RIIO ED2 Engineering Justification Paper (EJP)

Island Generation – Battery Point

Investment Reference No: 345/SHEPD/REGIONAL/BATTERYPOINT

Scottish & Southern Electricity Networks

Contents

1 Summary Table

Table 1 below provides a high level summary of the key information relevant to this engineering justification paper (EJP) for Island Genration – Battery Point.

Table 1 Summary Table

<table>
<tr><td>Name of Scheme/Programme</td><td colspan="7">Island Generation – Battery Point</td></tr>
<tr><td>Primary Investment Driver</td><td colspan="7">The primary investment driver is North of Scotland Resilience. This is due to the fact that the existing four generators that they will replace are past the end of their scheduled life and without intervention to replace the station could not support the load in the event of a mains supply failure.</td></tr>
<tr><td>Investment Reference</td><td colspan="7">345/SHEPD/REGIONAL/BATTERYPOINT</td></tr>
<tr><td>Output references/type</td><td colspan="7">CV15 – QoS and North of Scotland</td></tr>
<tr><td>Cost</td><td colspan="7">[redacted] SHEPD</td></tr>
<tr><td>Delivery Year</td><td colspan="7">Project to be delivered over the period of RIIO-ED2</td></tr>
<tr><td>Reporting Table</td><td colspan="7">Business Plan Data Tables
• CV15 – QoS and North of Scotland</td></tr>
<tr><td>Outputs included in RIIO ED1 Business Plan</td><td colspan="7">Not applicable.</td></tr>
<tr><td rowspan="3">Spend apportionment</td><td colspan="7">RIIO ED2 Spend (£m)</td></tr>
<tr><td></td><td>2024</td><td>2025</td><td>2026</td><td>2027</td><td>2028</td><td>Total</td></tr>
<tr><td>SHEPD</td><td></td><td></td><td>[redacted]</td><td>[redacted]</td><td>-</td><td>[redacted]</td></tr>
</table>

2 Introduction

This EJP looks into the options for the potential replacement of 4 older diesel generators at Battery Point Power Station in Stornoway. It focusses on the relevant Investment Drivers, Stakeholder Engagement Feedback and Optioneering, ultimately deciding on a preferred solution.

2.1 Background to Investment

SSEN have seven embedded island generation sites. These embedded generation power sites play a crucial role on the Scottish Islands often being the last resort to keep power flowing to homes and businesses during planned maintenance or faults on the network. They are only ever used as backup and provide a security of supply to customers. This EJP's objective is to investigate the benefits of installing 1 or 2 new 5MW Generators at Battery Point, Stornoway Power Station. These would each replace two of the oldest generators on site. At this point in time one of the older generation sets has been removed from service due to increasing unavailability of spares. The new generators are more efficient and emit less harmful emissions into the atmosphere.

2.2 Reasons for the Timing

The eight Generators currently installed at Battery Point Power Station were installed as far back as 1954, therefore due to the age of the generators they are overdue replacement. Furthermore, spare parts are becoming difficult to source making the generators un-economical to run.

2.3 Expected Outputs

The output for the preferred option will be delivery of two new 5MW Generators at the site. These generators will replace the oldest and least reliable generators at Battery Point, Stornoway Power Station.

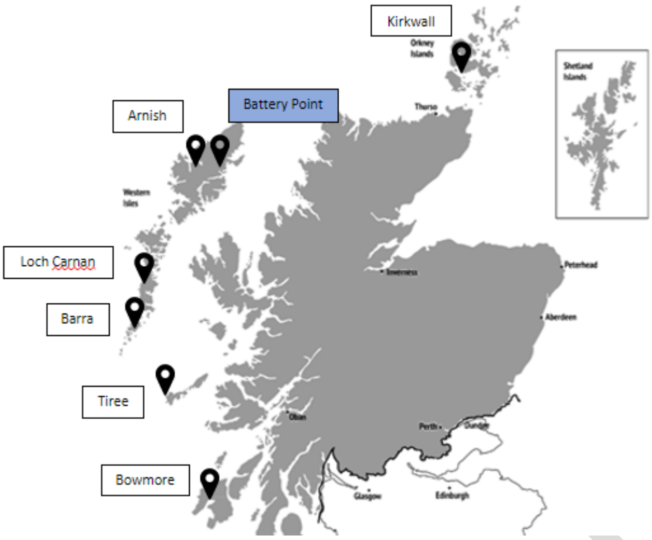
3 Background Information

The section provides a background to the strategy and the assets under consideration. It describes the main and possible drivers for the intervention, the assets under consideration and feedback received from the stakeholder engagement activities.

3.1 Island Generation

Battery Point, Stornoway Power Station is one of 7 Island Generation sites for the Scottish Islands. These embedded generation power sites play a crucial role on the Scottish Islands in what is often the last resort to keep power flowing to homes and businesses during planned maintenance or faults on the network. They are only ever used as a backup and provide a security of supply to customers.

Figure 1 - 7 Island Generation Sites - Battery Point in blue



While the mains supply cable is out of service, Battery Point (Stornoway Power Station) which is normally a stand-by station, is required to operate full time to maintain security of supply, supported by Arnish Power Station and mobile diesel generation.

3.2 Investment Drivers

The Primary investment driver for this EJP is North of Scotland Resilience. The permanent generation plant at Battery Point comprises of eight Mirrlees medium speed internal combustion engines ranging between 2350kVA and 5400kVA. The age of the eight engines varies, the oldest engines are 1, 2, 5 and 6 and the newest 3, 8, 9 and 10.

The table below summarises the eight Mirrlees medium speed internal combustion engines at Battery Point.

Table 1 Battery Point Generation Plant

Engine #	Engine Type	Year of Manufacture	kVA	Power Factor	Thermal Input (MW)	Electrical Output (MW)
1	Mirrlees KVSS-12	1954	2550	0.8	5.1	2
2	Mirrlees KVSS-12	1954	2550	0.8	5.1	2
3	Mirrlees KV Major Mk2	1975	5400	0.96	10.5	4.6
5	Mirrlees KVSS-16	1957	3400	0.85	7.4	2.2
6	Mirrlees KVSS-12	1957	2350	0.85	5.1	2
8	Mirrlees KV Major	1979	4141	0.85	9.2	3.5
9	Mirrlees KV Major Mk2	1972	5400	0.85	12	4.6
10	Mirrlees KV Major Mk2	1975	5400	0.85	9.5	4.6

The options in this paper will look to replace the Mirrlees KVSS generators, engines 1,2,5 and 6. These are the oldest generators and most polluting at Battery Point.

Asset Condition

There are various issues relating to the asset condition of engines 1,2,5 and 6.

- Generator lives are typically 40 years. Engines 1 & 2 are 67 years old / engines 5 and 6 are 64 years old. Due to the age of units 1,2,5 and 6, they are considered to be "end of life"
- Engine no 1 at Battery Point has already been removed from service as it has a defect on the crankshaft that is not economical to repair. This means the station is immediately 2MW down.
- The original equipment manufacturer has formally stated that these engines are no longer supported. There is often a struggle to find spares, which often means resorting to searching around the world. As these engines are 1950s era, they stopped manufacturing them decades ago therefore the spares market is very poor as most industries have already removed them from service.
- When spares are found it often takes months to deliver them and if any of the engines have unique parts e.g. undersized bearings, this aggravates the problem further. No 2 engine at Battery Point has been out of service for at least 6 months awaiting a thrust bearing.
- Engines 5 and 6 are due overhauls and until stripped down, it cannot determine the extent of the work they may require. Should they require a significant number of spares, they may be out for a very long time and there is no guarantee that they will return to service at all, especially if the spares are not available.
- The station needs all the engines to be able to meet peak winter demand. During running of the station, engines require to be taken out periodically for maintenance and any faults which may occur on them. During the recent run of the station due to the mains cable failure, there was an additional 6MW of Mobile Diesel Generation on site to manage maintenance and defects. They ran often, especially during the winter months where the peak demand is.

Secondary Investment Drivers

These are also the worst environmental performing engines in the station and are the last engines to be run, as agreed with SEPA. They are less efficient than the other engines and therefore require more fuel to achieve their output. This in turn produces more CO_2.

Reducing CO_2 Emissions - The tonnes of CO_2 emitted per tonne of fuel burned remains constant therefore reducing fuel consumption is key. New diesel generators similar to the new ones proposed for Battery Point `have been installed at Lerwick Power Station. The data from these sites gives the efficiency of the new LPS engine at around 43.6%. The existing Mirrlees engines have an average thermal efficiency rating of 34.46%. A modern generator is therefore ~10% more efficient hence reducing greenhouse gases, specifically CO_2.

A further secondary investment driver is that the new 5MW diesel generators that this EJP examines will be fitted with a Selective Catalytic Reduction (SCR) system. The SCR acts as a filter, cleaning the emissions before they are released into the atmosphere leading to a secondary investment driver of the societal benefits of reduced air pollution.

Ofgem have introduced a requirement for DNOs to submit an Environmental Action Plan which has minimum requirements which need to be met to ensure DNOs contribute to decarbonising the energy system and reduce the impact of network activity on the environment.

The reduction of carbon emissions is a minimum requirement of the Environmental Action Plan (EAP). SSEN's EAP includes Science Based Targets which help meet SSEN's registered commitment with the Science Based Targets Initiative (SBTi).

SSE were the first UK DNO to set Science Based Targets (SBT's) that align with a 1.5 degree trajectory as follows:

- 55% reduction in Scope 1 and 2 emissions by 2033.
- 35% of SSEN's supply chain spend committed to SBTs by 2026/2027.

Reducing diesel consumption will have a significant impact on achieving the science-based targets. Fuel consumption accounts for 4.2% of SSEN's carbon emissions. It is the second largest category following losses (91% of emissions).

3.3 Stakeholder Engagement Feedback

In preparation of SSEN's RIIO ED2 business plans several stakeholder engagement exercises have been undertaken to better understand what will be important to SSEN's customers during RIIO ED2 and to ensure the views of stakeholders are reflected in the cost and volumes proposed.

SSEN have undertaken the following stakeholder events. In total there were 84 attendees with a range of representation from customers, utility companies, developers, environmental representatives, charities, and town councils. During the events the following subjects were put to SSEN's stakeholders. A summary of the key feedback that was gathered from the stakeholder engagement exercises is available and presented with the full report.

Stakeholder Event – 23rd February 2021

Stakeholder Event	Date	Relevant Topics	# Stakeholders Attending
SSEN Distribution RIIO – ED2 Stakeholder and Consumer Engagement Powering Scotland's Islands: Hebrides	23 February 2021	Our subsea cable investment programme - Learnings from RIIO ED1 - Our future subsea cable strategy - Innovation on the Islands	25

The key consideration raised by stakeholders in relation to Remote Island Generation was the effects of network failures on generators and communities, in relation to lost revenue and lost community benefit.

Based on this feedback, the following recommendation emerged:

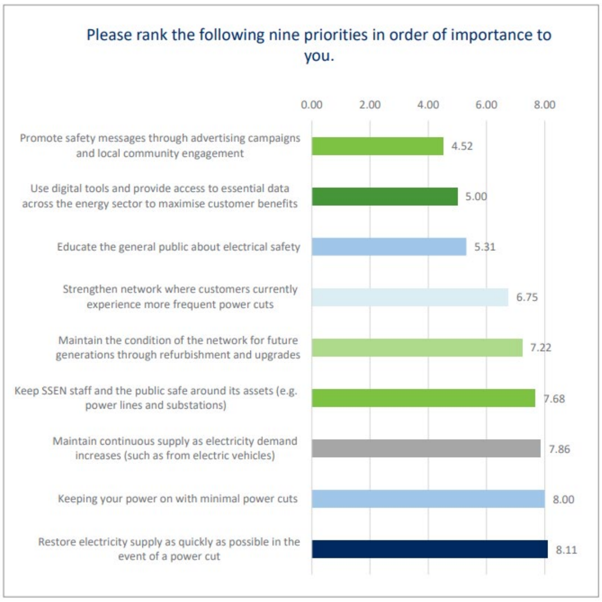
- Please factor in the implications of cable failures on remote islands and on their communities into the risk assessment process and the planning for ED2. If the mains cable to Lewis & Harris fails (as it has done recently) the communities rely on Battery Point power station to give them a reliable source of power.

Stakeholder Event – 24th September 2020

Stakeholder Event	Date	Relevant Topics	# Stakeholders Attending
Distribution Annual Workshop North	24th September 2020 1 October 2020	Sustainability – helping the UK meet its net zero emissions targets Maintaining a reliable and resilient network for the future	84

Subject 3: Network Resilience

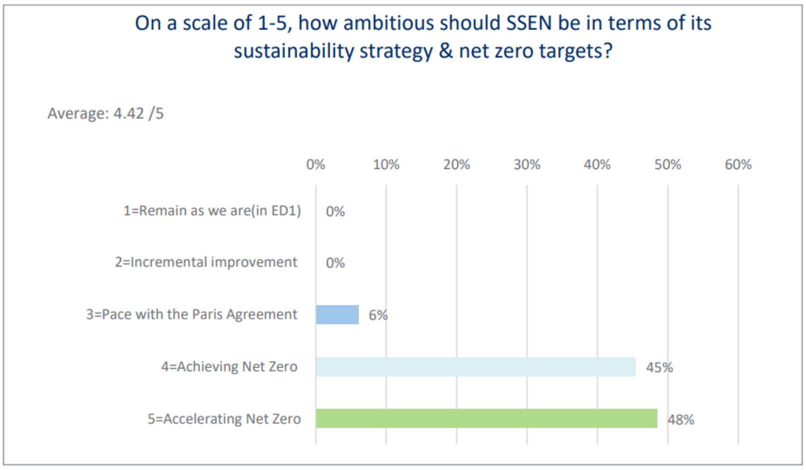
Stakeholder Feedback: The majority of stakeholders agreed with the order of priorities as ranked by domestic and business customers under resilience, with the prevailing view that maintaining a continuous service and keeping the lights on are the lifeblood of DNOs and represent their primary purpose. This was reflected in the electronic voting, where ‘restore electricity supply as quickly as possible in the event of a power cut’ came out top, with 8.11 out of 10.



For the Islands, restoring supply is even more important due to the isolated nature of these locations. New generators at Battery Point will ensure the reliability of this site and its ability to continue to provide electricity to the islands in the event of a fault or maintenance work to the network.

Subject 1: SSEN’s Sustainability Strategy and Net Zero Targets

Stakeholder Feedback: Conversations around the Environmental Action Plan confirmed that stakeholders firmly believed that action around net zero should be as ambitious as possible. This was reflected in the electronic voting, where 48% of attendees nominated ‘accelerating net zero’, the most ambitious approach, as their preferred option for SSEN’s sustainability strategy. Although affordability was still a caveat, and it was generally acknowledged that targets would inevitably be tempered and affected by politics and funding, the consensus was that SSEN should provide strong, decisive leadership in this area. Option 4, the most ambitious path to net zero, was seen as the most idealistic route, and many saw option 3 as a more realistic direction of travel. Some stakeholders wanted to see a more detailed financial breakdown setting out the differences in costs before deciding between the two.



Given stakeholder desires for SSEN to be as ambitious as possible to accelerate net-zero, it is important SSEN start taking steps now to reduce CO2 emissions on the Island Generation sites.

4 Optioneering

The table below summarises the options considered for replacing the current diesel generators.

Table 2 Options Summary Table

Option	Description	Status
1	Do Nothing	Not viable
2	Do Minimum – replace existing generators no. 1 & 2 with 1 new 5MW generator	Progressed
3	Replace all 4 Mirrlees KVSS generators, no. 1,2,5&6, with 2 new 5MW generators	Progressed / Preferred Option
4	Install battery storage system at Battery Point	Not progressed – further investigation required

4.1 Option 1. Do nothing.

The current diesel generators remain in place. The current generators are reaching end of life and not replacing them is not feasible. See section 3.2 for more detailed reasoning.

Not viable option.

4.2 Option 2. Do Minimum. Replace existing generators no. 1 & 2 with 1 new 5MW generator.

This option looks at replacing 2 existing Mirrlees KVSS Generators (oldest or least reliable engines 1 & 2) with a new larger 5MW Diesel Generator. The current generators provide 4MW so capacity would also be increased to 5MW.

- Generator lives are typically 40 years. Engines 1 & 2 are 67 years old. Due to the age of units 1 and 2, they are considered to be “end of life”
- Engine no 1 at Battery Point has already been removed from service as it has a defect on the crankshaft that is not economical to repair. This means the station is immediately 2MW down.
- The original equipment manufacturer has formally stated that these engines are no longer supported. There is often a struggle to find spares, which often means resorting to searching around the world. As these engines are 1950s era, they stopped manufacturing them decades ago therefore the spares market is very poor as most industries have already removed them from service.
- When spares are found it often takes months to deliver them and if any of the engines have unique parts e.g. undersized bearings, this aggravates the problem further.
- The station needs all the engines to be able to meet peak winter demand. During running of the station, engines require to be taken out periodically for maintenance and any faults which may occur on them. During the recent run of the station due to the mains cable failure, there was an additional 6MW of Mobile Diesel Generation on site to provide the facility to manage maintenance and defects and they ran often, especially during the winter months over the peak demands.
- These are the worst environmental performing engines in the station and are the last engines to be run, as agreed with SEPA. They are less efficient than the other engines and therefore require more fuel to achieve their output. This in turn produces more CO_2.

In this option the CAPEX cost of replacing engines 5 and 6 has been put in the first year of ED3. As per the reasons stated above, they need to be replaced in a timely fashion and certainly not beyond ED3.

Progressed to CBA

4.3 Option 3. Replace all 4 Mirrlees KVSS generators, no. 1,2,5 & 6, with 2 new 5MW generators.

Replace all Mirrlees KVSS generators, 4 in total, with 2 new 5MW Diesel Generators. The current generators provide 8.2MW so capacity would also be increased to 10MW.

Specific points relating to engines 5 and 6 (which are unique to this option) are underlined

- Generator lives are typically 40 years. Engines 1 & 2 are 67 years old / engines 5 and 6 are 64 years old. Due to the age of units 1,2,5 and 6, they are considered to be “end of life”
- Engine no 1 at Battery Point has already been removed from service as it has a defect on the crankshaft that is not economical to repair. This means the station is immediately 2MW down.
- The original equipment manufacturer has formally stated that these engines are no longer supported. There is often a struggle to find spares, which often means resorting to searching around the world. As these engines are 1950s era, they stopped manufacturing them decades ago therefore the spares market is very poor as most industries have already removed them from service.
- When spares are found it often takes months to deliver them and if any of the engines have unique parts e.g. undersized bearings, this aggravates the problem further. No 2 engine at Battery Point has been out of service for at least 6 months awaiting a thrust bearing.
- Engines 5 and 6 are due overhauls and until stripped down, it cannot determine the extent of the work they may require. Should they require a significant number of spares, they may be out for a

very long time and there is no guarantee that they will return to service at all, especially if the spares are not available.

- The station needs all the engines to be able to meet peak winter demand. During running of the station, engines require to be taken out periodically for maintenance and any faults which may occur on them. During the recent run of the station due to the mains cable failure, there was an additional 6MW of Mobile Diesel Generation on site to provide the facility to manage maintenance and defects and they ran often, especially during the winter months over the peak demands.
- These are the worst environmental performing engines in the station and are the last engines to be run, as agreed with SEPA. They are less efficient than the other engines and therefore require more fuel to achieve their output. This in turn produces more CO_2.

There has been a synergy cost saving of £500K for the two new engines being installed at the same period (this option) as opposed to over ED2 and ED3 as per CBA option 2. This is due to savings to be had in contractor, civils, and materials.

Progressed to CBA.

4.4 Option 4. Install battery storage system or hybrid generation option at Battery Point.

Fitting a battery system at Battery Point could be a more environmentally friendly solution. Given future decreasing demand/ increasing embedded generation this option may make more sense from an asset management point of view. The station would be able to shift from reserve role post fault to a balancing role during intact conditions. This secondary benefit would reduce losses in the export cable to the mainland by using the battery to peak shave and/or to allow for more non-firm generation to be added to the islands. Like the other diesel EJP this would require a full SAMP to investigate the load shape on the island and consider both Power and Energy requirements to size and design the concept solution.

This option has not been taken to CBA as further investigation and data collection is required.

5 Analysis and Cost

This section considers in more detail each of the options taken forward from the Optioneering section.

5.1 Approach and Assumptions

A detailed Cost Benefit Analysis (CBA) exercise has been undertaken to support the investment strategy that is detailed in this EJP. The CBA has been undertaken over the lifetime of the proposed investment.

The Ofgem CBA tool has been used to build a CBA and includes for the following cost and benefit elements. The completed CBA is included within the Island Generation Investment Decision Pack (IDP).

- Capex cost for the new generator(s)
- Opex savings associated with the ongoing maintenance of the generator(s)
  - Reduction in fuel consumption
- Carbon footprint (t CO_2). Carbon saving of replacing the generator a new one compared to keeping the current generator in place. This has been converted to a financial value based on Ofgem carbon prices and included in the NPV.
- NPV 45 years – estimated life of the generator

The capex costs are based on new engines recently installed at Lerwick. This includes the engine cost, installation, and other works such as procurement and additional labour. For Lerwick the engine supplier advised the cheapest solution was to purchase the unit incl. all auxiliary equipment and for SSEN to complete the install themselves with delivery and commissioning assistance from the supplier. The total cost for Lerwick was [redacted]. The same cost has been used for Battery Point.

Opex costs with regard to inspection and standard works are assumed to be similar with the new engines. However, fuel costs will be reduced. Savings vary depending on how often the generators are used. A range has been presented with 2019 data showing average fuel use and 2020 data showing higher use in the case of a major fault.

Carbon savings have also been estimated based on the lower fuel consumption of the new generator compared to the old. Similarly, to Opex, savings vary depending on how often the generators are used and estimates have been made for 2019 and 2020.

These Opex and carbon savings have been scaled for each option based on the size and number of generators replaced. The workings in Table 3 are for all generators.

Table 3 - Fuel use comparison to estimate Opex savings. Text in green is data provided other cells have been estimated/calculated.

	Old Gen		New Gen		
	2019	2020	2019 estimated	2020 estimated	Saving
Efficiency	34%		43.6%		9.1%
Fuel burned (g/kWh)	186		203		17.0 g / kWh
Fuel used (litres per year)	1,260,000	6,210,000	1,154,000	5,690,000	106,000 – 520,000 litres
Fuel cost (£ per year)	945,000	4,660,000	866,000	4,271,000	£79,000 - £390,000
Hours operated (MWh per year)	5,300	26,100	5,300	26,100	
t CO2 per t fuel	3.2		3.2		
CO2 emissions (t per year)	3,400	16,900	3,200	15,500	200 – 1,400 tonnes CO2

5.2 CBA results

Table 4 summarises the results of the CBA analysis.

Table 4- Summary of CBA results

Option	Description	# units replaced	CBA Results			
			Capex	Opex saving (45yr life)	Co2 saving kg (40yr life)	NPV (40yr life)
1	Do Nothing	-	Not progressed	Not progressed	Not progressed	Not progressed
2	Do Minimum – replace existing generators no. 1 & 2 with 1 new 5MW generator	2 *(1 larger new unit)*	[redacted] [1]	£1,452k	5,546 t CO_2	-£7,165k
3	Replace all 4 Mirrlees KVSS generators, no. 1,2,5&6, with 2 new 5MW generators	4 *(2 larger new units)*	[redacted]	£1,470k	5,628 t CO_2	-£6,701k
4	Install battery storage system at Battery Point	-	Not progressed	Not progressed	Not progressed	Not progressed

[1] - In this option the CAPEX cost of replacing engines 5 and 6 has been put in the first year of ED3 due to the reasons stated in section 4.3.

5.3 Preferred Option

Given the results of the CBA and the reasons stated in section 4.3 option 3 is preferred.

The full asset management plan for these assets should be considered, as 10 years from now SSEN may not require as much back up generation. For example, the emergence of smart grids, construction of new transmission lines on the Islands, local generation and other factors may reduce the need for additional generators. This is being looked into from a whole system perspective.

6 Deliverability and Risk

This section discusses SSEN's intended approach to delivering this. It summarises the outputs and delivery profile as well as highlighting any risks or constraints.

6.1 RIIO-ED2 BPDT Figures

Figure 2 summarises the proposed volumes and costs associated with the investment.

SHEDP – CV22

Asset Category	Unit	2024	2025	2026	2027	2028	Total
Island Generation – Battery Point new diesel engine installation	#	1					**1**
	£m			[redacted]	[redacted]		[redacted]

Figure 2 - Proposed Volumes & Costs

7 Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that SSEN intends to take during RIIO ED2 for the non-load related replacement of the current diesel engines at Battery Point with new engines.

A background into the assets has been provided. The use of the assets is as backup generators when works are carried out or there is a fault. The generators are reaching end of life and require replacement as sourcing replacement parts is becoming increasingly difficult and expensive.

Investment options have been described and assessed through a CBA to determine the most cost-effective intervention. Not all these options are considered

- Option 1: Do Nothing – **not viable**
- Option 2: Do Minimum – replace existing generators no. 1 & 2 with 1 new 5MW generator – **progressed**
- Option 3: Replace all 4 Mirrlees KVSS generators, no. 1,2,5&6, with 2 new 5MW generators - **progressed / recommended option.**
- Option 4: Install battery storage system at Battery Point - **Not progressed as further investigation required**

The volumes that have been identified are based on the preferred investment, option 3.

In total, this investment represents a total spend of [redacted] in RIIO ED2.