FEARNA STORAGE

Fearna Pumped Storage Hydro Scheme
EIA Report

Appendix 12.3 - Carbon Calculator

February 2025

Quality Information

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Technical Appendix 12.3: Carbon Calculator

Fearna Pump Storage Scheme

Fearna Storage Limited

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Basis of Report

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Table of Contents

1.0 Introduction

SLR Consulting Ltd (SLR) was commissioned by Fearna Storage Limited (the Applicant) to undertake a high level outline assessment of the projected net Greenhouse Gas (GHG) carbon benefits for the proposed Fearna Pumped Storage Scheme (hereafter referred to as the "Proposed Development").

1.1 Proposed Development

The Proposed Development is located approximately 23km west of Invergarry, accessible via an unnamed road west off of the A87, approximately 2km northeast of Loch Quoich, and approximately 5km west of Colle Mhorgil in the Scottish Highlands.

The function of the Proposed Development would be to create a large-scale long duration electricity storage scheme (LDES) with up to 1,800MW 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, the existing Quoich reservoir, and an upper reservoir created by raising the level of Loch Fearna. The reservoirs would be connected by an underground waterway system, with the turbines located in shafts within a powerhouse structure by the shore of the Quoich reservoir.

Full details Proposed Development and evolution are provided in **Chapter 2: The Proposed Development** 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 Fearna PSH scheme is based on calculation of the GHG emissions (tCO_2e) 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 Carbon Calculator

The assessment for generating potential Carbon Losses (tCO_2e) and Carbon Savings (tCO_2e) 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 (tCO_2e) losses associated with the Proposed Development have been estimated using data relevant to the Proposed Development from the industry standard Carbon Calculator Tool[1] spreadsheet based on the current unavailability of the Online SEPA Carbon Calculator website[2]

The Carbon Calculator Tool[1] 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 1,744,562 tCO_2e.

The volume of materials (rock, sand and gravel) generated during the construction phase have been estimated at 10.5 million (M) m^3. To calculate the GHG losses associated with the extraction of this material which is not included within the Carbon Calculator Tool[1] the GHG emissions for aggregate[3] material use have been used. The calculated GHG losses associated with the use of 10.5M m^3 of materials within the Proposed Development are of the order of 206,550 tCO_2e.

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 during 'pumping' mode, when surplus electricity in the grid would be used to power the reversible pump turbines to pump water from the lower to the upper reservoir, to be stored to allow generation when required to 'prime' the PSH scheme.

The carbon emissions savings are calculated using the emission factor of 0.207 t CO2 MWh from the Carbon Calculator Tool[1] for the counter factual case for power generation which has been assumed to be the UK Grid Mix.

[1] Scottish Government Windfarm Carbon Assessment Tool – Version 2.14.1 27/01/2023.

[2] https://informatics.sepa.org.uk/CarbonCalculator/

[3] UK Government GHG Conversion Factors for Company Reporting. Material use. Scope 3. Version 1.1 2024. https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

The net emission of GHG (tCO_2e) which would be saved by utilising the PSH for power generation instead of the UK Grid mix is of the order of 1,951,112 tCO_2 per year.

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.	1,744,562	tCO2e	Scottish Government Windfarm Carbon Assessment Tool – Version 2.14
2	GHG Emissions from volume of materials extracted during construction.	206,550	tCO2e	EIA Chapter 3: Consideration of Alternatives and Design Evolution
Greenhouse Gas (GHG - Carbon) Potential Savings Associated with Development				
3	UK Grid mix emission factor	0.207	(t CO2 MWh-1)	Scottish Government Windfarm Carbon Assessment Tool – Version 2.14
4	Annual generation from the Fearna 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 Fearna PHS.	4,500,000	MWh	Converted from No.4 above.
6	GHG Emissions avoided.	931,500	tCO2e/ year	Annual Fearna output of 4,500,000 MWh x UK Grid 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 2.1 years.

Table 2: Carbon Balance Payback

GHG Impact (tCO_{2e}) of Development	GHG Benefit (tCO_{2e}) per year (avoided CO2)	Approx Payback Time (Years)
1,951,112	931,500	2.1

Annex A - Carbon Balance Assessment

Fearna Pumped Hydro Storage(PHS)				
	Description	**Value**	**Units**	**Information Source**
No	*Greenhouse Gas (GHG - Carbon) Impact of Development*			
1	GHG Emissions from construction and development.	**1,744,562.00**	tCO2e	Scottish Government Windfarm Carbon Assessment Tool – Version 2.14
2	Volume of materials extracted	10,200,000	m3	EIA Chapter 3: Consideration of Alternatives and Design Evolution
3	Tonnage of materials extracted	27,540,000	tonnes	Assumes conversion factor of 2.7 for metasedimentary rock.
4	GHG Emission per tonne of aggregate used.	0.00750	tCO2e	UK Government GHG Conversion Factors for Company Reporting 2024 - Aggregates material use
	GHG Emissions from aggregate production	**206,550**	tCO2e	
5	GHG Emissions Total	**1,951,112.00**		
	GHG Benefit of Development			
6	Grid-mix emission factor	0.207	(t CO2 MWh-1)	Scottish Government Windfarm Carbon Assessment Tool – Version 2.14
7	Annual generation from the Fearna PHS. Assumes all operations are carried out using power generated by renewable sources i.e Wind Power.	4,500.0	GWh	Gilkes Energy
8	Annual generation from theFearna PHS.	4,500,000	MWh	Converted from No.7 above.
9	GHG Emissions avoided.	**931,500**	tCO2e/ year	Annual Fearna output of 4,500,000 MWh x Grid Mix Emission Factor.
10	Payback Time	2.09	years	