

EARBA STORAGE

A GILKES ENERGY COMPANY

Earba Pumped Storage Hydro Scheme EIA Report

Appendix 12.6: Carbon Balance Calculations

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Technical Appendix 12.6: Outline Carbon Balance

Earba Pump Storage Scheme

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Basis of Report

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Annex A – Carbon Balance Assessment



1.0 Introduction

SLR Consulting Ltd (SLR) was commissioned by Earba Limited (the Applicant) to undertake an outline assessment of the projected net Greenhouse Gas (GHG) carbon benefits for the at the proposed Earba Pumped Storage Scheme (hereafter referred to as the “Proposed Development”).

1.1 Proposed Development

The Proposed Development is located within Ardverkie Estate, to the south of Loch Laggan approximately mid-way between Newtonmore and Spean Bridge and approximately 13km west of Dalwhinnie in the Scottish Highlands.

The function of the Proposed Development would be to create a large-scale long duration electricity storage scheme (PSH) with up to 1800MW generation capacity to store and release energy to or from the electricity transmission system, to help balance supply and demand for power at a national scale. The Proposed Development would operate by transferring water between a lower reservoir, Lochan na h-Earba (Loch Earba) and an upper reservoir, Loch a' Bhealaich Leamhain (Loch Leamhain). The maximum water level of these existing lochs would be raised by constructing dams to increase their storage capacity. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

Full details Proposed Development and evolution are provided in **Chapter 3: Consideration of Alternatives and Design Evolution** of the EIA Report.

1.2 Background and Benefit of PSH

PSH works on a very simple principle, exploiting gravitational potential energy. Two reservoirs in close proximity to each other but at different heights are required. At times of peak electricity demand, water stored in the upper reservoir is released to the lower reservoir, flowing through a turbine. This converts the gravitational potential energy of the water into useable electrical energy. At times of low electricity demand, the excess energy on the grid can be used to pump water back to the upper reservoir where it can be stored again until times of high demand.

Benefits of PSH in relation to reduced carbon emissions include:

- reduction of electrical grid carbon emissions by displacing fossil fuel generation; and
- increasing efficiency of the electrical grid by reducing wind power curtailment during times of low demand.

1.3 Methodology and Limitations

The assessment of the net benefit associated with the Earba PSH scheme is based on calculation of the GHG emissions (tCO₂e) during the construction phase, then comparing this with the net carbon benefits of the energy outputs during the operational phase in terms of avoided GHG emissions associated with electricity generation from the PSH using 100% surplus energy generated from renewable sources (i.e wind power).

This is a similar approach to that adopted and accepted by regulators when assessing GHG emissions associated with wind farm developments. This methodology does not represent a detailed assessment but is aimed at providing a high-level assessment of the potential carbon benefits of the Proposed Development.



2.0 Outline Carbon Balance Assessment

The assessment for generating potential Carbon Losses (tCO₂e) and Carbon Savings (tCO₂e) is detailed below in Sections 2.1 and 2.2 with the calculations detailed in Table 1 and detailed in Annex A.

2.1 Proposed Development Carbon Losses

The GHG (tCO₂e) losses associated with the Proposed Development have been estimated using data relevant to the Proposed Development from the industry standard Carbon Calculator Tool¹.

The Carbon Calculator Tool¹ was designed for high level assessment of carbon payback times for wind farm developments. However, this tool has been considered suitable for this assessment to calculate the main carbon losses as the Proposed Development is similar in terms of ancillary development infrastructure (access tracks, borrow pits, and construction compounds) and construction materials (concrete). The Carbon Calculator Tool uses the following key inputs to determine the carbon losses associated with the construction of the Proposed Development;

- Volume of concrete utilised within the Proposed Development
- Length of track
- Extents of development
- Operational duration of the development

The Carbon Calculator reference data is provided in Table 1. The calculated GHG losses associated with the Proposed Development are of the order of 1,743,381 tCO₂e.

The volume of materials (rock, sand and gravel) generated during the construction phase have been estimated at 11.5 million (M) m³. To calculate the GHG losses associated with the extraction of this material which is not included within the Carbon Calculator Tool¹ the GHG emissions for aggregate² material use have been used. The calculated GHG losses associated with the use of 11.5M m³ of materials within the Proposed Development are of the order of 240,638 tCO₂e.

2.2 Proposed Development Carbon Savings

The annual power generation from the Proposed Development when operational is 4,500 GWh.

This assessment assumes that to facilitate the annual power generation surplus energy generated from renewable and low carbon sources is used to pump water from Lochan Earba to Loch Leamhain and to 'prime' the PSH scheme.

The carbon emissions savings are calculated using the current emission factor of 0.432 t CO₂ MWh from the Carbon Calculator Tool¹ for the counterfactual case for power generation which has been assumed to be the UK Grid Mix.

The net emission of GHG (tCO₂e) which would be saved by utilising the PSH for power generation instead of the UK Grid mix is of the order of 1,944,000 tCO₂ per year.

¹ Scottish Government (2016). *Calculating potential carbon losses and savings from wind farms on Scottish peatlands. Technical Note* – Version 2.1.0.0

² UK Government GHG Conversion Factors for Company Reporting. Material use. Scope 3. Version 1.1 2023. <https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting>



Table 1: Carbon Balance Assessment

Item	Description	Value	Units	Source
Greenhouse Gas (GHG - Carbon) Potential Losses Associated with Development				
1	GHG Emissions from construction and development.	1,743,381	tCO ₂ e	SEPA Carbon Calculator Tool. Reference - UMEP-72LT-NKNZ v0
2	GHG Emissions from volume of materials extracted during construction.	240,638	tCO ₂ e	EIA Chapter 3: Consideration of Alternatives and Design Evolution
Greenhouse Gas (GHG - Carbon) Potential Savings Associated with Development				
3	UK Fossil fuel-mix emission factor	0.432	(t CO ₂ MWh ⁻¹)	SEPA Carbon Calculator Tool
4	Annual generation from the Earba PHS. Assumes all operations are carried out using power generated by renewable sources i.e Wind Power.	4,500	GWh	Gilkes Energy Ltd.
5	Annual generation from the Earba PHS.	4,500,000	MWh	Converted from No.4 above.
6	GHG Emissions avoided.	1,944,000	tCO ₂ e/ year	Annual Earba output of 1,000,000 MWh x Fossil Fuel Mix Emission Factor.

2.3 Carbon Balance and Payback Time

The carbon losses and carbon savings have been summarised in Table 2 below. It is shown that the carbon payback time is calculated as approximately 1.0 years.

Table 2: Carbon Balance Payback

GHG Impact (tCO ₂ e) of Development	GHG Benefit (tCO ₂ e) per year (avoided CO ₂)	Approx Payback Time (Years)
1,984,018	1,944,000	1.0





Annex A - Carbon Balance Assessment

Earba Pumped Hydro Storage(PHS)				
	Description	Value	Units	Information Source
No	<i>Greenhouse Gas (GHG - Carbon) Impact of Development</i>			
1	GHG Emissions from construction and development.	1,743,381.00	tCO2e	SEPA Carbon Calculator Tool. Reference - UMEP-72LT-NKNZ v0
2	Volume of materials extracted	11,500,000	m3	EIA Chapter 3: Consideration of Alternatives and Design Evolution Assumes conversion factor of 2.7 for metasedimentary rock. UK Government GHG Conversion Factors for Company Reporting - Aggregates material use
3	Tonnage of materials extracted	31,050,000	tonnes	
4	GHG Emission per tonne of aggregate used.	0.00775	tCO2e	
	GHG Emissions from aggregate production	240,638	tCO2e	
5	GHG Emissions Total	1,984,018.50		
6	<i>GHG Benefit of Development</i> UK Fossil fuel-mix emission factor	0.432	(t CO2 MWh-1)	SEPA Carbon Calculator Tool
7	Annual generation from the Earba PHS. Assumes all operations are carried out using power generated by renewable sources i.e Wind Power.	4,500.0	GWh	Gilkes Energy Converted from No.7 above.
8	Annual generation from the Earba PHS.	4,500,000	MWh	
9	GHG Emissions avoided.	1,944,000	tCO2e/ year	Annual Earba output of 40,000 MWh x Fossil Fuel Mix Emission Factor.
10	Payback Time	1.02	years	



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