years with unprotected sections lasting as long as the current install. In reality the whole cable will likely last the length of time of the protected sections, as based on the engineering analysis and design the protected areas are the areas most at risk of damage. Unprotected sections are less likely to be damaged, so options 3A looks at modelling all sections of the cable with a life expectancy of 45 years as per the protected sections.

Option 3D considers the inputs of option 1F but looks at what societal benefit is lost or gained if the existing cable is decommissioned. This highlights that decommissioning the existing cable would result in a negative impact on societal value of £3,346,735 over the original Option 1F, it is therefore not recommended to decommission the existing cable.

Overall, there is an increase in the societal value, as expected, if the cable life is extended.

It is reasonable to assume that the life expectancy of the new cable could be extended beyond the current installed cable, which is 18 years old, when considering that the existing cable was installed with no protection or stabilisation and that the route would not have been micro routed for the optimum cable lay location along the route. Options 3A to 3C show the improved societal value based on expected life between 25 and 45 years.

Table 3 Sensitivity testing

Option	**Scenario methods**	**Total Societal Value**	**Net change^ (£)**	**Net Change^ (%)**
Baseline	Surface lay 100% (The installation method used for the cable we are replacing)	-£10,503,823	£-	
3A	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45% **[Life expectancy of whole cable - 45 years]**	-£9,898,317	£605,505	-5.8%
3B	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45% **[Life expectancy of whole cable - 35 years]**	-£10,745,373	-£241,550	2.3%
3C	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45% **[Life expectancy of whole cable - 25 years]**	-£11,960,888	-£1,457,065	13.9%
3D	Jetting 34.92%, Split pipe protection 3.63%, Surface lay 61.45% **[Decommission existing cable]**	-£20,046,417	-£9,542,594	91%

^The net change is compared to the baseline assumption.

Option 3A,B & C show that as the overall expected life of the cable increases the overall societal value will also increase. Should the cable last 45 years as modelled for all sections of protected cable then option 1 F would return a positive value to society over the baseline scenario.

Option 3D can be compared to Option 1F and shows that should SHEPD decommission the existing subsea cable installation, this will have a negative impact on societal value in the region of £3.35 Million.

Interpretation of results

Phase one of the CBA model shows that surface laying the new Mull - Coll submarine electricity cable was the highest value to society when compared against the baseline, however it has been confirmed that split pipe protection will be required on both shore ends of the new cable. In conjunction with this, it has been determined that some level of protection and stabilisation will be required on this route. Option 1 F provides a suitable level of protection and sufficient stabilisation of the cable and is also the best value solution against all other burial option modelled.

Phase two shows combinations of protection scenarios in compliance with the National Marine Plan hierarchy of installation and the need to consider the views of other stakeholders and marine users. After these considerations the CBA shows no option with additional protection/stabilisation improves the overall societal value when compared against option 1F. Option 1F is deemed to be the preferred installation method based on the design process undertaken up to this point. From design analysis burial only via Jet trenching should be able to provide sufficient stabilisation and protection for this cable.

When applying sensitivity testing to Option 1F in phase three, the impact of an increase in expected lifecycle shows option 1F could have a lower cost to society than anticipated, if all sections of the cable in the model have cable life expectancy set at 45, 35 or 25 years instead of 18 years for unprotected sections. Should the new install last the full 45 years lifecycle this would actually provide a positive societal value even comparing against the baseline. This phase of the analysis also shows that decommissioning the existing cable will result in a negative impact on the overall value to society of the solution. Therefore, should not be undertaken unless absolutely necessary.

Recommendation

The CBA model considers the societal value of different installation methods for the Mull - Coll submarine electricity cable. We understand that other externalities not modelled need to be considered. These include marine planning policy, final engineering design requirements (including shore end protection) and the cumulative impact of our submarine electricity cables on other legitimate marine users.

Therefore, SHEPD propose that option 1F, Burial by Jetting 5.4km, split piping both shore ends 0.56km & Surface lay 9.5km is put forward for final design consideration.

As stated previously in the CBA summary, there may be the requirement for modifying the basis of the CBA for the replacement cable, which will be determined upon conclusion of the detailed design and engineering process. These modifications may require to be remodelled in the CBA to show the difference in societal value.