Fairholme BESS – Dog Trap Lane, Minety (PL/2022/05412)

Carbon Dioxide savings of installing battery storage capacity onto the UK power grid

Introduction

At Wiltshire Council's Northern Planning Committee on 16th April 2024, committee members requested further information on the CO_2 emissions equivalent (referred to subsequently as simply 'carbon' for ease) of the Fairholme Battery Energy Storage System (BESS) proposal on land off Dog Trap Lane Minety (ref. PL/2022/05412). Members wished to see figures presented that would support the case that BESS schemes save on carbon.

This document provides an overview of the associated carbon savings and the carbon costs for the delivery of the Fairholme BESS proposal.

Headline Figures

Estimated net total carbon cost (i.e. how much carbon the BESS would contribute, accounting for the battery unit manufacturing, construction and operational activities):

+ 53,108 tonnes of CO_2

Estimated total carbon saved (i.e. how much carbon the BESS would directly save, accounting for a 40 year lifespan):

- 1,249,240 tonnes of CO_2

Overall carbon savings:

- 1,196,132 tonnes of CO_2

1.2 million tons CO2 over the project lifetime, equivalent of 1.4 million trees being planted in year 1

Technical Discussion and Carbon Savings Calculations

BESS are an essential element of a low carbon to net zero carbon electricity grid. As outlined in the Planning Design and Access Statement supporting the application, BESS allow greater reliance on intermittent renewable generation in two important ways:

1. Firstly, BESS allow zero carbon electricity generated by renewables to be stored during periods of excess generation and released to the grid during times of excess demand. An example is when solar energy is stored up during the middle of the day and released back into the grid during the early evening (when peak demand typically occurs). The reality is more complex but that simple view summarises the process.

2. Secondly, and equally important, BESS provide vital grid stability services to allow an efficient stable power grid, increasingly powered by intermittent renewable generation. In summary, traditional fossil fuel generators provide stabilising inertia to the system (a large steam generator unit has a substantial mass of spinning machinery which does not want to change speed readily) and reactive power from their generator sets (which makes the electrical grid more efficient).

   As we depend more and more on renewable energy, we lose this essential inertia and reactive power from the electricity grid. BESS units are able to provide both these services due to the nature of the energy stored and the power conversion technology the BESS utilises. This is known as synthetic inertia and reactive power support.

Both the above factors mean that BESS indirectly have a significant carbon saving, through the allowance of more renewable generation onto the grid, and the avoidance of costly (and carbon intensive) network infrastructure upgrades which the BESS alleviate.

On the other side of the equation, producing the batteries for a BESS unit requires mining of the required material, processing, assembly into batteries, transport etc which has a carbon cost. Since the batteries have a lifespan of approximately 10 years, and the project is 40 years long, we calculate the full carbon impact over the project lifecycle.

Carbon Savings Calculation

There is excellent data from reputable sources that give numbers to the different impacts above. Whilst the figures used in the following calculations are not specific to the Fairholme site, BESS carbon impacts are similar across the sector due to the very similar technology used, and so recent data can be applied to all new BESS sites with a high degree of confidence that the resulting figures are representative. Indeed, new sites using the latest technology are likely to be at the current peak of carbon savings as BESS technology is consistently improving in it's operational efficiency. This also means that the carbon savings will likely improve over the lifetime of the project as the technology evolves (and as new units are installed).

One of the UK power grid modelling experts, Modo, recently studied the carbon saving produced by adding BESS to the UK power grid.[1] They have calculated that each MWh of BESS added to the grid, in 2022, produced a saving of 263 tons of CO_2 per annum.

The Fairholme BESS project is a 47.5MW, 2.5 hour system so in terms of MWh, the scheme is 47.5MW x2.5 = 118.75MWh.

Using Modo's 2022 figures then, the project will save 263 x 118.75 = 31,231 tons of CO_2. Over a 40-year lifespan:

31,231 x 40 = **1,249,240 tons of CO_2 equivalent saving.**

Carbon Costs Calculation

Manufacturing the Batteries

On the carbon costs, research by the Swedish Environmental Research Institute estimates that the carbon footprint of producing lithium ion batteries as 61-106kg CO2-eq/kWh.[2] Using the more conservative higher end of this estimate of 106kg CO2-eq/kWh, this equates to 106,000 kgs per MWh, or 106 tons/MWh.

Applying this to the Fairholme BESS (118.75MWh) we have:

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[1]The carbon benefit of battery energy storage in Great Britain (https://modoenergy.com/research/8973)

[2] Lithium-Ion Vehicle Battery Production - Status 2019 on Energy Use, CO2 Emissions, Use of Metals, Products Environmental Footprint, and Recycling (https://www.ivl.se/english/ivl/publications/publications/lithium-ion-vehicle-battery-production----status-2019-on-energy-use-co2-emissions-use-of-metals-products-environmental-footprint-and-recycling.html)

118.75 x 106 = 12,587 tons CO_2 equivalent for the project. Over the 40-year lifetime the batteries will be expected to be replaced four times (note, this is an overestimate as battery technology improves, lifespans are increasing). This gives:

12,587 x 4 = 50,348 tons CO_2 equivalent cost

Construction Impacts

In terms of construction impacts, Field (a developer of BESS systems in the UK) carried out a recent Life Cycle Assessment (LCA) of one of their BESS sites (20MW capacity)[3]. The LCA calculates the lifetime carbon impacts of the project. The construction impacts were estimated at 230t CO_2 equivalent for the project lifetime (20 years).

If we take a very conservative approach in applying this to the Fairholme BESS and scale it proportionally (i.e. x2 for a 40year lifetime and x6 for a 118.75MWh capacity), the Fairholme BESS construction carbon cost would be 230 x 12 = 2,760t CO_2 for its 40year lifetime. However, in reality, increasing the capacity and project lifetime would result in a lower CO_2 per MW construction carbon cost as scaling up production spreads the overall carbon costs, so this figure is conservative.

Total Carbon Costs

Adding the battery manufacturing and site construction carbon costs, we get:

50,348 + 2,760 = **53,108 tonnes of CO_2 equivalent costs**

Overall Carbon Calculation:

Using the figures calculated above, the Fairholme BESS project would have save a CO_2 equivalent of:

1,249,240 – 53,108 = **1,196,132 of CO_2 equivalent over project lifetime**

These numbers are based on recent data, which means they are conservative for a number of reasons:-

- Battery technology is improving rapidly, increasing efficiency and lifespan which will reduce the carbon cost of the batteries
- Batteries are increasingly replacing fossil fuel generators in reserve services. Reserve is currently delivered almost entirely by generators with high carbon intensity. With new reserve products coming and increasing reliance on BESS, this will improve the carbon savings in this report

[3] Field Energy - Independent LCA audit reviewed by DNV.pdf - Google Drive