Shetland DSO Feasibility study

CLIENT: Scottish Hydro Electric Power Distribution

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1 Introduction

At present, Shetland's electricity requirements are largely met by generation from the Lerwick diesel Power Station ('Lerwick'). Originally commissioned in 1953, Lerwick was expected to retire in 2020 to ensure compliance with the EU Industrial Emissions Directive ('IED'). In May 2016, Scottish Hydro Electric Power Distribution ('SHEPD') issued an invitation to tender for the New Energy Solution ('NES') process, aimed at securing a competitive solution to meet Shetland's future electricity requirements following the closure of Lerwick. SHEPD received two bids from:

- a distribution cable between Shetland and mainland Scotland proposed by National Grid Shetland Link Ltd with back-up units provided by Aggreko UK ('D-link'), and
- a new thermal power station on Shetland ('on-island generation').[1]

During 2016 and 2017, Baringa supported SHEPD in the economic assessment of the NES competitive tender. Of the two technically compliant bids that Baringa was asked to analyse in detail, we found the D-link solution to be the more cost effective, and therefore the preferred tenderer. However, in November 2017, Ofgem rejected the D-link solution because of two significant developments that post-dated Baringa's analysis:

- The emissions targets defined in the EU IED will now only apply from 2030 to small isolated systems such as Shetland. This decision, announced on 31 July 2017,[2] enables the existing Lerwick Power Station to continue operation beyond 2020; and
- In October 2017, the UK Government announced that wind farms on remote islands - including Shetland - would be eligible to compete in the 2019 CfD auction for less established technologies, making the possibility of a transmission link between Shetland and the mainland a realistic possibility.[3]

Given the ***potential*** for a transmission solution to deliver the best value to consumers, SHEPD decided in 2018 to undertake a revised assessment that included the possibility of a high-voltage direct current link ('T-link'), providing a transmission connection to the mainland that might serve both island demand and wind generation capacity on Shetland, assuming that this capacity is successful in the 2019 CfD auction.

Baringa has been engaged to identify the best solution for consumers by comparing the T-link option against the best NES option, where some of the costs of NES options are updated to account for more recent market data.

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[1] An initial sifting process was conducted by Mott MacDonald and PB Power to remove bids that did not meet financial, technical or security of supply requirements. Two bids were identified as meeting the necessary requirements and were assessed by Baringa in more detail.

[2] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.

[3] https://www.gov.uk/government/news/boost-for-island-wind-projects-as-uk-government-announces-new-funding-for-renewable-generation, consulted on 10 August 2018.

Baringa’s approach to identifying the most beneficial solution to meeting Shetland’s needs is composed of the following stages:

- **Updating the NES options:** Using updated modelling inputs, Baringa’s in-house optimisation model identifies the best NES solution, i.e. the NES option that minimises the cost of meeting Shetland demand;
- **Comparison of T-link and the best NES option:** The best NES option and the T-link are compared on a Net Present Value (‘NPV’) basis to identify the most beneficial solution for consumers. If the T-link is identified as the best available option, the comparison with the best NES option informs the range within which any DSO contribution may fall, where the upper bound is the amount that would make consumers indifferent between the best NES option and the T-link option.

  SHEPD’s technical advisor has separately determined an exogenous DSO contribution value. The final assessment of the T-link and the best NES option relies on this external contribution value.

The rest of the report is structured as follows:

- In section 2, we detail our methodology for updating the NES evaluation and present the results of our updated analysis;
- In section 3, we provide an assessment of the T-link option and compare the best NES option against the T-link option; and
- In section 4, we provide our conclusions.

For the purposes of producing a publishable version of our report, we have redacted details that are confidential and commercially sensitive.

2 NES option update

In this section, we assess the updated costs and benefits of the two NES options, i.e. the D-link and the on-island generation solution, and identify the solution that would deliver better value to consumers on the basis of the assumptions in our modelling.

The best NES option forms the counterfactual against which the T-link option is assessed in Section 4.

2.1 Methodology

2.1.1 Market modelling

Baringa's Market Dispatch Model ('MDM') is an optimisation model which minimises generation costs for Shetland given a number of input assumptions on fuel prices, power station characteristics, costs, and demand patterns.[4] We have re-run the MDM with updated inputs in light of evolutions in market conditions and in the Shetland power system. Such changes include updates in fuel, carbon and power prices.

We obtain a new set of results for detailed power dispatch, and re-calculate the costs of meeting Shetland's needs from the D-link and the on-island generation solution.

We model outcomes under the three main commodity scenarios published by BEIS (Low, Central and High). We also model the case in which there is 9 MW of additional industrial baseload power demand starting from 2024.

2.1.2 Cost for consumers

Using outputs from the MDM, we compare the D-link and on-island power plant on the basis of their respective costs and benefits for consumers under the different scenarios. We assume that costs are ultimately recovered from consumers such that a lower cost solution generates savings for consumers. The annual cost of each solution is captured within our analysis:

- CAPEX is reflected on an annuity basis, to ensure that options with different economic lives are compared on a like-for-like basis and options that have a longer economic life as well as a higher total cost are not unfairly disadvantaged. The treatment of CAPEX is explained in more detail below;[5]
- Fixed Operations and Maintenance ('FOM') is valued based on updated parameters provided to Baringa by SHEPD;
- Costs of power imports from GB include the cost of electricity from the mainland and of losses, valued at GB power prices as estimated by Baringa;

[4] The MDM also uses input wholesale power prices for Great Britain, which are determined from our GB Power Model. In the case of the D-link, all energy is valued at the GB wholesale price (on an hourly basis).
[5] In informing the CAPEX costs for each of the NES options, we have relied on information from the original submissions to the competitive process that was published by Ofgem. In certain cases, availability of more up-to-date information meant that the original submissions have been replaced by more up-to-date benchmarks.

- Plant utilisation costs include plant Variable Operations and Maintenance ('VOM'), fuel costs and carbon emissions, where fuel and carbon prices are taken from the relevant BEIS price scenario;
- Cost of testing fuel corresponds to the cost of the fuel burnt when testing the standby power station in the case of the D-link;
- Other generation costs correspond to the running costs of existing wind in order to meet demand;
- Renewable generation curtailment is valued at the cost of additional generation that is brought in to cover the energy gap from any curtailment action; and
- We assume that there would be no difference in demand TNUoS tariffs paid by Shetland consumers between the D-link and On-island generation options. The same assumption is made for the comparison of the best NES option with the T-link in Section 3.1.1..

Baringa's analysis is carried out over 20 years, from 2023 to 2042. This duration corresponds to the shortest of the economic lives of the different options (20 years for the on-island power station), i.e. the time horizon over which all of the options would be operational. Undertaking an assessment over a longer time period, such as the lifetime of the links (45 years), would require making an assumption on the cost of refurbishment or replacement of both the on-island power station and the standby generator. Given the high uncertainty associated with this assumption, we consider that limiting our assessment to 20 years is preferable.

To avoid penalising options with a longer economic life, we treat CAPEX, connection and GSP costs as upfront payments. We annuitize these values over the lifetime of the asset, using the WACC of the developer as the relevant rate feeding into the calculation of the CAPEX annuity. This means that, for the on-island plant, we account for the totality of the CAPEX, while for the D-link, we only account for the first 20 years of CAPEX. This accounts for the longer economic life of the D-link.

The output of this analysis is the net present value ('NPV') of the costs of each option: annual costs are discounted to their present value to ensure that differences between the dates at which they are incurred are taken into account. The rate used to discount any costs is 3.5% in real terms, as recommended by government in the Green Book guidance on project appraisal (Social Time Preference Rate).[6]

Based on the outcome of NPV analysis, the best NES option is the solution for which the NPV of the costs is the lowest. In other words, the best NES option is the option that meets Shetland's electricity needs at the lowest cost. This option forms the competitive benchmark against which the T-link is compared.

2.2 NES evaluation

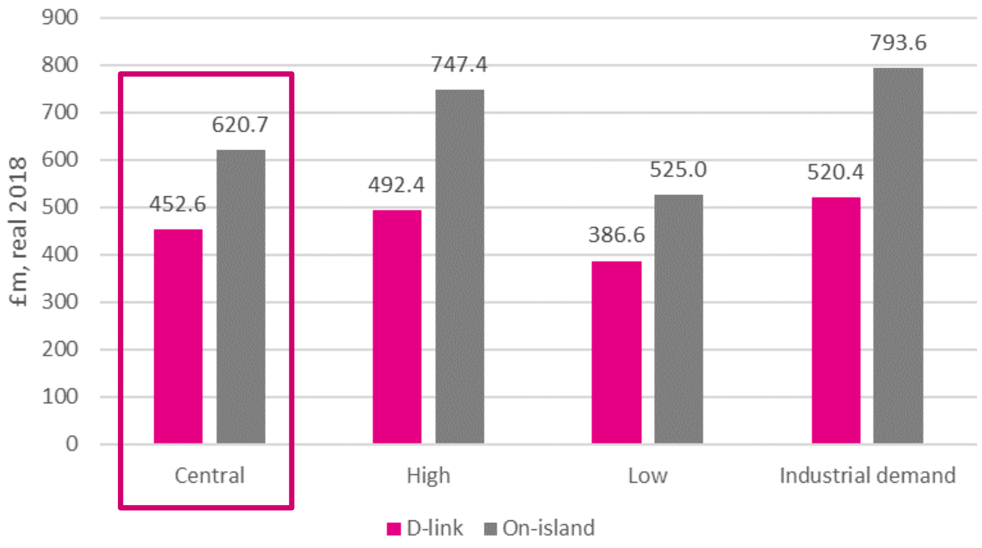
In all modelled scenarios, we find that the on-island power station is significantly more expensive than the D-link. For example, expected costs of meeting Shetland demand over 2023-42 are £452.6m in the case of the D-link and £620.7m in the case of the on-island generator. The finding

[6] HM Treasury (2018), 'The Green Book – Central government guidance on appraisal and evaluation'

that the D-link is significantly cheaper than the on-island plant matches the conclusions of the previous NES assessment carried out in 2016-17.

Costs associated with the NES options under different scenarios are presented in Figure 1 below.

Figure 1: Comparison of the D-link and on-island plant options (NPV of total cost)



The benefit of building the D-link over the on-island plant is the difference between the costs of the on-island plant and the costs of the D-link. In the central case, the benefit of the D-link corresponds to the net avoided costs of the on-island plant, i.e. £620.7m - £452.6m = £168.1m.

We conclude that the D-link is the preferred NES option, in that it results in lower costs for consumers. The D-link is therefore the benchmark against which the T-link will be assessed.

3 Transmission solution assessment

3.1 Methodology

3.1.1 Comparison of the T-link with the best NES option

We compare direct solution costs for consumers associated with the T-link with the best NES solution, the D-link, using the same methodology as for the NES options (described in section 2.1.2). This comparison informs the maximum DSO contribution value for which the T-link results in consumer benefits as compared to the best NES option.

Using Baringa's MDM, we model the Shetland electricity system in the case where a T-link is built and Shetland-based wind capacity is delivered in the upcoming CfD auction. We determine outcomes under a range of scenarios, including Low/Central/High commodity prices, High industrial demand, and different combinations of wind farms being built on Shetland. For each modelled scenario, we obtain the T-link utilisation profile, losses and the generation profiles of all Shetland-based generators, and calculate the cost of meeting Shetland's electricity needs under the T-link option.

In the T-link scenarios, new large-scale wind farms, together with T-link imports, would be the main sources of electricity for Shetland. Because large scale wind farms are able to export their electricity to the mainland through the T-link and would earn the GB power price, we assume that they sell their production to Shetland consumers at the GB power price.

A key difference between the approaches for NES options and the T-link relates to the corresponding CAPEX values. In the case of the NES evaluation, we have used CAPEX values submitted in the competitive tender and published by Ofgem, and updated to account for inflation. The T-link CAPEX treatment is different because the T-link would be shared between Shetland generation and Shetland demand. More specifically, the cable would be used to export Shetland wind most of the time, but would also enable power imports into Shetland, when Shetland wind generation is too low to serve demand. Because the share of T-link CAPEX covered by developers is borne by a private party, the DSO contribution is the only portion of the overall T-link CAPEX which has a welfare impact on consumers.

We therefore consider that the element of T-link CAPEX modelled in our CBA should be limited to the value of any DSO contribution to cable costs. This assumes that no additional charges beyond those put in place to recover the cost of the DSO contribution are levied on consumers as a result of the T-link being built.

In practice, we model T-link solution costs for different values of the DSO contribution and identify the maximum DSO contribution such that the T-link is cheaper than the D-link.

3.1.2 Comparison of the T-link and D-link for an external DSO contribution value

As part of any implementation process, we understand that SHEPD would look to contribute a fixed amount to the T-link, where such amount would be defined independently. Based on the methodology described in a separate note ('SHEPD Recommendation overview'), SHEPD's technical advisors determine an exogenous value for any DSO contribution, based on an estimate of fair value of the T-link for consumers.

We therefore undertake a final assessment of the costs and benefits of the T-link against the best NES solution, using the external DSO contribution as CAPEX input for the T-link.

3.2 Results

3.2.1 Comparison of the T-link with the best NES option

We compare the direct costs of the T-link against the costs of the best NES option. We find that the size of the DSO contribution is the key factor in determining whether direct solutions costs are lower for the T-link than for the D-link.

The T-link is significantly cheaper than the D-link when no DSO contribution is needed for the T-link to be built. As the DSO contribution increases, so does T-link CAPEX. For a contribution of exactly £376m,[7] the costs of meeting Shetland demand are equal for the D-link and the T-link options, and consumers are indifferent between them. Finally, for a contribution beyond £376m, the T-link becomes more expensive than the D-link.

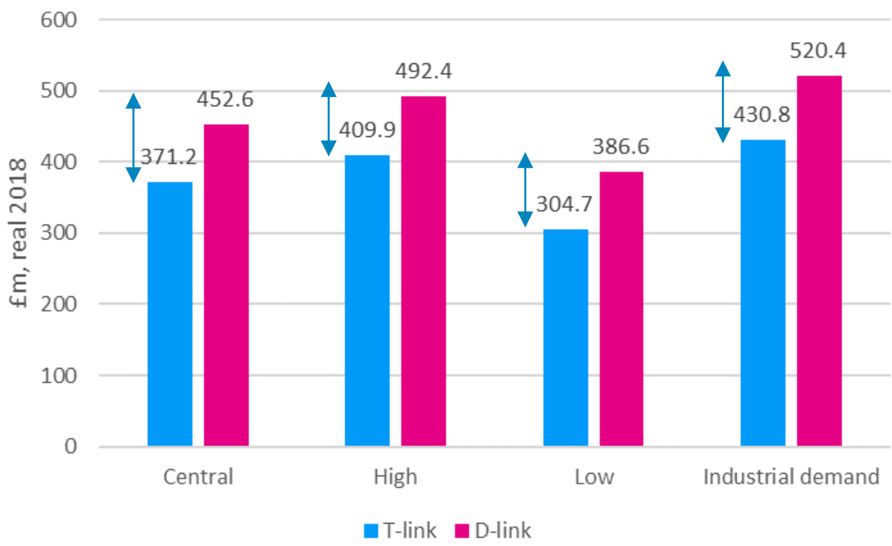
Hence, for DSO contribution values up to £376m, our assessment finds the T-link to be the preferred option.

3.2.2 Outcomes with a fixed DSO contribution

Within the range of potential DSO contributions such that the T-link is built and is the cheapest solution for consumers (£0-£376m), SHEPD's technical advisors have estimated a fair value of the Shetland link to consumers of £251m in 2018 real terms. For a contribution value of £251m, there are significant benefits to building T-link.

The costs of meeting Shetland's electricity needs under different commodity price and demand scenarios are summarised in Figure 2 for a DSO contribution of £251m.

Figure 2: Costs of T-link vs D-link: DSO contribution of £251m



We find that the T-link is the cheapest option for meeting Shetland's electricity needs under all modelled scenarios. For Central modelling assumptions, the benefits associated with the T-link are the net avoided costs of building the D-link, estimated at £452.6m - £371.2m = £81.4m (over 20 years). We find that the direct cost benefit of building the T-link remains broadly constant across scenarios.

4 Conclusion

Our assessment of direct solution costs shows that the T-link option delivers a better balance of costs and benefits to Shetland consumers than the best NES option, the D-link, for DSO contribution values up to £376m. Any DSO contribution should be set to achieve a balance between the risk of (i) foregoing significant consumer benefits by setting the contribution too low for the best-value option to be delivered and (ii) the risk of consumers paying more than the minimum amount that would enable the T-link to be built.

SHEPD's technical advisors have determined a value for any DSO contribution, based on the fair value of the T-link. At this contribution value, we find that the T-link generates £81.4m of benefit to consumers in the form of avoided solution costs of the D-link (over 20 years). Hence, the exogenously determined fair contribution value appears to strike a balance between (i) the contribution being too large to deliver significant benefits to consumers, and (ii) the contribution being too small for a solution that is beneficial to consumers to be viable.