Scottish & Southern Electricity Networks

RIIO-ED2 Engineering Justification Paper (EJP)

Hybrid Generators

Investment Reference No: *10/SSEPD/ENV/GENERATION*

Contents

1 Executive Summary

Our Environmental Action Plan (EAP) sets out our methodology that we propose to undertake during the RIIO-ED2 period in response to increasingly ambitious environmental drivers and stakeholder expectations. Ofgem have introduced a requirement to prepare an Environmental Action Plan as part of our RIIO-ED2 submission and setting a Science Based Target (SBT) is one of these minimum requirements for the EAP.

This paper sets out our plans to purchase 50 23Kva hybrid generators to replace our existing stock of 50 30Kva diesel generators over the RIIO-ED2 period in response to increasingly ambitious environmental drivers and stakeholder expectations. The primary driver for this scheme is Environmental.

Following optioneering and detailed analysis, as set out in this paper, the proposed scope of works is:

- The purchase of 50 new 23kVA hybrid generators to replace 50 30kVA diesel generators

The cost to deliver the preferred solution is £[redacted] m and the works are planned to be completed over the course of RIIO-ED2.

This scheme delivers the following outputs and benefits:

- Proposed CO_2 saving 5,600 tCO_2e for SHEPD & SEPD
- Contribute towards a reduction in air and noise pollution
- Reduced running costs compared to diesel generators

2 Summary Table

Name of Scheme/Programme	Hybrid Generators
Primary Investment Driver	The primary investment driver is Environmental. • CO2 emissions could be significantly reduced through replacing the current fleet of ~50 30Kva diesel generators with hybrid generators that run off battery storage when charged. • Hybrid generators would also contribute towards a reduction in air and noise pollution • The current diesel generators are reaching their end of life and the new hybrid generators would have cheaper running costs
Scheme reference/ mechanism or category	10/SSEPD/ENV/GENERATION
Output references/type	Hybrid Generators
Delivery Year	RIIO-ED2
Reporting Table	C6 – V&T Non-Capex
Outputs included in RIIO-ED1 Business Plan	No

Cost	£[redacted]m			
Spend Apportionment	**Licenced Area**	**ED1 (£m)**	**ED2 (£m)**	**ED3+ (£m)**
	SEPD		£[redacted]m	
	SHEPD		£[redacted]m	
Delivery Year	RIIO-ED2 (2024 – 2028)			

3 Introduction

3.1 Background to Investment

This Engineering Justification Paper (EJP) examines the replacement of our current 30kVA diesel generators that we use across their network with 26kVA hybrid generators. For the purpose of this paper larger 100kVA hybrid generators have not been considered until further testing has been undertaken. These diesel generators are used to provide power when works are being undertaken on a part of the network, they are transported on a trailer to the desired location and typically run for a few days until the works are complete.

The hybrid system comprises of a diesel generator and battery/inverter system. The diesel generator is used to charge the battery, enabling the generator to then run off battery power for a period of time. As a result of the generator not running constantly and running at an optimised load when charging the battery, it delivers significant savings in fuel consumption, reduction of emissions and other benefits.

3.2 Investment Drivers

The primary investment driver for the replacement of diesel generators with hybrid is environmental. The reduction of carbon emissions is a minimum requirement as part of our Environmental Action Plan (EAP). The emissions from diesel generators are considerable and could be significantly reduced by replacing them with hybrid generators. The replacement of the diesel generators with hybrid also delivers secondary societal benefits such as reduction in air and noise pollution due to the reduced runtime of the diesel generator. The hybrid generators produce less NOx and Particulate matter and are delivered to site charged, supplying quieter, cleaner power and reducing air and noise pollution in the local area.

3.3 Reasons for the Timing

We currently own 20 30kVA diesel generators in the South (SEPD) and 30 30kVA diesel generators in the North (SHEPD). These generators date from 2009 – 2018. SEPD look to replace their generators when they reach 30,000 operating hours, based on Offgrid usage data we have assumed this equates to every ~10 years. Therefore, some of these generators are overdue replacement and the remaining generators will require replacement during RIIO-ED2. At present a hybrid solution is only available at 26kVA and therefore only the 30kVA diesel generators will be replaced. There are options available at 100kVA, however we are in the process of testing these hybrids. It is expected that more alternatives will become available over the next few years and we will continue to work with suppliers on alternatives and develop their options.

3.4 Expected Outputs and Year of Delivery

The output at the end of RIIO-ED2 will be a new set of 50 hybrid generators, replacing the current dated diesel generators. These new generators will be purchased throughout RIIO-ED2 as the current fleet is phased out.

4 Background Information

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

4.1 Hybrid Generators

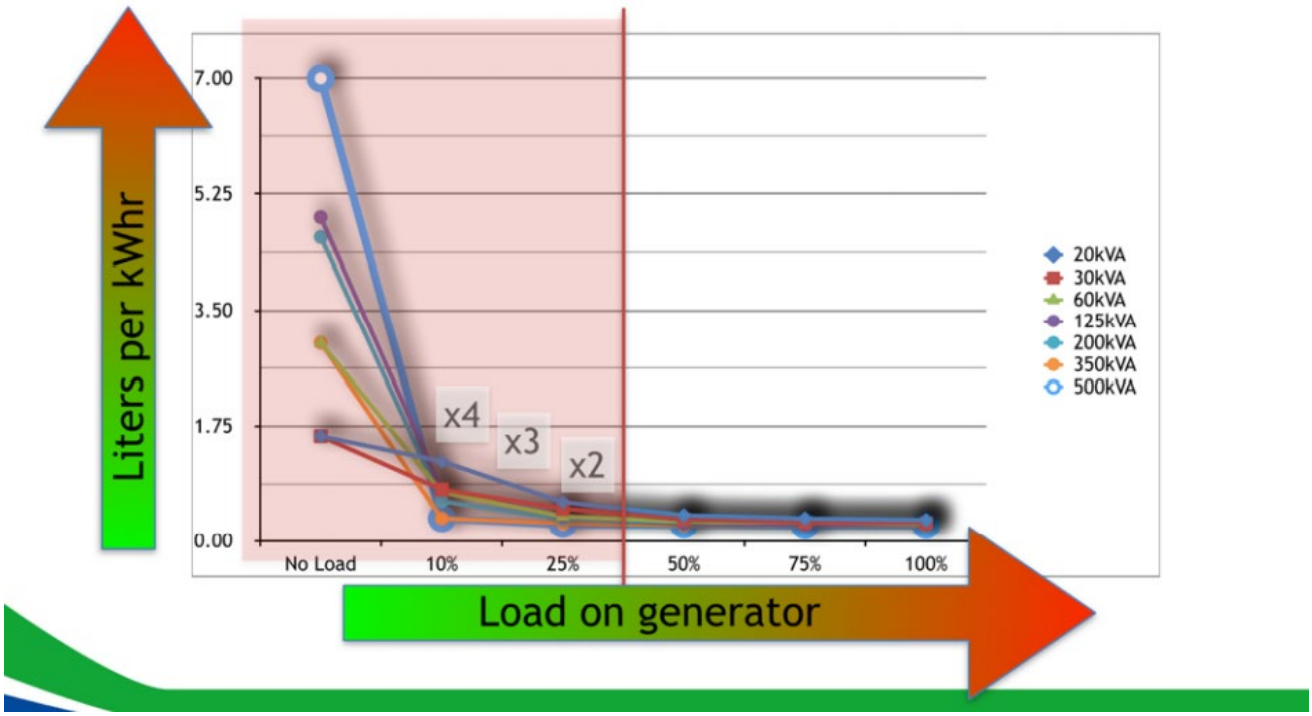
For a 26kVA hybrid generator solution, the hybrid system comprises of a diesel generator and battery/inverter system. The hybrid system provides an alternative to running a generator 24/7. When the generator is on, it is made to work harder by charging a battery, so that energy can be stored, and the system can run on battery power. This is beneficial as generators often experience short periods of high demand and long periods of lower demand. Generators that are lightly loaded burn more fuel, less cleanly for every kWh of electrical energy generated, figure 1. Therefore, the ability for the generator to run on battery power for periods of lower demand delivers several benefits.

For example, a Hybrid Generator unit with a 20kWh battery, (assuming the generator charging the battery is working at it's most efficient) the following can be applied:

- Battery charging efficiency is >90%
- Energy required to be delivered to system to fully charge the battery = 20 / 90% = 22kWh
- Generator fuel consumption per kWh generated is 0.3 litres/kWh
- Fuel required to charge the battery = 0.3l/kWh x 22kWh = 6.6 litres

The additional fuel required to charge the battery compared to just running the diesel generator is 2 litres, but it enables the system to run for double the time before it needs refuelling.

Figure 1 Offgrid graph demonstrating that the fuel burned per kWh generated increases exponentially as load drops below 30%, i.e. the generator is less efficient at low load.



We purchased 10 hybrid generators in 2020. They have been used for supplying 3-4 domestic houses during planned or unplanned outage periods. These generators have been performing well. Only minor issues have been experienced where staff are not plugging in the generators to charge on return and therefore the batteries can end up failing or not holding their charge. Strict controls for when the hybrid sets are returned to the depot should address these issues.

At present a hybrid solution is only available at 26kVA. There are 100kVA hybrid generators being tested but these are not yet ready for roll out. In addition, there was consideration of using an electric vehicle to transport the hybrid generator. Due to the weight of the battery, the subsequent limited range of an electric vehicle (EV) may be an issue for some rural areas and the costs are likely to be prohibitive in the short-term. Using EVs to transport the generator will be reassessed during the RIIO-ED3 cycle.

Biodiesel is also an option to power these generators, with solutions available in the market. This option still requires further investigation into the logistics of biodiesel supply and customer attitude as often these generators power local areas such as residential homes and the smell from biodiesel generators could be unpopular with local residents. Nevertheless, it is possible for Hybrid generators to be adapted to accommodate biodiesel. The cost implications for conversion, the logistics involved to supply the generators and any societal impact of biodiesel as a fuel will be investigated in the lead up to RIIO-ED3.

At end-of-life hybrid generator batteries are recycled. For example, Offgrid recycle the aluminium cases and copper wires. The core substances in the cells are also recovered and used back in the manufacturing chain. This helps to reduce waste and the environmental credentials of the hybrid generators.

4.2 Licence Obligations and Environmental Action Plan Minimum Requirements

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). Our EAP includes Science Based Targets which help meet our registered commitment with the Science Based Targets Initiative (SBTi).

SSEN Distribution are the first UK DNO to commit to setting Science Based Targets (SBT's) in line with a 1.5°C pathway. The targets are in line with the level of decarbonisation required to meet the most ambitious goal of the Paris Agreement – to limit global warming to 1.5°C above pre-industrial levels.

Verified by the Science Based Targets initiative (SBTi), we're cutting emissions further and faster by:

- Committing to reduce our combined Scope 1 and 2 emissions by 55% by 2033 from a 2020 baseline
- Setting a voluntary target and committing to working closely with our supply chain so that 35% of our suppliers will set science-based targets by 2026.

Reducing diesel consumption will have a significant impact on achieving the science-based targets. Fuel consumption accounts for 4.2% of our carbon emissions. It is the second largest category following losses (91% of emissions). The emissions from diesel generators could be significantly reduced by replacing them with hybrid generators. In the EAP we commit to reducing Business Carbon Footprint (BCF) from fuel consumption by 35%. To achieve this, where possible generators will be replaced with Hybrid assets and we will investigate alternative fuel types working in conjunction with the supply chain. We will also investigate operational methods to reduce reliance on mobile generators.

4.3 Investment Drivers

The primary investment driver for this EJP is environmental, reducing CO2 emissions. This will help us meet our targets set out above in the Environmental Action Plan.

1. Sustainability – reduction CO2 emissions

Hybrid generators consume considerably less fuel due to them running on battery power for part of the time. A typical example of a domestic fault has been set out below with data provided from Offgrid:

- A 30kVA diesel generator for 24 hours to supply domestic consumer uses ~ 55-60 litres of fuel
- A 26kVA hybrid generator uses ~ 24-26 litres of fuel.

In the above scenario the fuel consumed is less than half - a saving of 64%. Carbon emissions can be calculated at 3.1kg per 1 litre (includes CO2 to produce and deliver the fuel as well as the emissions). Therefore, a saving of 96.1kg of CO2 per 24-hour period (31 litres x 3.1kg CO2/l).

There are also several secondary drivers and benefits to the investment set out below:

2. Affordability – opex reduction**.** Offgrid-energy calculated an average benefit of £46,810 over the 10-year life of the hybrid generators – this comes from using less fuel, having fewer visits to site to re-fill the fuel tanks and from reduced maintenance costs. They also forecast that the cost of red diesel may increase with new legislation that is being brought in (Reform of red diesel and other rebated fuels entitlement), so the fuel savings may be even greater. These benefits and the calculations are outlined in appendix 1.

3. Manageability – less trips to site to refuel**.** The fuel tank size of the diesel generator is 100 litres compared to the hybrid generator of 219 litres. In addition, as the hybrid generator uses less fuel than the diesel, fewer trips to site are required to refuel.

4. Noise reduction. The hybrid generators can be delivered to site charged, and therefore run very quietly off battery power. In residential areas, noise reduction/ elimination ranks very highly in terms of environmental benefits. It also enables sites to operate longer hours, reducing nuisance or complaints. In other areas, it would be possible, to have the main generator turn off at the end of the working day and have the hybrid system to support the basic night-time loads through to the next morning without noise.

5. Longer generator life. Another benefit of utilising hybrid power is reduced running hours of the generator. Fewer running hours means less need to service the generator saving cost and reducing the waste materials (oil, filters etc) that are created. Furthermore, the fact that the generator will be working harder results in better working conditions and longer service life.

6. Reduced air pollution - hybrid generators produce less NOx and Particulate matter. The level of pollutants relates to the efficiency of combustion, combustion is more efficient in the hybrid generator and a large proportion of the time the generator is also running on battery power.

7. Integration of renewables. Hybrid generators have the potential to be charged using renewable energy further reducing their carbon emissions and impact on the environment.

4.4 Stakeholder Engagement Feedback

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

We have undertaken the following stakeholder events. In total there were 193 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 our stakeholders. A summary of the key feedback that was gather from the stakeholder engagement exercises is presented with the full report available.

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
Distribution Annual Workshop South	23rd September 2020 30th September 2020	Sustainability – helping the UK meet its net zero emissions targets Maintaining a reliable and resilient network for the future	109

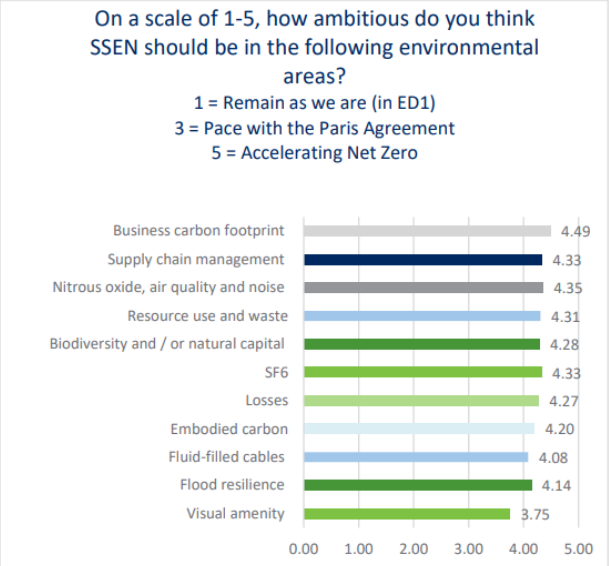
Subject 1: SSEN's Sustainability Strategy and Net Zero Targets

Stakeholder Feedback: In both Scotland and England, stakeholders wanted us to be as ambitious as possible with its sustainability strategy and net zero targets. This was reflected in the electronic voting, where 93% opted for either 'accelerating net zero' or 'achieving net zero'. In both licence areas, during the 18 discussions option 4 (accelerate net zero) was advocated as the stretch, or ideal, target, and option 3 (achieve net zero) was seen as potentially the more realistic goal. Delegates felt that strong leadership was lacking from central government in this area and urged us to step up, work together with other DNOs and LEPs, and forge the way. Affordability was raised as an issue, however, with many calling for transparency in terms of how this level of ambition would affect consumer bills.

Hybrid generators can contribute to reducing CO2 emissions as well as showing financial benefits and therefore are a key option to progress with as consumer bills will not be impacted and will meet stakeholder desires of taking actions to accelerate net zero.

Subject 2: SSEN's Environmental Action Plan

Stakeholder Feedback: During the electronic voting, stakeholders were asked how ambitious we should be with regard to each area of its Environmental Action Plan. Stakeholders wanted the company to be more ambitious across all environmental areas, with even the lowest-ranking area receiving a score of 3.75 out of 5. Stakeholders wanted us to be most ambitious 16 with regard to 'business carbon footprint', which was ranked highest at both the northern Scotland and central southern England workshops.



Given carbon footprint is ranked highest, we are looking to undertaken measures to address this top priority area. Hybrid generators are used in areas visible to the public and therefore are a visual indication to stakeholders of new technology being utilised to reduce carbon footprint.

4.5 Assets Applicable

4.6 SHEPD

The Scotland Network (SHEPD) has a number of diesel generators currently in use. In total there are 107 ranging from 30kVA to 1250kVA. We are looking to replace the 30Kva diesel generators with hybrid generators. There are 30 of these diesel generators to be replaced and they are set out below including their manufacture dates.

Table 1 SHEPD diesel generators to be replaced with hybrid generators

Generator ID	Year of manufacture
30-1N	2009
30-2N	2009
30-3N	2010
30-4N	2010
30-5N	2010
30-6N	2010
30-7N	2010
30-8N	2010
30-9N	2010
30-10N	2010
30-11N	2010
30-12N	2010
30-15N	2011
30-16N	2011
30-17N	2011
30-18N	2011
30-20N	2013

30-21N	2013
30-22N	2013
30-23N	2013
30-24N	2013
30-25N	2013
30-26N	2016
30-27N	2016
30-28N	2016
30-29N	2016
30-30N	2016
30-31N	2016
30-32N	2016
30-33N	2016
TOTAL	**30 Generators**

4.7 SEPD

The Southern Network (SEPD) also has a number of diesel generators currently in use. These are:

- 12 500KVA sets
- 13 200KVA sets
- 25 100KVA sets
- 20 60KVA sets
- 20 30KVA sets
- 6 battery generators
- 10 hybrid generators - rated at approx. 20kVA

There are 20 of the 30kVA diesel generators and we plan to replace these with hybrid generators. The details for the diesel generators being replaced are set out below.

Table 2 SEPD diesel generators to be replaced with hybrid generators

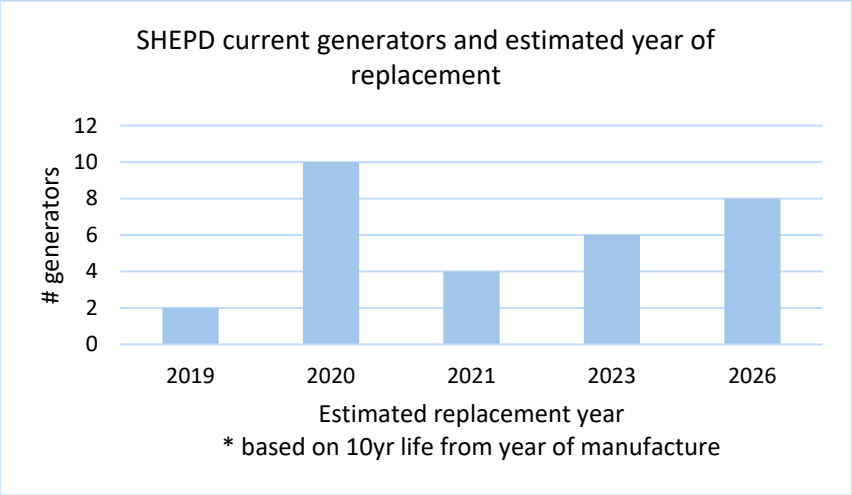
Generator ID	Voltage	Lease end date
030-01	30kva Gen Trl	26/06/2027
030-02	30kva Gen Trl	22/06/2027
030-03	30kva Gen Trl	22/06/2027
030-04	30kva Gen Trl	22/06/2027
030-05	30kva Gen Trl	27/06/2027
030-06	30kva Gen Trl	27/06/2027
030-07	30kva Gen Trl	27/06/2027
030-08	30kva Gen Trl	27/06/2027
030-09	30kva Gen Trl	29/06/2027
030-10	30kva Gen Trl	29/06/2027
030-11	30kva Gen Trl	19/10/2026
030-12	30kva Gen Trl	19/10/2026
030-13	30kva Gen Trl	19/10/2026
030-14	30kva Gen Trl	19/10/2026
030-15	30kva Gen Trl	11/04/2028
030-16	30kva Gen Trl	11/04/2028
030-17	30kva Gen Trl	11/04/2028
030-18	30kva Gen Trl	11/04/2028
030-19	30kva Gen Trl	11/04/2028

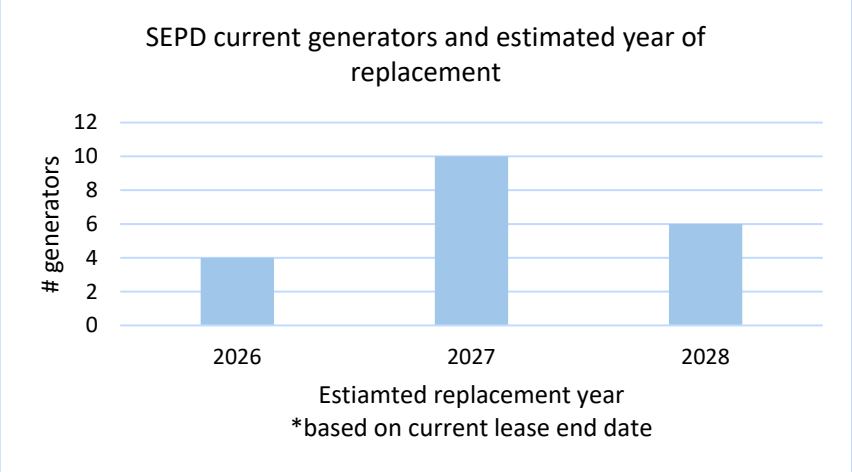
030-20	30kva Gen Trl	11/04/2028
TOTAL		**20 generators**

4.8 Evidence Supporting Investment / Asset Condition

SEPD look to replace their generators when they reach 30,000 operating hours, based on usage we have assumed this equates to every ~10 years. These generators date from 2009 – 2018. Therefore, some of these generators are overdue replacement and the remaining generators will require replacement during RIIO-ED2.

The graphs below indicate the estimated years for replacement for the diesel generators. Some of these generators are overdue replacement and thus there are a number of generators likely to need to replacement all together at the start of RIIO-ED2.





5 Optioneering

This section describes the options considered. The options under consideration are the ones whose outputs address the needs identified in Section 3 in full. The table below summarises the options considered for replacing the current diesel generators.

Table 3 Options Summary Table

Option	Description	Status
0	Do Nothing	Not viable
1	Do Minimum - end of life replacement like for like	Base case – Progressed
2	End of life replacement of diesel generators with hybrid generators	Progressed
3	Accelerated replacement of diesel generators with hybrid generators	Progressed
4	Phased replacement of diesel generators with hybrid generators	Progressed

5.1 Option 0. Do nothing

The current diesel generators remain in place. The current generators are reaching end of life and not replacing them is not feasible as these generators are required to enable work to be carried out on the network.

Option 0 not viable.

5.2 Option 1. Do Minimum – end of life replacement like for like

Replace current 30kVA diesel generators with new Stage V conventional diesel generators when they reach end of life. For SHEPD replace diesel generator units over 10 years old at the start of RIIO-ED2. Replace other SHEPD and SEPD diesel generator units as they reach end of life over the course of RIIO-ED2.

For both SEPD and SHEPD using a new more modern Stage V conventional Diesel Generator uses more fuel per kWh than IIIA Generators hence producing more carbon emissions. This does not meet SSE's Sustainability targets nor comply with EAP as no de-carbonisation benefits are offered.

Option 1. Estimated year of replacement with **diesel** generator (# units per year).

	2023/24	2024/25	2025/26	2026/27	2027/28
SHEPD	22			8	
SEPD				4	16

Option 1 progressed as base case, but not recommended as no environmental benefit to meet targets.

5.3 Option 2. End of life replacement of diesel generators with hybrid generators

Replace current 30kVA diesel generators with new 26kVA hybrid generators when they reach end of life. For SHEPD replace diesel generator units over 10 years old at the start of RIIO-ED2. Replace other SHEPD and SEPD diesel generator units as they reach end of life over the course of RIIO-ED2.

The carbon savings and fuel cost benefits of potentially £200-500/month per generator will be weighed against upfront cost of £35-43k per unit. If biodiesel is to be used with these units, further investigation is required as to whether it is readily available at the sites proposed for the generators. Any issues with supply to remote areas should be investigated before decision is made on what fuel type the generator will run on.

Option 2. Estimated year of replacement with **hybrid** generator (# units per year).

	2023/24	2024/25	2025/26	2026/27	2027/28
SHEPD	22			8	
SEPD				4	16

Option 2 progressed - recommended.

5.4 Option 3. Accelerated replacement of diesel generators with hybrid generators

Replace current 30kVA diesel generators with new 26kVA hybrid generators at the start of RIIO-ED2 in order to maximise the carbon savings. The current lease end dates are 10/2026 - 04/2028.

The carbon savings and fuel cost benefit savings of potentially £200-500/month per generator will be weighed against upfront cost of £35-43k per unit. Lead times should be checked with Generator manufacturer to investigate if this option is feasible.

If biodiesel is to be used with these units, further investigation is required as to whether it is readily available at the sites proposed for the generators. Any issues with supply to remote areas should be investigated before decision is made on what fuel type the generator will run on.

Option 3. Year of replacement with **hybrid** generator (# units per year).

	2023/24	2024/25	2025/26	2026/27	2027/28
SHEPD	30				
SEPD	20				

Option 3 progressed, feasible option if generator supply can meet demand.

5.5 Option 4. Phased replacement of diesel generators with hybrid generators

Replace current 30kVA diesel generators with new 26kVA hybrid generators, although extend generators past current end of life date as additional backup/spares. This enables costs to spread over RIIO-ED2, rate of ~6 per year for SHEPD. SEPD some generators to be replaced early to help spread the costs.

If biodiesel is to be used with these units, further investigation is required as to whether it is readily available at the sites proposed for the generators. Any issues with supply to remote areas should be investigated before decision is made on what fuel type the generator will run on.

Option 4. Year of replacement with **hybrid** generator (# units per year).

	2023/24	2024/25	2025/26	2026/27	2027/28
SHEPD	6	6	6	6	6
SEPD			4	6	10

Option 4 progressed.

6 Analysis and Cost

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

6.1 Approach and Assumptions

Within the CBA a comparison is made to the base case option 2 which is a like for like replacement (diesel for new diesel). The Ofgem tool has been used to build this CBA and includes for the following cost and benefit elements. The assumptions for these areas are stated in the appendix and in the tool. The complete CBA is also included within the Hybrid Generation Investment Decision Pack (IDP).

- Capex cost for the new generator
- Opex cost associated with ongoing maintenance of the generator
  - Annual fuel costs
  - Annual refuelling costs
  - Annual maintenance costs
- Carbon footprint (t CO2). Carbon saving of replacing the generator with a hybrid generator compared to replacement with another diesel generator. This has been converted to a financial value based on Ofgem carbon prices and included in the NPV.
- NPV 15yrs

Our draft RIIO-ED2 Business Plan costs are derived from our outturn RIIO-ED1 expenditure. We have modified costs per activity, capturing and reporting those adjustments in our cost-book. By tying our costs back to reported, outturn, real life data this approach provides multiple data points on which both the Regulator and we can benchmark cost efficiency. It provides a high level of cost confidence in our Business Plan cost forecast for RIIO-ED2.

Through our benchmarking analysis, we recognised that not all Non-Load related RIIO-ED1 actual unit costs sit within the upper quartile efficiency band. Where this is the case, we have applied a catch-up efficiency to those cost categories. Further detail on our unit cost approach, cost efficiency and cost confidence for RIIO-ED2 can be found within our ***Cost Efficiency (Annex 15.1)***.

6.2 CBA Results

The table below summarises the results of the CBA analysis.

Table 4 Summary of CBA results

			CBA Results			
Option	**Description**	**# units replaced**	Capex	Opex	Co2 saving kg (15yr life)	NPV (Whole Life)

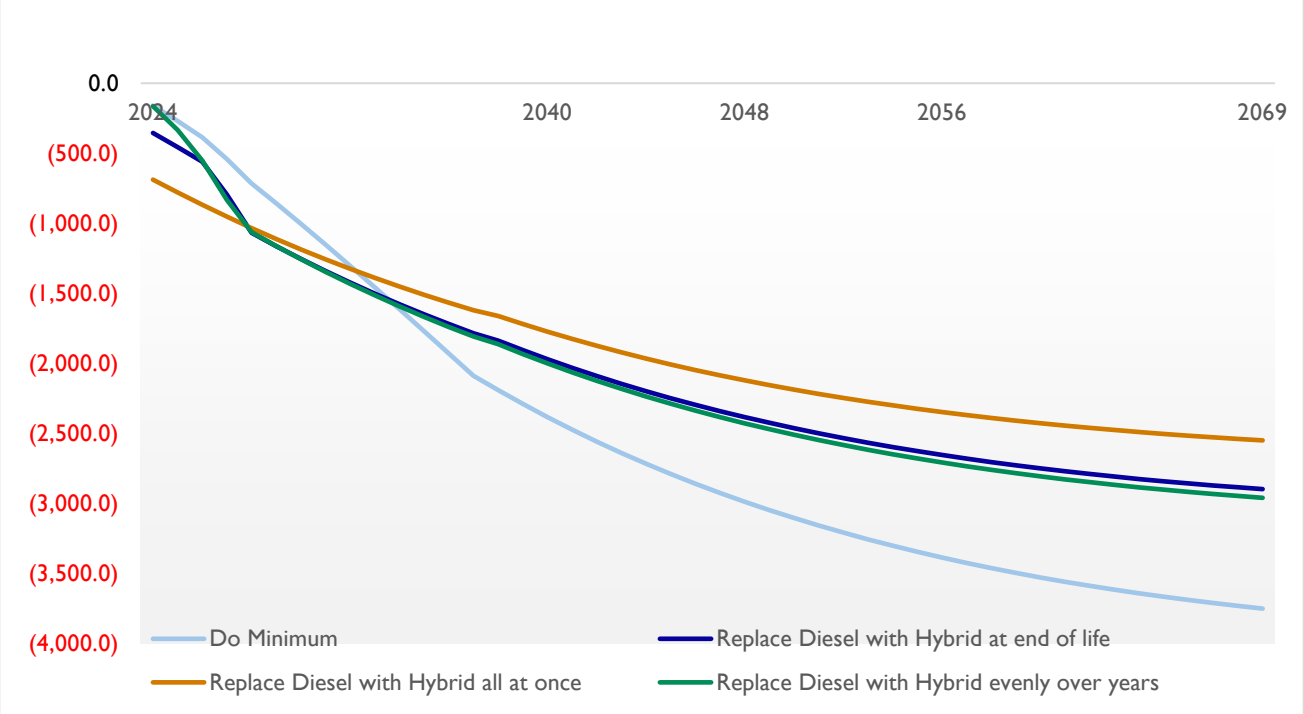
0	Do Nothing	-	-	-	-	-
1	Do Minimum - end of life replacement like for like	50	[redacted]	[redacted]	568 t CO_2	-£3,670k
2	End of life replacement of diesel generators with hybrid generators	50	[redacted]	[redacted]	5,600 t CO_2	-£2,510k
3	Accelerated replacement of diesel generators with hybrid generators	50	[redacted]	[redacted]	6,560 t CO_2	-£2,150k
4	Phased replacement of diesel generators with hybrid generators	50	[redacted]	[redacted]	5,400 t CO_2	-£2,590k

*capex of hybrid generators could increase or decrease over time but assumed same price as to purchase now

The results of the CBA show the capex cost is considerably lower for the purchase of diesel generators. The same number of generators are being purchased in all options. Based on capex this would drive a preference to replace with diesel as opposed to hybrid. However, the opex costs for hybrid generators are considerably lower than diesel generators. This is due to the hybrid consuming less fuel and therefore fuel costs being ~£2,100 cheaper per year. In addition, the number of refuelling events is also reduced saving ~2,500 per year. Replacing the diesel units sooner in option 4 maximises these savings.

In addition, the carbon savings of the hybrid generators are considerably higher. Carbon emissions of the diesel are estimated as 9,400 kg CO2 / yr compared to 36 kg CO2/yr with the hybrid. Again, the sooner the units are replaced the higher the carbon savings.

This is further illustrated in the graph below which shows how the NPV progresses over time for SHEPD and SEPD.



6.3 Preferred Option

The clear preferences delivering both financial and carbon savings are replacing the diesel generators with hybrid generators, options 2, 3 and 4. The preferred option is option 2. Replacing with hybrid at end of life.

The preference would be option 2 (replacing at end of life) over option 3 (accelerated replacement) as there is concern whether suppliers could meet demand and possible constraints on lead time if bulk replacement is progressed in option 3. In addition, if benefits are lower than expected replacing the units in a phased approach (option 2) enables more time to realise any potential implications. Option 2 is preferred to option 4 (phased replacement extending past end of life). This is not only because it means the generators are not extended past end of life, but also increases the carbon savings as they are replaced sooner. The financials are also more favourable due to the cheaper running costs of hybrids.

Installing hybrid generators as per option 2 equates to an NPV saving of c. £775k compared to option 1, do minimum replacing like for like. The standard approach replacing like for like would have previously been requested to Ofgem. This is saving Ofgem £775k. In addition, there is the benefit that replacing with a hybrid generator is more environmentally friendly saving ~5,000 t CO2 over a 15-year life. If the additional financial savings were to be used for carbon offsetting a further ~4,600 t of CO2 could be offset.

7 Deliverability and Risk

Our ***Ensuring Deliverability and a Resilient Workforce (Chapter 16)*** of our business plan it describes our approach to evidencing the deliverability of our overall plan as a package, and its individual components. Testing of our EJPs has prioritised assessment of efficiency and capacity, and this has ensured that we can demonstrate a credible plan to move from SSEN's RIIO-ED1 performance to our target RIIO-ED2 efficiency. We have also demonstrated that SSEN's in house and contractor options can, or will through investment or managed change, provide the capacity and skills at the right time, in the right locations. This assessment has been part of the regular assessment of our EJPs, IDPs and BPDTs, and we will further refine our bottom-up efficiencies and work plan phasing for our final submission in December through the ongoing development of our RIIO-ED2 Commercial & Deliverability Strategy and engagement with our supply chain.

Our deliverability testing has identified a major strategic opportunity which is relevant to all EJPs.

- In RIIO-ED2 SSEN will change the way Capital Expenditure is delivered, maximising synergies within the network to minimise disruptions for our customers. This is particularly relevant for a Price Control period where volumes of work are increasing across all work types.
- The principle is to develop and deliver Programmes of work, manage risk and complexity at Programme level and to develop strategic relationships with our Suppliers and Partners to enable efficiency realisation.
- The Commercial strategy will explore the creation of Work Banks (WB) and identify key constraints. The Load work will be the primary diver for a WB, supplemented by non-Load work at a given Primary Substation. This approach will capitalise on synergies between the Load and Non-Load work, whereby the associated downstream work from a Primary Substation will maximise outage utilisation, enabling the programme to touch the network in a controlled manner with the objective of touching the network once. Where there is no Primary Load scheme to support the non-Load work, these will be considered and packaged separately, either insourced or outsourced dependant on volume, size and complexity.
- Transparency with the Supplier in terms of constraints, challenges, outage planning and engineering standards will capitalise on efficiencies, supported by a robust contracting strategy.

The specific considerations for deliverability based on the scope of this EJP are detailed below:

- Training
- location including access issues and civils
- supply chain
- Work phasing and project interdependencies
- System interfaces for controls, Network operation and SCADA

7.1 RIIO-ED2 BPDT Figures

The outputs for this investment will be a new fleet of fifty 26kVA hybrid generators by the end of RIIO-ED2. These will replace the current fifty 30kVA diesel generators used in SEPD and SHEPD that are reaching end of life.

The total RIIO-ED2 planned spend is £[redacted]m of which £[redacted]m is for SHEPD where 30 hybrid generators are being purchased and £.[redacted]m is for SEPD where 20 hybrid generators are being purchased. Operational costs total £0.76m across both regions. The costs have been allocated over the course of RIIO-ED2. This is for the preferred option, option 2, where the generators are replaced at end of life. Estimates have been made as to when the current generators will reach end of life.

SHEDP – CV22

Asset Category	Unit	2024	2025	2026	2027	2028	Total
Hybrid Generators (SHEPD)	#	22			8		**30**
	[redacted]	[redacted]			[redacted]		[redacted]

*capex not discounted

SEDP – CV22

Asset Category	Unit	2024	2025	2026	2027	2028	Total
Hybrid Generators (SEPD)	#				4	16	**20**
	[redacted]				[redacted]	[redacted]	[redacted]

*capex not discounted

7.2 Risks/Constraints

Data has been collected on our hybrid generators that were purchased in 2020. At this point in time, we have not achieved the same level of benefits as Offgrid predicted from their generators. Currently we have been seeing around £800/month benefit from 4 of the generators combined. The Offgrid numbers applied in the CBA were around £400/month benefit for one generator, ~1,610 for 4 generators. This is 50% of the total benefit predicted. However, there were months where a single unit saved us £500+/month, more than the CBA estimate. The savings depend on how often the hybrid generators are used. At present the generators are not used as often with engineers preferring to use the familiar diesel generators. More work needs to be done to encourage staff to use the hybrids and it is expected in the future the hybrids will be used more. In order to mitigate for potentially lower benefits, option 3 (end of life replacement with hybrid) has been progressed which is a more phased approach to replacement than option 4 (accelerated replacement with hybrid). This will enable continued monitoring of the benefit delivered and updates to the CBA prior to each purchase.

Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that we intend to take during RIIO-ED2 for the non-load related replacement of the current diesel generators.

A background into the assets has been provided including their use as backup generators when works are carried out or there is a fault. The current generators expected life has been summarised and a comparison of hybrid generators to a standard diesel generator has been made.

4 investment options have been described and assessed through a CBA to determine the most appropriate solution. Not all these options are considered viable.

- Option 0: Do Nothing – **not viable**
- Option 1: Do Minimum - end of life replacement like for like – **base case, not recommended**
- Option 2: End of life replacement of diesel generators with hybrid generators – **recommended**
- Option 3: Accelerated Replacement of diesel generators with hybrid generators - **progressed**
- Option 4: Phased replacement of diesel generators with hybrid generators – **progressed**

The preferred option is option 2, replacement with hybrid generators at end of life. Installing hybrid generators based on option 2 in comparison with diesel generators in option 2 equates to a cost saving of circa £775k over the lifetime of the proposal (15yrs). This is a significant saving to the consumer in addition to the CO_2 reduction benefits ~5000 t of CO^2 over 15 years. The saving of ~£775k could potentially offset a further 4,600 tCO^2.

The volumes that have been identified are the same for all options, 30 new generators in SHEPD and 20 in SEPD. During RIIO-ED2 the lifespan of each asset will be confirmed prior to its replacement through continued inspection and maintenance activity.

For the preferred option, option 2 the total investment is £[redacted] of which £[redacted]m is for SHEPD and £[redacted]m for SEPD throughout RIIO-ED2.

Appendix 1 Assumptions and data provided by Offgrid on hybrid generators

Offgrid assessment and data for 30kVA Diesel (Euro V) Generator compared to the 26kVA Hybrid Generator.

CBA analysis:

- Used average numbers.
- Capex unit cost increased to £43,000 for hybrid generator. This includes the cost for the battery and subsequent disposal of the battery at end of life.

Diesel vs Hybrid cost benefit analysis (for DNO restoration applications). Information provided by Offgrid.

	30kVA Euro V Diesel Generator (annual)	30kVA Euro V Diesel Generator (lifespan)	26kVA Hybrid Generator (annual)	26kVA Hybrid Generator (lifespan)
Unit cost (capex)	[redacted]	[redacted]	[redacted]	[redacted]
Min Annual Fuel Cost	£624.00	£6,240.00	£0	£0
Max Annual Fuel Cost	£29,484.00	£294,840.00	£1033.2	£10332
Average Annual Fuel Cost	£2,632.50	£26,325.00	£526.50	£5265
Min Annual Maintenance Cost	£150.00	£1,500.00	£75.00	£750
Max Annual Maintenance Cost	£900.00	£9,000.00	£225.00	£2250
Average Annual Maintenance Cost	£300.00	£3,000.00	£75.00	£750
Refuelling in-situ Min	£0.00	£0.00	£0.00	£0.00
Refuelling in-situ Max	£13,000.00	£130,000.00	£1000.00	£10,000
Refuelling in-situ Average	£3,000.00	£30,000.00	£500.00	£5000
Total Min Cost (exc. Depreciation) +25% repairs*	[redacted]	[redacted]	[redacted]	[redacted]
Total Max Cost (exc. Depreciation) + 100% repairs*	[redacted]	[redacted]	[redacted]	[redacted]
Total Average Cost (exc. Depreciation) + 50% repairs	[redacted]	[redacted]	[redacted]	[redacted]

	30kVA Euro V Diesel Generator (annual)	30kVA Euro V Diesel Generator (lifespan)	26kVA Hybrid Generator (annual)	26kVA Hybrid Generator (lifespan)
Min CO2 emissions Kg	2,230	22,298	0	0
Max CO2 emissions Kg	191,982	1,919,823	308	3,077
Average CO2 emissions Kg	9,407	94,068	36	362
Noise				
Air Pollution (NOx, PM's)				

Assumptions

	30kVA Euro V Diesel Generator (Annual)	26kVA Hybrid Generator (Annual)	Comments
Min fuel consumption (ltrs/hr) @10%	3.2		
Max consumption (ltrs/hr) @50%	8.2		
Average consumption (ltrs/hr)	4.5		*Used average consumption in CBA*

Min Hours used per week	5	0	
Max hours used per week	168	14	
Average hours used per week	15	3	
Min hours used per year	260	0	
Max hours used per year	8736	728	
Average hours used per year	780	156	*Used average hours over year to estimate benefits in CBA*
Cost of diesel per ltr	£0.75		
CO2 / ltr	2.68		*Used this figure provided by Offgrid*
Lifespan (yrs)	10		
Re-fuelling per event	£250.00		
Generator service cost	£75.00		
Generator repair costs (lifetime)	£5,000		
Battery replacement cost (per 10 years based on average use – 4000 cycles)	£[redacted]		