Orkney Islands Council

Net Zero Transition

Final Report

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Contents

1 Introduction

This report has been produced by Aether for the Orkney Islands Council (OIC) Net Zero Transition Study. The information provided in this report is intended for use as an evidence base to support OIC's formative Climate Strategy and Action Plan.

First, it presents **greenhouse gas (GHG) emissions baseline data** for OIC's estate and operations, which indicates current sources of emissions from the council's activities. Next, it describes OIC's likely GHG emissions under a **'business as usual' (BAU) scenario**, which reflects the impacts of committed GHG reduction measures. Additional **decarbonisation scenarios** have also been modelled, representing various levels of ambition, with different combinations of measures that include energy efficiency, behavioural and technological changes, and more. Next, the report provides **recommendations on priority actions** OIC can take to mitigate its GHG emissions. Finally, it sets out options for OIC to **compensate for (or 'offset') residual emissions**.

1.1 Why is it important to take action on climate change?

There is an overwhelming scientific consensus that human activities are causing global temperatures to increase, with serious knock-on effects for our atmosphere, land and oceans. The UK Climate Change Risk Assessment (2022) identified 61 risks and opportunities for Scotland[1] including:

- More severe and frequent storms and flooding
- A greater risk of wildfires and heatwaves
- Rising sea levels and coastal erosion
- Food safety and food security
- Other changes in the ecosystem that pose a risk to agriculture
- Cascading failures for infrastructure networks (water, energy, transport, ICT)

These effects would have a serious impact on people at a local and regional level. But when this type of disruption happens all across the world – threatening homes, businesses, food and water security, and human health – the risks become much greater.

Governments around the world acknowledged the urgency of this problem, signing international agreements such as the 1997 Kyoto Protocol and 2016 Paris Agreement which have sought to mitigate the damage. This can be done both by (a) reducing GHG emissions, to limit the overall temperature rise and therefore avoid even more extreme climate change, and (b) making sure that our communities, economy, and infrastructure are resilient to the changes that are already underway. This report focuses on point (a), which is referred to as GHG mitigation.

[1] https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Scotland-Summary-Final-1.pdf

In July 2019, OIC declared a climate emergency[2], and reaffirmed the priority to work towards a carbon neutral economy. For remote communities, particularly for islands like Orkney, climate action planning is particularly complex as they have additional sensitivities to factor into decision making that can often vary from location to location, based on factors such as transport, distribution of resources and island population needs. Due to its geographic location, Orkney also already faces much more extreme weather than the rest of the UK, and its settlement patterns are positioned close to the sea. Therefore, national policies or measures that are intended to be broadly applicable to the country as a whole may be more challenging to implement and/or less relevant as a result of these unique characteristics.

The services that OIC provides, and the potential solutions that it could adopt to mitigate GHG emissions, are almost unique among UK Local Authorities due to the islands' remote nature which often demands additional infrastructure, resilience and forward-planning, alongside the need to optimise the use of existing assets. For example, it provides services relating to harbour and inter-island air travel, which are unusual for a local authority. Although OIC is embracing this challenge, the Council has acknowledged that they are currently "below the pace required within recognised net zero aligned approaches."[3] There is a need for further, accelerated action.

On the positive side, the unique characteristics of Orkney and OIC as a council mean that there are unique opportunities for GHG reductions that might not be feasible elsewhere. For example, Orkney has a large amount of renewable energy potential and there are a number of innovative technological trials underway for systems ranging from low carbon aviation, to hydrofoil ferries, to green hydrogen production. The council is in a good position to implement some of these solutions ahead of the curve.

1.2 Policy context and other drivers

OIC's climate change ambitions sit within the context of a variety of national and international treaties and legislation. They are supported by additional local policies and strategies. A summary is provided below.

International context: The UK ratified the Paris Agreement in 2016. The Paris Agreement is an international treaty that commits signatories to pursue action to limit global warming to 2°C, with an ambition of keeping it below 1.5°C.

UK context: The UK Climate Change Act 2008 (as amended in 2019) requires emissions to reduce to net zero by 2050 at the latest. Additionally, the Committee on Climate Change (CCC), which is the UK Government's independent advisory body on climate change, sets out 5-year carbon budgets that must be met as stepping stones along the way. These targets have been set in response to the scientific evidence compiled by the Intergovernmental Panel on Climate Change (IPCC).[4]

Scottish context: The Climate Change (Scotland) Act 2009 set a legally-binding GHG emissions reduction target for whole country, which is expressed as a percent (%) improvement, relative to 1990 levels. Whereas the original Act would have required an

[2] https://www.orkney.gov.uk/media/akqorobh/item-24-climate-change-strategy.pdf
[3] https://www.orkney.gov.uk/Files/Committees-and-Agendas/Policy-and-Resources/PR2023/PR19-09-2023/Item%2024%20Climate%20Change%20Strategy.pdf
[4] https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

80% cut in GHG emissions by 2050, it was amended in 2019 to require a 100% net reduction by 2045. The Scottish Government had also set an interim target for 2030, however this was removed in 2024 following a report by the UK Climate Change Committee.[5] This ambitious target would require emissions to reach net zero five years in advance of the rest of the UK.

Furthermore, all Scottish Local Authorities have a duty[6] to take action on climate change in support of this national target and report[7] their progress under the Climate Change (Duties of Public Bodies: Reporting Requirements) Amendment Order 2020.

Local context: In 2019, Orkney Islands Council (OIC) declared a climate emergency and through the adopted Council Plan 2023-28, has confirmed a high level of ambition for achieving net zero in advance of the national target date of 2045. OIC has set out a vision and principles for its approach to tackling climate change, which include:

- **Action and Ownership** – to understand and reduce our emissions at the earliest opportunities;
- **Collaboration and Co-ordination** – across Council services and with partners and the community;
- **Transparency** – in the setting and addressing of our carbon targets; and
- **Sustainability** – building our resilience and adapting to the changing climate.[8]

In addition, OIC has further local policies and measures that are relevant to GHG emissions reduction:

- A Carbon Management Plan (CMP) which aims to reduce OIC total carbon dioxide emissions in the financial year 2025 by 42% compared to the baseline year 2004-05.
- A core principle within the Council Plan 2023-28 of ‘protecting our environment and combatting climate change’ with ‘sustainable and accessible services for all’ and working towards becoming net zero.
- The Delivery Plan describes the projects that will support the Council Plan, and there are a number of climate-related actions under the theme of ‘Growing Our Economy’. Decarbonisation is given high prominence as a first priority.
- An overarching outcome within the Orkney Local Transport Strategy where 'transport contributes to a successful and just transition to a net-zero carbon and sustainable community' with further intentions to reduce car vehicle kilometres where possible in the context of a dispersed population.
- An Area Waste Plan with the aim to contribute to sustainable development of the area by developing waste management systems that will influence waste generation, reduce its environmental impact, improve resource efficiency, stimulate investment and maximise the economic opportunities arising from waste.
- A core principle within the OIC Sustainable Procurement Strategy of 'protecting our environment and combating climate change'.
- The forthcoming Local Development Plan will recognise OIC’s role in addressing the global climate emergency.

[5] https://www.theccc.org.uk/publication/scotlands-carbon-budgets/
[6] https://www.legislation.gov.uk/ssi/2020/281/made
[7] https://sustainablescotlandnetwork.org/ssn-manual/reporting
[8] https://www.orkney.gov.uk/your-council/our-future/climate-change/

- Orkney, along with Shetland and the Outer Hebrides, is part of a pan-island innovation project, the Islands Centre for Net Zero, which will support research into a renewable energy transition.

These policies and drivers have been taken into consideration when developing the list of GHG reduction actions (also known as 'mitigation measures') for OIC, including timescales. More details of the actions are provided in subsequent chapters.

1.3 Terminology used in GHG accounting

This section briefly describes key terminology that is used throughout this report.

1.3.1 Units of measurement

Greenhouse gases (GHGs) are gases in the Earth's atmosphere that trap heat, thus contributing to climate change. Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are the primary GHGs, but there are others, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).[9]

These gases have different effects on the atmosphere over set time periods. For example, one tonne of methane has a different impact on temperature rise, or global warming potential (GWP), than one tonne of carbon dioxide. 'Carbon dioxide equivalent' or CO_2e is a measure used to compare the emissions from various GHGs based on their GWP. It represents the amount of CO_2 that would have to be emitted to have the equivalent global warming effect over a specified time period, allowing easier comparison of emissions from different GHGs.

1.3.2 Scope 1, 2 and 3 emissions

In GHG accounting, it is standard practice to group emissions into different categories or 'scopes'. This is done in order to clarify which sources of emissions arise directly or indirectly from an organisation's activities, and which ones they have the most control over. It also helps to avoid double-counting between different organisations. The table below provides definitions of these scopes, with relevant examples for OIC.

Table 1: Definitions of GHG accounting scopes

Scope	Definition	Examples
Scope 1	Direct GHG emissions from sources owned or controlled by OIC	Burning fossil fuels within Council buildings e.g. gas fired boilers or petrol and diesel in fleet vehicles
Scope 2	Indirect GHG emissions from the consumption of purchased electricity, steam or other sources of grid-distributed energy	Electricity used across the Council estate – council offices, EV charging points and street lighting
Scope 3	Other GHG emissions that occur indirectly from OIC's activities	Emissions from staff working from home and commuting, or from operations which are run by a third party (e.g. Pickaquoy Leisure Centre or from waste disposal).

Examples of reasons why emissions might not be included in the GHG inventory would be if there is insufficient data to produce a meaningful estimate, as in the case of emissions from OIC pension funds, or where the Council lacks any significant influence,

[9] https://naei.beis.gov.uk/overview/ghg-overview

as in the case of grid electricity (which OIC does not generate) being provided to members of the public through chargers owned by OIC (where the council does not operate the vehicle). However, this does not preclude these sources from consideration in climate action plans. More information is provided in **Section 2**.

1.4 Structure of this report

The remainder of this report is structured as follows:

- **Section 2** describes OIC's current GHG emissions baseline and data sources.
- **Section 3** models future greenhouse gas emissions and presents the Business As Usual (BAU) and emissions reduction scenarios.
- **Section 4** presents priority interventions for Net Zero and outlines measures for consideration by OIC.
- **Section 5** describes opportunities for OIC to compensate for any remaining emissions, sometimes called 'offsetting' or 'insetting'.
- **Section 6** provides a summary and conclusions.
- The **Appendices** provide further detail on the modelling assumptions and methodology used as part of this project.

For a description of how the above sections relate to Tasks 1-5 as defined in the Invitation to Tender (ITT), please refer to **Appendix A**.

2 OIC GHG Emissions Baseline

This section describes the sources of emissions that are included in OIC's GHG emissions baseline. This is important for identifying relevant GHG mitigation measures, understanding their potential scale of impact, and therefore being able to prioritise actions and next steps for OIC.

2.1 Emissions included within this study

In Scotland, Local Authorities are required to report their GHG emissions and progress annually in line with the Public Bodies (Climate Change) Duties Reporting guidelines hosted by the Sustainable Scotland Network (SSN).[10] Data for the financial year 2023-24 (the most recent year for which estimates were available when this analysis was prepared) have been used as the basis for GHG scenario modelling. In this report, any subsequent references to a percent (%) reduction are stated in relation to that baseline.

The sources of GHG emissions included in this study largely align with those that are already included in OIC's publicly available reports. Some extensions in scope have been implemented following discussions between Aether and OIC. Those changes were recommended based on a review of available data, and informed by GHG reporting best practice and standards including the internationally recognised Greenhouse Gas Protocol and forthcoming requirements set out by Environmental Standards Scotland.[11] The most significant change was to introduce a more consistent approach to reporting emissions from tenanted properties, which was done for the sake of completeness and consistency. For purposes of this study and net zero projections, the emissions from Orkney College have also been included.[12]

The baseline covers:

- Electricity
- Heating gas oil and LPG for buildings owned by OIC, including its operational buildings, social housing and commercial tenanted properties; note that this includes both the direct emissions from burning fuel and the 'well-to-tank' emissions associated with transporting it to the facility
- Water and wastewater treatment
- Construction & vehicle fleet (including marine)
- Ferries, tugs and harbour craft
- Public transport, including buses and the Inter-Isles Air Service
- Business travel
- Staff commuting [estimated by Aether]
- Emissions from waste
- Fluorinated gases (f-gases) from refrigeration and cooling systems and heat pumps

[10] https://sustainablescotlandnetwork.org/uploads/store/mediaupload/1879/file/PBDR%20Guidance%202022%20Final%20pdf.pdf Note, this is the current guidance at the time of writing (spring 2026) but may be updated in future.
[11] https://www.gov.scot/publications/scottish-government-improvement-plan-response-environmental-standards-scotland-investigation-climate-change-delivery-improvement-report/pages/1/
[12] https://www.orkney.gov.uk/media/vkgd1pye/item-18-council-climate-change-study.pdf

All GHG emissions data were provided to Aether by OIC, with the exception of staff commuting. Aether provided an estimate of emissions from staff commuting. A rough assumption was made about the typical daily commuting distance for OIC employees travelling by car, based on a weighted average of the distances between OIC's offices and other population centres on the Mainland. The emissions per passenger kilometre for individuals travelling by car were then taken from the DESNZ GHG Conversion Factors for Company Reporting.[13] A staff travel survey could be undertaken in future to provide more accurate information.

For more information on which sources of emissions were included and why, please refer to **Appendix B**. Further information on the quality of different data sources in OIC's historic GHG inventory can be found in **Appendix B.5.2.**

2.2 Baseline GHG emissions

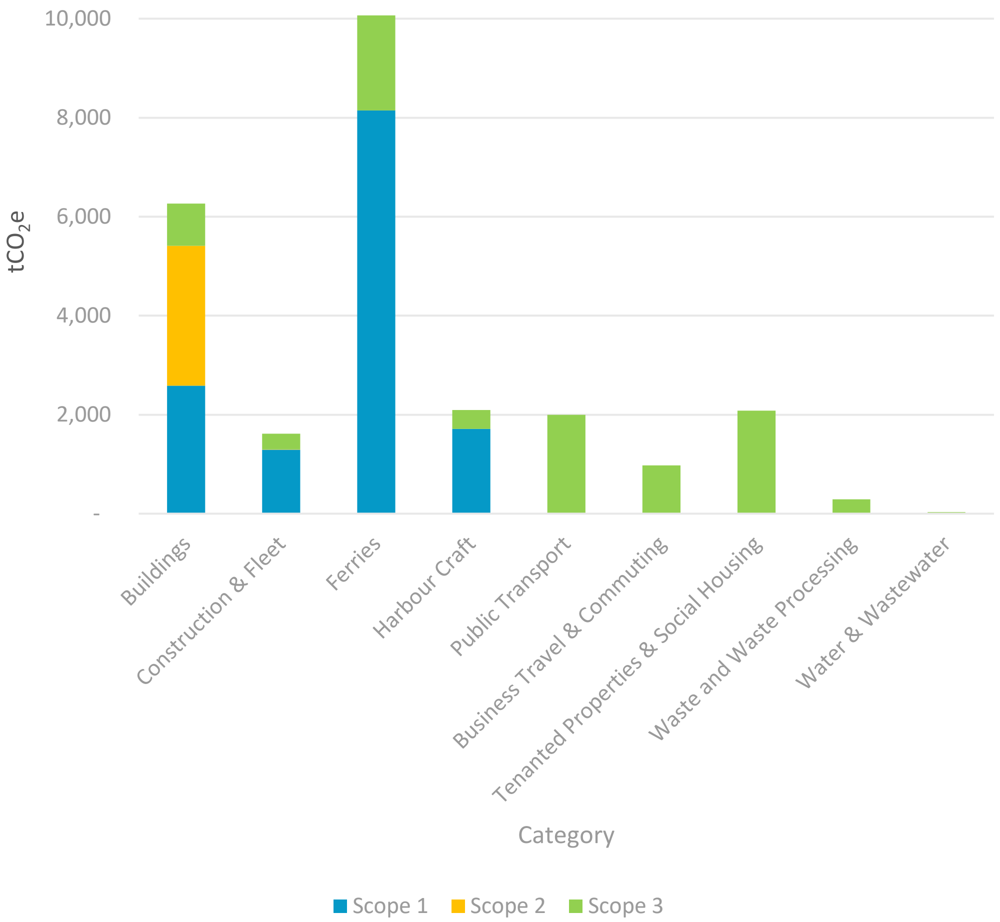
For purposes of this study, OIC's 2023-24 emissions are estimated to be **25,411 tCO_2e**. Of the sources of emissions reported here, 54% are categorised under Scope 1, 11% under Scope 2 and 35% under Scope 3.[14]

Note, however, that there is a variety of other emissions which could be reported under Scope 3 if OIC chooses to expand its GHG inventory in future, and the decision to include or exclude a source of Scope 3 emissions can have a large impact on these percentages. Please refer to **Appendix B** for more information.

A breakdown of the main emission sources can be viewed in **Figure 1**.

[13] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023
[14] The main differences between this figure and OIC's 2023/24 GHG inventory as reported within its PBCCDR are due to the inclusion in this study of emissions from Orkney College, a change in the emission factor for waste sent to landfill, and the inclusion of additional well-to-tank emissions for fuel use.

Figure 1. OIC 2023-24 baseline emission sources by scope



A more detailed breakdown of the Council's emissions is presented in **Table 2**.

Table 2. 2023-24 OIC Emissions by source, scope and % of total emissions

Emission Source	Scope	Emissions (tCO_2e)	% of total
Buildings		**6,263**	**25%**
Electricity	2	2,830	11%
Electricity (T&D)	3	245	1%
F-gases	1	14	<1%
Heating Gas Oil	1	2,351	9%
Heating Gas Oil (WTT)	3	580	2%
LPG	1	218	1%
LPG (WTT)	3	26	<1%
Business Travel & Commuting		**978**	4%
Business travel (domestic flights)	3	332	1%
Business travel (ferry)	3	5	<1%
Business travel (land) – Petrol/diesel car	3	187	1%
Business travel (long haul flights)	3	31	<1%
Commuting - Petrol or diesel car	3	423	2%
Construction & Fleet		**1,614**	6%
Construction (gas oil)	1	193	1%
Construction (gas oil) (WTT)	3	44	<1%
Construction (kero)	1	242	1%

Emission Source	Scope	Emissions (tCO_2e)	% of total
Construction (kero) (WTT)	3	60	<1%
Fleet (diesel)	1	857	3%
Fleet (diesel) (WTT)	3	208	1%
Fleet (elec)	2	9	<1%
Fleet (elec) (T&D)	3	1	<1%
Ferries		**10,065**	**40%**
Electricity - Orkney Ferries	3	67	<1%
Electricity - Orkney Ferries (T&D)	3	6	<1%
Ferry Fleet	1	8,149	32%
Ferry Fleet (WTT)	3	1,843	7%
Harbour Craft		**2,096**	**8%**
Harbour Craft	1	491	2%
Harbour Craft (WTT)	3	111	<1%
Tugs	1	1,218	5%
Tugs (WTT)	3	275	1%
Public Transport		**1,995**	**8%**
Bus Service	1	1,234	5%
Bus Service (North Isles)	1	48	<1%
Bus Service (WTT)	3	300	1%
Inter-Island Air Service	1	326	1%
Inter-Island Air Service (WTT)	3	86	<1%
Tenanted Properties & Social Housing		**2,080**	**8%**
Non-Residential Electricity Use	3	27	<1%
Non-Residential Electricity Use (T&D)	3	2	<1%
Social Housing Electricity Use	3	1,887	7%
Social Housing Electricity Use (T&D)	3	163	1%
Waste and Waste Processing*		**290**	**1%**
Waste (Energy From Waste Plant)	3	154	1%
Waste (Landfill)	3	4	<1%
Waste (Recycling)	3	60	<1%
Waste (Transport by Sea)	3	72	<1%
Water & Wastewater		**30**	<1%
Sewerage	3	9	<1%
Water supply	3	21	<1%
Grand Total		**25,411**	**100%**

T&D refers to T&D losses. These are the upstream emissions of purchased fuels e.g. the mining or refining of liquid and gas fuels or the extraction or production of electricity and steam.

WTT (or 'Cradle to Gate' within GHG Protocol Standard) refers to Well-to-Tank emissions, where reporting companies include 'all emissions that occur in the life cycle of purchased products, up to the receipt by the reporting company'.

* Note that the waste emissions in this report have been updated in this final report since the original analysis was carried out in winter 2024/25. This is due to new information on waste quantities becoming available, and a change in SSN's guidance about whether Scottish Authorities are required to report on their own waste or all of the waste that they collect. The impact on headline figures is low because waste comprises a small portion of OIC's emissions. The GHG mitigation measures in this report focus on OIC's operational waste; these recommendations still apply.

Table 2 shows that in 2023-24 that the highest source of emissions was ferries, tugs and **harbour craft** at 48% of total emissions with the biggest contributor being Marine Gas Oil (MGO) used in the ferry fleet. It should be noted that it is fairly unique for a local authority to have Harbour Craft and Ferries and to provide this vital service for residents. Extra consideration is needed when developing emission reduction measures for lifeline vital services.

The next most significant source of emissions is associated with OIC's operational **buildings**, including emissions from electricity, heating and f-gases; these combine to 25% of the total. OIC's Carbon Management Plan contains a range of measures which would mitigate these emissions, reflecting their importance within OIC's GHG inventory. Note that, as is the case with some of the other categories reported, this includes Scope 1 and 2 emissions which OIC can directly influence through measures aimed at reducing energy use onsite, and Scope 3 emissions (WTT and T&D losses) which it can only influence indirectly by reducing consumption, because it does not control the wider supply chains and infrastructure that provide the energy.

Public transport, which includes bus services and the inter-island air service, represent 8% of OIC's emissions. Most of this (6% of the total) is associated with bus services with a smaller proportion (2% of the total) due to aviation. Note that the data here includes estimates and proportions may change as data improves; see **Appendix B.5.2**.

Construction & fleet emissions include OIC's vehicle fleet (e.g. diesel vehicles) along with other mobile machinery used in the quarry and construction services. Approximately 4% of OIC's emissions are associated with diesel vehicles and the rest of this category accounts for 2% of the total.

Business travel accounts for 4% of OIC's emissions. Approximately half of this is due to domestic flights and the other half is due to land transport. **Staff commuting** by car is also estimated to be at 2% of OIC's emissions, but note that this should be understood as a preliminary estimate and could be improved by a staff travel survey.

Emissions from **tenanted properties** here include electricity use in non-residential properties (<1% of the total) and social housing (8% of the total). The latter has been based on Energy Performance Certificate (EPC) data, and is therefore based on modelling assumptions about the likely performance of buildings but not on actual occupant energy use. EPC data can provide an indication of average energy consumption for similar properties in the building stock as a whole, but it can be significantly higher or lower in individual properties so these figures should be interpreted with caution.

Waste management accounts for 1% of OIC's emissions. In line with the reporting requirements of the Greenhouse Gas Protocol (see **Appendix B**), this largely relates to the emissions associated with transporting waste to the waste management facilities, which in Orkney's case include transportation by sea. Most of the emissions are associated with waste being sent to the Shetland Energy Recovery Plant (ERP), where it is incinerated and used to supply a local heat network.[15]

Water and wastewater treatment (i.e. sewerage) represent a very small proportion (<0.5%) of the overall total. The majority of the water and wastewater emissions are

[15] The emissions from that heat network are reported separately by Shetland Islands Council (SIC) which means there is potentially some overlap between OIC's and SIC's reporting to SSN. However, the scale of emissions is relatively small, and the Councils report emissions under different scopes, with SIC reporting waste incineration under Scope 1 and OIC reporting it under Scope 3. This double-counting is not an issue in the context of this study and is not considered to have a significant impact on SSN's aggregated reporting.

associated with activities occurring in OIC's operational buildings, but some water may be used in the public realm, parks, toilets and other outdoor spaces.

For context, **area-wide emissions in Orkney** were approximately 345,000 tCO_2e in 2023 (the most recent year for which statistics are available).[16] OIC's emissions are an order of magnitude lower than those for the area as a whole, which is typical for Scottish Authorities.

2.3 How does the baseline inform recommendations on GHG mitigation measures?

The GHG baseline is important for understanding which sources of GHG emissions occur due to OIC's activities, which mitigation measures would be appropriate to reduce these, and the scale of GHG emissions reduction that is achievable.

In addition, it is also important to consider which emissions OIC has direct or indirect influence over, based on the scope. In the case of OIC, it would have direct influence over the electricity and heat used in its own operational buildings and fleet, and can choose the technologies and solutions that are best available. If the Council does not have operational control over buildings, vehicles or equipment, then introducing measures to reduce or change their use may be more challenging. Therefore, decisions have to be made about which opportunities to prioritise. This will be explored in more detail in **Section 4**.

[16] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-statistics-2005-to-2022

3 Modelling future GHG emissions

This section describes the approach used to explore future GHG emissions scenarios. Then it presents key results and provides commentary on the implications for OIC.

3.1 Overview of modelling approach

This GHG emission trajectory study for the Council has been undertaken using Aether's Carbon Scenario Model (CSM). Originally developed for use by local authorities (funded by Resource Efficient Scotland and Sustainable Scotland Network[17]), this Excel-based tool has been adapted to provide a bespoke modelling solution for OIC.

Within the model, baseline emissions are disaggregated by sector (e.g. buildings, vehicles, waste) and by fuel type (e.g. electricity, gas, petrol). The model is then configured to specify whether each source of emissions will increase or decrease over time, and by how much.

Changes in the BAU scenario may be due to wider trends (e.g. population growth and national grid decarbonisation) or OIC's own planned and committed projects (e.g. building refurbishment). Changes in the net zero scenario(s) incorporate the same assumptions as the BAU, plus the impacts of additional GHG reduction policies and measures.

In each case, the scale of the impact is informed by an evidence base that includes stakeholder engagement, literature and policy reviews, and technical assumptions. Key sources of information include the Carbon Management Plan (CMP), and meetings with OIC officers carried out between winter 2024 and spring 2025.

The model is then configured to specify the timeframe over which the changes occur or the actions are implemented. Based on all of this information, the model recalculates emissions for each source of emissions for each year up until 2045.

This process provides insight into how close OIC could get towards achieving net zero, quantifies the scale of impact from individual GHG reduction measures, and highlights any areas where there is likely to be a shortfall against targets. The results can then be used as an evidence base to prioritise actions and identify key risks, as discussed in **Section 4.**

However, it is important to understand that these are illustrative scenarios based on assumptions and not projections or predictions. **Any estimates of future emissions – particularly ones that extend decades into the future – are associated with significant uncertainty and subject to adjustments as the evidence base improves and unforeseen technology and behaviour changes arise.**

[17] https://sustainablescotlandnetwork.org/resources/carbon-footprint-and-project-register-tool

3.2 Scenarios assessed

This study has evaluated several potential pathways for OIC:

1) A '**Business as Usual**' (BAU) scenario which accounts for changes that are likely to occur based on planned and committed measures

2) Three **decarbonisation scenarios** representing different levels of ambition:

    a. **Minimum ambition**: Buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2045. These no longer use fossil fuels and instead rely on renewable energy. In 2045 there are residual emissions associated with ferries, tugs/harbour craft, aircraft, waste, and other Scope 3 emissions sources, which are partially but not fully mitigated by energy efficiency and behavioural/operational measures.

    b. **Medium ambition**: Buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2040. Additionally, by 2045, some (but not all) marine vessels and aircraft have switched to hybrid or electric propulsion systems. In 2045 there are residual emissions associated with ferries, tugs/harbour craft, aircraft, waste, and other Scope 3 emissions sources which are partially but not fully mitigated by energy efficiency and behavioural/operational measures.

    c. **High ambition**: Buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2035. Marine vessels and aircraft are fully decarbonised by 2045, at which point fossil fuels are entirely phased out. Emissions from waste treatment are mitigated through carbon capture and storage (CCS) technologies and the small residual emissions (mainly from waste and wastewater treatment) are offset, either via CCS or nature-based solutions.

These scenarios reflect OIC's current activities and emissions and take into account the timescales in which mitigation measures could theoretically be implemented, based on technological readiness. Since there are already commercially available solutions to decarbonise building energy use, cars and vans, along with various other appliances and equipment, implementing those measures by 2045 is part of the minimum ambition scenario, whereas higher ambition scenarios would see those changes happen sooner. By contrast, technologies such as zero emission ferries or planes, and carbon capture and storage for waste incinerators, are at a comparatively earlier stage of development in the UK, so become more prominent in the medium and higher ambition scenarios.

Rather than just defining scenarios in terms of the percentage (%) GHG reductions to be achieved by a certain year, or defining scenarios based on which scope(s) reach net zero by that year, this approach offers several benefits:

- Targets will not need to be re-calculated if and when OIC expands the scope of its GHG inventory.
- OIC can demonstrate that it is pursuing ambitious actions for different sources of emissions individually, even if the headline GHG reductions are constrained by the limits of available technology.

Further details of each scenario are presented below.

3.3 The 'Business as Usual' scenario

3.3.1 BAU scenario: Assessment of future GHG impacts

Modelling assumptions for the BAU scenario were derived through a process of discussion and engagement with OIC which included:

- Detailed discussions with OIC officers to confirm the implementation status of each individual project in the CMP, as set out in the 'Management Programme and Updates Review';
- Individual and small group engagement with OIC officers, focusing on energy, buildings, housing, waste, marine services, procurement, and strategic projects;
- Correspondence with an expert in sustainable aviation from HiTrans regarding future aviation trends and technologies relevant to Orkney; and
- Facilitated discussions and meetings in person with OIC staff at OIC's offices in December 2024.

In addition, a policy review was undertaken to identify wider trends and regulatory drivers that might impact OIC's emissions. The review covered the national and local climate-related policies and strategies as set out in **Section 1.2**, along with technical evidence such as the CCC's Carbon Budget advice to the UK Government[18], the National Grid's Future Energy Scenarios, and the GHG impact assessment of the Scottish Climate Change Plan Update (CPPu, see **Appendix C** for details).

A collated list of BAU measures was then circulated to OIC officers via email for feedback prior to the modelling being carried out. In summary, these are:

- Planned refurbishment of St Margaret's Hope Primary School and Stromness Academy
- Replacing a proportion of boilers (c. 1 in 5) with heat pumps when they reach end-of-life
- LED lighting upgrades at South Pier and Kirkwall Pier
- Sale of Garden House, Stromness Community Centre and Egilsay School
- Construction of a new care facility to replace St Rognvald House
- Construction of a new nursery
- Where possible, upgrading social housing to an EPC rating of 'B' when the properties become vacant
- Construction of c. 100 new energy efficient homes per year for the next 10 years
- Substitution of diesel vans with electric vehicle (EV) models, as part of the natural replacement cycle
- Decreasing emissions from OIC employee commuting – not as a direct result of OIC intervention but due to consumer trends and national policies which make people more likely to own EVs rather than petrol or diesel cars
- A decrease in the amount of waste sent to landfill, and increase in recycling rates, due to regulatory changes and financial incentives to cut residual waste
- Trials of 2x electric hydrofoil ferries and 1x electric bin lorry – *note, these have not been modelled as they are only trials but are listed here for completeness*

[18] https://www.theccc.org.uk/publication/the-seventh-carbon-budget/

- Construction of a six-turbine, consented up to 30MW wind farm at Quanterness – *under GHG accounting principles, this does not directly impact OIC's emissions as explained in **Appendix D**, but it is listed here for completeness*

Appendix E contains a more detailed list of the timescales for implementation and basis of the GHG assessment for each measure listed above.

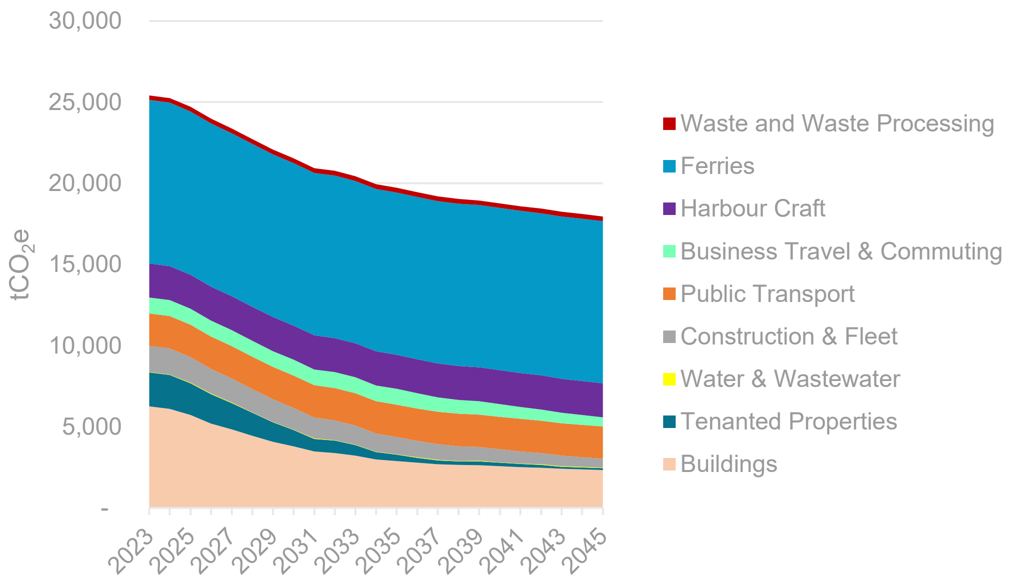
Emission sources that are not impacted by the above list of actions are assumed to remain constant in future years in the BAU scenario.

Note that there is a variety of additional projects that have been explored by OIC but for which the timeframes are unclear or are on hold. Those were excluded from the BAU scenario but have been considered when developing the more ambitious decarbonisation scenarios.

3.3.2 BAU Scenario: Results

Results of the BAU analysis are shown below. These results include all of the Scope 1, 2 and 3 emissions reported in **Section 2**.

Figure 2. BAU emissions to 2045



Overall, GHG emissions are estimated to decrease by 15% by 2030, or up to 29% by 2045, dropping from 25,411 tCO_2e to approximately 18,000 tCO_2e in that time period. The majority of the changes are associated with decarbonisation of the national electricity grid, which under current UK policy ambition would reach net zero emissions in the 2030s. That trend alone would result in an estimated 20% reduction in emissions by 2045. Because the scale and timing of grid decarbonisation is uncertain, and it is outside of OIC's ability to control, this is considered a significant risk to OIC achieving its climate change targets and it results in high levels of uncertainty in the BAU projection despite the fact that most of the measures are confirmed OIC projects.[19]

[19] Recommendations on actions OIC can take to play its part in supporting grid decarbonisation, and thereby mitigating this risk, are described in Section 4.

The BAU results show different changes occurring across different GHG emission categories due to the other building upgrades and fleet replacement, which are discussed in turn below.

Emissions from **buildings** would potentially reduce by an estimated 63%. Grid decarbonisation alone accounts for a 50% reduction and the remainder is due to interventions such as planned refurbishments, replacing some boilers with heat pumps, and the sale of some properties. From an emissions standpoint, phasing out the use of fossil fuels would be the most significant measure OIC could take to further reduce these emissions. Note that, even if additional measures are adopted to improve efficiency and switch to zero emission energy sources, there would still be some small (14 tCO_2e) emissions associated with f-gases which are used in refrigeration and cooling systems and heat pumps.

Emissions from **tenanted non-residential properties and social housing** would reduce by an estimated 94%. This is because all of the energy use reported in those properties is electricity, and therefore the changes are linked to assumptions about grid decarbonisation. Energy demand is further reduced due to measures such as uptake of upgrading social housing to EPC 'B' where possible, as required by the Energy Efficiency Standard for Scottish Housing (EESH) legislation. These have a smaller impact on emissions but may have important other impacts on energy bills and the tenants' thermal comfort and are therefore still beneficial for those reasons.

There are no BAU measures aimed at reducing **water consumption** so the BAU shows no change in this category, although in practice water efficiency measures might be incorporated as part of routine maintenance and building refurbishment.

The shift to using electric vans would reduce emissions from **construction and fleet** by an estimated 66%. The remainder of those emissions are associated with other equipment and machinery that currently runs on fossil fuels and for which no specific alternative technologies have been proposed by OIC as part of the BAU.

Public transport emissions remain constant over time. In reality this would likely change as a result of trends such as population changes, tourism, travel fares, and vehicle efficiency but no specific, committed measures have been identified as part of BAU. Note that both the air carrier (Loganair) and bus operator (Stagecoach) have set their own net zero targets and in practice it is likely that some vehicles and aircraft will switch to more energy efficient or zero emission alternatives, but those have not been modelled in this scenario.

Emissions from **business travel and commuting** have been estimated to decrease by 43%, assuming that in future it becomes more common for people to choose EVs instead of petrol or diesel cars.

For **harbour craft and ferries**, there is a small reduction of 1% which is due to a reduction in emissions from the grid electricity currently used by Orkney Ferries as listed in OIC's GHG baseline data. Discussions with OIC indicated that there were no plans confirmed at this stage for switching to lower emission vessels, so no additional measures are modelled in the BAU, even though options are currently under review by OIC. Note that the hydrofoil ferries are not included in the results shown above as their electricity consumption is unknown and they would only be utilised for a relatively short period of time; their omission would therefore not affect the headline GHG reductions described in this chapter.

There is a small reduction in **waste** emissions assumed to occur as a result of new regulations. This has been indicatively modelled as a 2-3% reduction in waste arising, which is an intentionally conservative figure.

Some of OIC's proposed BAU measures involve constructing new buildings, which would tend to increase, rather than decrease, operational energy use and GHG emissions unless they are replacing older, less efficient properties. Although not included in the estimates shown above, new construction would also result in embodied carbon being emitted as a result of the material extraction and construction process, which for modern buildings is usually significantly higher than the operational emissions. OIC does not currently report construction related emissions from capital projects[20] but this could be added in future; see **Appendix B** for more information.

As noted previously, the **Quanterness Wind Farm** project is not included in the numerical results described above. This is because the electricity will be exported to the grid, rather than directly supplying OIC's properties, and because OIC has advised that the renewable energy certificates will not be retained. For context, however, a wind farm of this size and location could be expected to generate roughly 127,000 MWh of electricity per year[21] which is several times more than OIC's total electricity consumption. If the GHG savings from that project were attributed to OIC then the council's electricity-related emissions could potentially be 'netted off' (i.e. subtracted) from the total. The headline BAU results (i.e. the % reduction in emissions that is achieved by 2045) would remain largely unchanged, because it has already been assumed that the electricity system would be decarbonised by that point. However, there would be a steeper reduction in emissions in the short to medium term of around 20%, depending on how soon the wind farm becomes operational.

The question of whether and how to account for renewable electricity generation is complex.[22] OIC follows SSN guidance in its annual reporting and while its existing guidance allows renewable electricity generation to be subtracted from the total in some circumstances, this does not apply to OIC based on the current proposals for the wind farm. SSN have advised that they may review their existing guidance to ensure a more standardised reporting approach among Scottish public bodies.[23]

3.4 What additional measures are required?

The BAU analysis highlights that additional measures are needed to reach net zero. The diagram in **Figure 3** below provides a high-level overview of the strategic practical changes needed to reach net zero for different sources of emissions in OIC's current GHG inventory; further details will be provided in later sections. These are grouped into four main areas: buildings (including council buildings and tenanted properties),

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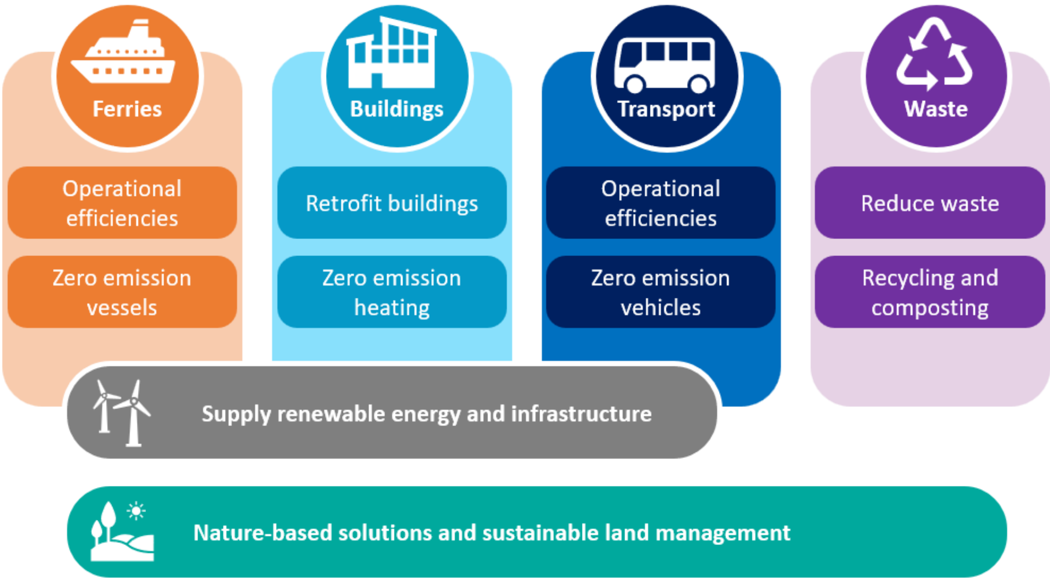
[20] These would be classified under Scope 3 and are optional to report based on current Public Bodies Climate Change Duties Reporting (PBCCDR) guidance.
[21] As advised by OIC
[22] https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf
[23] Email correspondence between OIC, Aether and SSN, January 2025.

transport (including business travel, public transport, and construction and fleet), ferries (harbour craft and ferries) and waste.[24]

Figure 3. Strategic GHG mitigation measures for key sources of OIC's 2023 emissions



Broadly speaking, emissions associated with **energy use** can be mitigated by firstly reducing energy demand, either through technological efficiency measures or behavioural/operational changes, then phasing out the use of fossil fuels in favour of renewable energy. This typically would involve a change in technology, for example:

- In **buildings**, swapping oil or LPG boilers for alternatives such as electrically-powered heat pumps
- In road **transport, aviation and marine services**, swapping internal combustion engine (ICE) vehicles for electric or hybrid alternatives, or utilising alternative fuels such as sustainable biofuel or green hydrogen.

The energy transition further relies on the availability of wider supporting infrastructure to supply renewable energy.

For **waste**, the priority is to reduce the amount generated in the first place. Unavoidable waste should then be managed in line with the waste hierarchy. Waste is a hard-to-abate sector, as some residual emissions from landfill or incineration are inevitable. The Climate Change Committee anticipates that these would need to be offset through technological carbon removals, such as installing carbon capture and storage (CCS) on facilities like the Shetland ERP.

Minor sources of emissions for OIC include emissions from **fluorinated gases** (f-gases) which are used in refrigerant and cooling systems and heat pumps, and emissions from **water supply and treatment**. F-gas emissions are mainly determined by regulations on allowable refrigerants. OIC can reduce these emissions by avoiding or minimising the use of systems containing high global warming potential (GWP) refrigerants, ensuring good maintenance to prevent leaks, and specifying low-GWP refrigerants wherever feasible.

[24] Water supply and treatment, business travel and homeworking are indirect Scope 3 emissions and account for a relatively small proportion of the total so are not shown on the diagram.

The approach to mitigation will also vary depending on who controls the emissions. Actions will differ for emissions directly managed by OIC, those influenced by staff (e.g. employee commuting), contractors (e.g. buses and aircraft), or tenants (e.g. council housing). These distinctions will be addressed in later sections.

In addition to the direct GHG mitigation measures described in this section, there will be a need to address residual emissions, e.g. through nature-based solutions (NbS) or carbon capture and storage (CCS) technologies. While SSN guidance states direct GHG mitigation measures should be prioritised, NbS and CCS projects will require advance planning. Please refer to **Section 5** for further information.

3.5 Decarbonisation scenarios

3.5.1 Scenario 1 – Minimum Ambition

As stated earlier, Scenario 1 has been defined as follows: Buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2045. These no longer use fossil fuels, and instead rely on renewable energy. There is assumed to be a 10% reduction in fuel use for ferries assuming that the current engines are replaced with new, more efficient ones. In 2045 there are residual emissions associated with ferries, tugs/harbour craft, aircraft, waste, and other Scope 3 emissions sources, which are partially but not fully mitigated by energy efficiency and behavioural/operational measures. Residual emissions would be partially compensated for, either by nature-based solutions or CCS.

The table below summarises the mitigation measures that are assumed to be implemented in Scenario 1, the impact they would have on annual GHG emissions (reported in aggregate for ease of interpretation) and the timescales for implementation. Further details are provided on these measures in **Section 4.2**. Note: Values may not sum due to rounding.

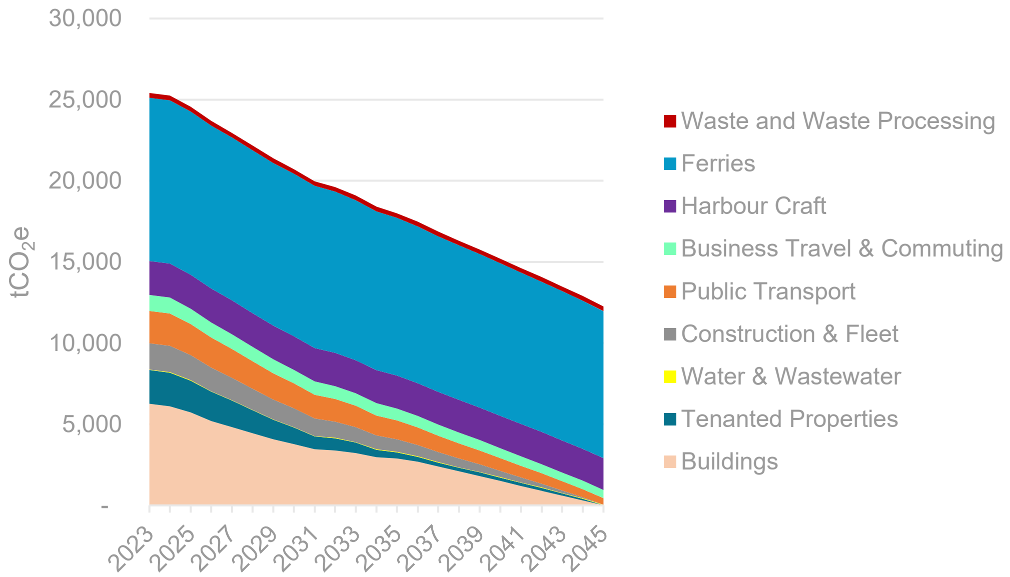
Table 3. Scenario 1 measures

Category	Overview of changes	GHG impact (tCO_2e)	% saving in this category
OIC buildings	All fossil fuel use is phased out by 2045, with all heating systems and cooking/catering replaced with electric alternatives. Energy is supplied via decarbonised grid electricity or other local renewable technologies. Where necessary, buildings are upgraded with energy efficiency measures to support the shift to zero direct emission heating systems while mitigating energy bill increases. There is a modest reduction in f-gas emissions by 2045 due to the introduction of new regulations on refrigerants and operational changes such as leak detection.	-6,250	Energy use: 100% F-gases: 20%
Tenanted Properties	As for OIC buildings.	-2,080	100%
Water & Wastewater	Water efficiency measures are implemented through 2045, which reduce water demand	-3	10%

Category	Overview of changes	GHG impact (tCO_2e)	% saving in this category
	and therefore reduce emissions from water supply.		
Construction & Fleet	All cars and vans switch to EV by 2045. The remaining construction vehicles switch to electric sustainable biofuel or other zero direct emission alternatives in the same timeframe.	-1,610	100%
Public Transport	All buses switch to EV by 2045. There is no significant change in fuel use or emissions from aircraft in that time.	-1,580	Buses: 100% Aircraft: 0%
Business Travel & Commuting	Measures are introduced to reduce the need for business travel, with approximately 1 in 10 trips being avoided. Where private vehicle journeys occur, by 2045 EV cars are the default for business travel and commuting.	-480	Business travel: 10% Commuting: 100%
Harbour Craft	Operational measures result in a decrease in fuel use and emissions for tugs and harbour craft, but the vessels do not undergo any significant retrofits or replacement between now and 2045.	-140	5-10%
Ferries	No significant changes in fuel use or emissions from ferries by 2045, although some GHG reduction occurs due to electricity grid decarbonisation.	-1,000	10%
Waste and Waste Processing	Operational and behavioural change measures, along with new regulatory requirements, result in a small additional decrease in the amount of waste by 2045, compared to the BAU.	-7	2-3%

In total, these measures would result in an estimated 52% decrease in emissions by 2045 compared to 2023. This is illustrated below in **Figure 4**.

Figure 4. Potential future GHG emissions in Scenario 1



In 2045 in Scenario 1, there would be residual emissions of approximately 12,000-12,500 tCO_2e, arising from:

- Marine vessels, vehicles, aircraft or other construction machinery that cannot switch to EV or another zero emission alternative
- Business travel
- Waste, water supply and water treatment systems
- Refrigerants (f-gases)

As evident from **Figure 4**, the main source of emissions in 2045 would be associated with ferries, tugs and harbour craft. This presents a key challenge for decarbonising OIC's operations.

3.5.2 Scenario 2 - Medium ambition

Scenario 2 has been defined as follows: Buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2040. Additionally, by 2045, some (but not all) marine vessels and aircraft have switched to hybrid or electric propulsion systems. In 2045 there are residual emissions associated with ferries, tugs/harbour craft, aircraft, waste, and other Scope 3 emissions sources which are partially but not fully mitigated by energy efficiency and behavioural/operational measures. Residual emissions would be partially compensated for, either by nature-based solutions or CCS.

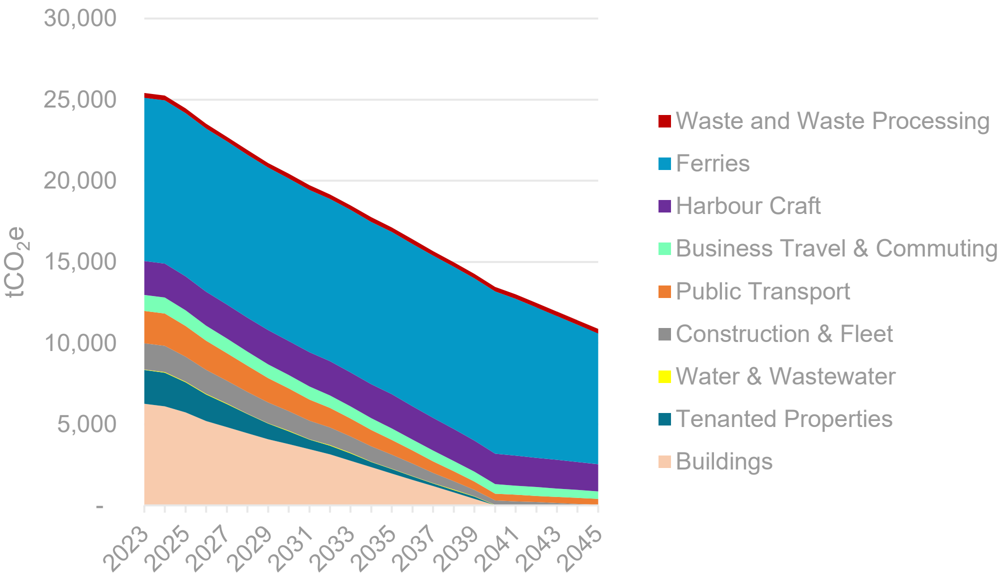
The table below describes the mitigation measures that are assumed to be implemented in Scenario 2, the impact they would have on annual GHG emissions (reported in aggregate for ease of interpretation) and the timescales for implementation. Further details are provided on these measures in **Section 4.2**. Note: Values may not sum due to rounding.

Table 4. Scenario 2 measures

Category	Overview of changes	GHG impact (tCO_2e)	% saving in this category
OIC buildings	As in Scenario 1, but changes affecting energy use are implemented by 2040.	-6,250	Energy use: 100% F-gases: 20%
Tenanted Properties	As for OIC buildings	-2,080	100%
Water & Wastewater	As in Scenario 1, but efficiency measures are implemented by 2040.	-3	10%
Construction & Fleet	As in Scenario 1, but the transition to EVs is complete by 2040.	-1,610	100%
Public Transport	All buses switch to EV by 2040. One of the two existing aircraft operating as part of the inter-island air service is retrofitted with a hybrid propulsion system in the 2040s.	-1,630	Buses: 100% Aircraft: 10-15%
Business Travel & Commuting	As in Scenario 1, but with more focus on avoiding air travel, resulting in fewer business trips by plane.	-520	Business travel: 15-20% Commuting: 100%
Harbour Craft	A combination of operational measures and comparatively low-capital cost (capex) retrofits, with potentially some electrification/hybridisation for some vessels, is assumed to deliver a moderate fuel saving by 2045. See **Section 4** for more information.	-420	10-20%
Ferries	As for Harbour Craft.	-2,000	20%
Waste and Waste Processing	Operational and behavioural change measures, along with new regulatory requirements, result in a small additional decrease in the amount of waste by 2045, compared to the BAU.	-15	5%

In total, these measures would result in an estimated 55-60% decrease in emissions by 2045 compared to 2023, potentially up to 65%. This is heavily dependent on what level of fuel savings are assumed to be achievable for the marine vessels. By 2045, the residual emissions of around 10,750-11,000 tCO_2e are largely from the same sources as in Scenario 1. This is illustrated below in **Figure 5**.

Figure 5. Potential future GHG emissions in Scenario 2



3.5.3 Scenario 3 - High ambition

In Scenario 3, buildings and land vehicles (fleet, buses, construction) are fully decarbonised by 2035. Marine vessels and aircraft are fully decarbonised by 2045, at which point fossil fuels are entirely phased out. Measures are implemented to reduce the quantity of waste arising, and emissions from waste incineration are mitigated at source through carbon capture and storage (CCS) technologies. The small residual emissions from f-gases, waste and wastewater treatment are compensated for via CCS or nature-based solutions.

The table below describes the mitigation measures that are assumed to be implemented in Scenario 3, the impact they would have on annual GHG emissions (reported in aggregate for ease of interpretation) and the timescales for implementation. Further details are provided on these measures in **Section 4.2**. Note: Values may not sum due to rounding.

Table 5. Scenario 3 measures

Category	Overview of changes	GHG impact (tCO_2e)	% saving in this category
OIC buildings	Changes affecting energy use are the same as those in Scenarios 1 and 2 but are assumed to be implemented by 2035. There is a higher level of reduction in f-gas emissions, assuming a higher rate of appliance replacement and specification of more low-GWP refrigerants.	-6,260	Energy use: 100% F-gases: 60-80%
Tenanted Properties	As for OIC buildings	-2,080	100%
Water & Wastewater	Assumes that efficiency measures are implemented as in Scenarios 1 and 2.	-30	100%

Category	Overview of changes	GHG impact (tCO_2e)	% saving in this category
Construction & Fleet	As in Scenario 1, but the transition to EVs is complete by 2035.	-1,610	100%
Public Transport	All buses switch to EV by 2035. All aircraft are replaced with electric, green hydrogen, or other zero direct emission alternatives, so air travel is fully decarbonised by 2045.	-2,000	100%
Business Travel & Commuting	All business travel and commuting is decarbonised by 2045. This assumes that technologies become available to phase out the use of fossil fuels for travel by land, air and sea.	-980	100%
Harbour Craft	Along with operational efficiency measures, all vessels are replaced with electric, green hydrogen, or other zero direct emission technologies by 2045.	-2,100	100%
Ferries	As for Harbour Craft.	-10,000	100%
Waste and Waste Processing	Operational and behavioural change measures, along with new regulatory requirements, result in a small additional decrease in the amount of waste by 2045, compared to the BAU. Waste is transported using zero direct emission vehicles and vessels. Emissions from incineration are captured at source with CCS on the ERP in Shetland.	-290	100%

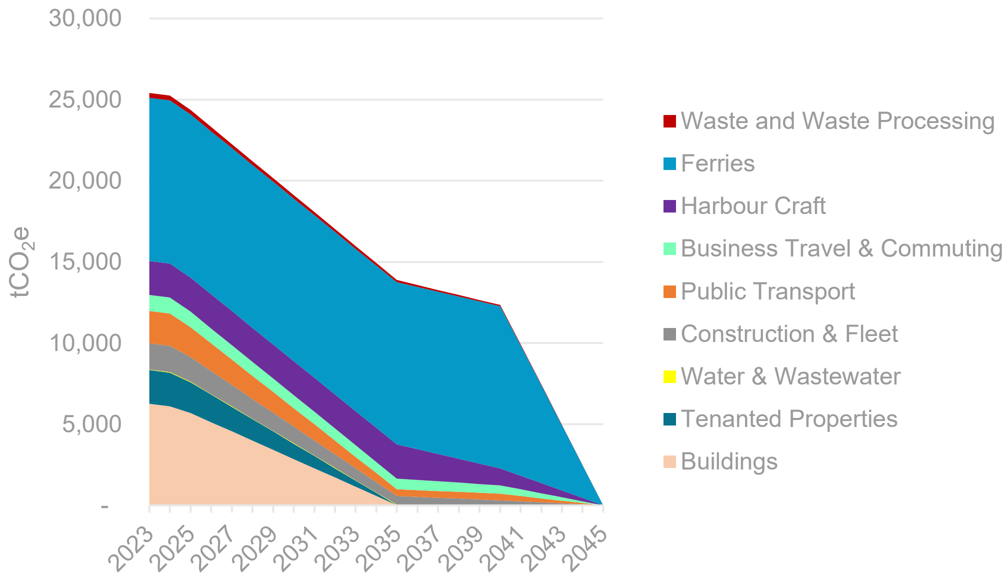
In total, these measures would result in an approximately 99% reduction in GHG emissions by 2045. It is likely that there would still be some residual emissions from f-gases, water/wastewater, and waste treatment that would need to be compensated or offset in other ways (discussed more in **Section 5**).

Scenario 3, more so than Scenarios 1 and 2, relies on the adoption of some key technologies that are not currently commercially available, most notably:

- Zero emission ferries, marine vessels, aircraft, and HGVs
- Carbon capture and storage for the Shetland ERP
- Sufficient renewable energy infrastructure and supply chains to support the phase-out of fossil fuels

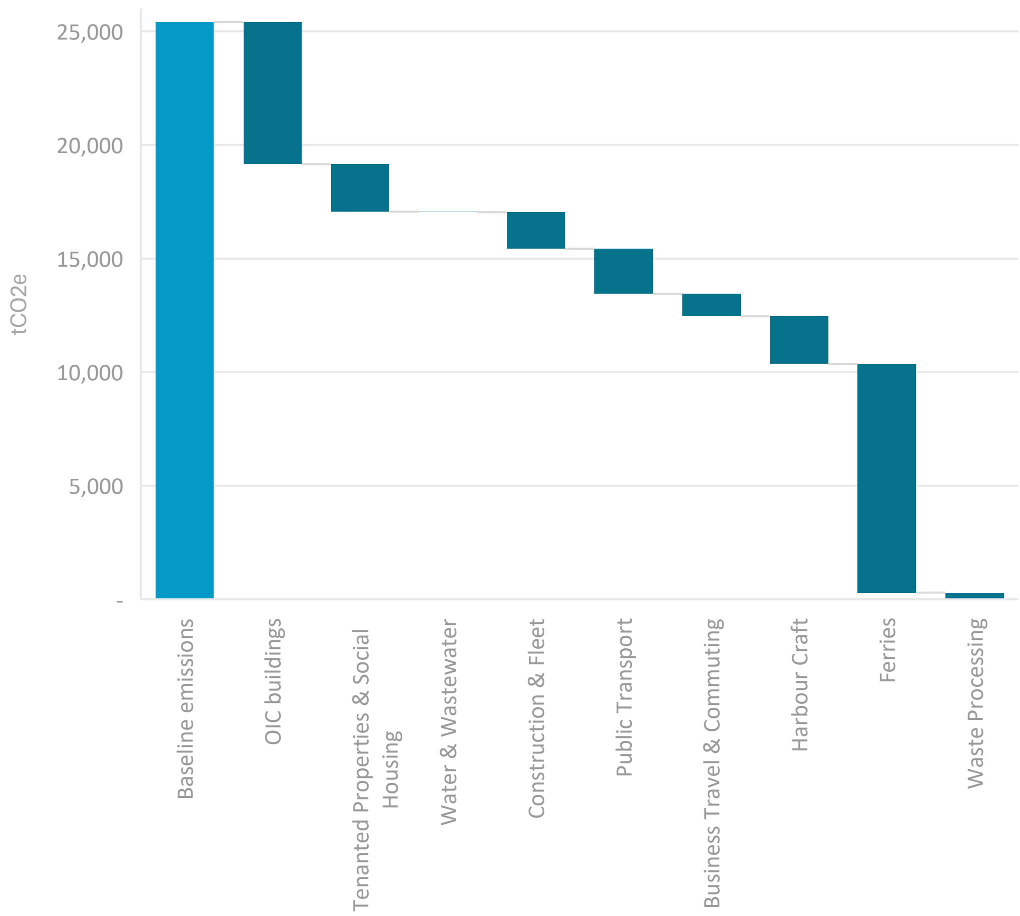
The graph below presents an indicative future trajectory, assuming that these measures can be implemented by OIC or its contractors/supply chain 2045.

Figure 6. Potential future GHG emissions in Scenario 3



The waterfall chart in **Figure 7** (below) illustrates the relative scale of impact from different categories of mitigation measures in Scenario 3. It represents the maximum GHG reduction that is theoretically achievable in each category.

Figure 7. Maximum potential GHG reductions from 2023/24 baseline associated with different categories of mitigation measures



In order for OIC to reach net zero, all of these measures would need to be implemented. However, based on this analysis, **the top 3 GHG mitigation priorities for OIC** can be summarised as:

1. **Decarbonising marine services**, including ferries, harbour craft and tugs
2. **Decarbonising buildings**, including OIC-operated and tenanted properties
3. Switching to an **electric vehicle and bus fleet**

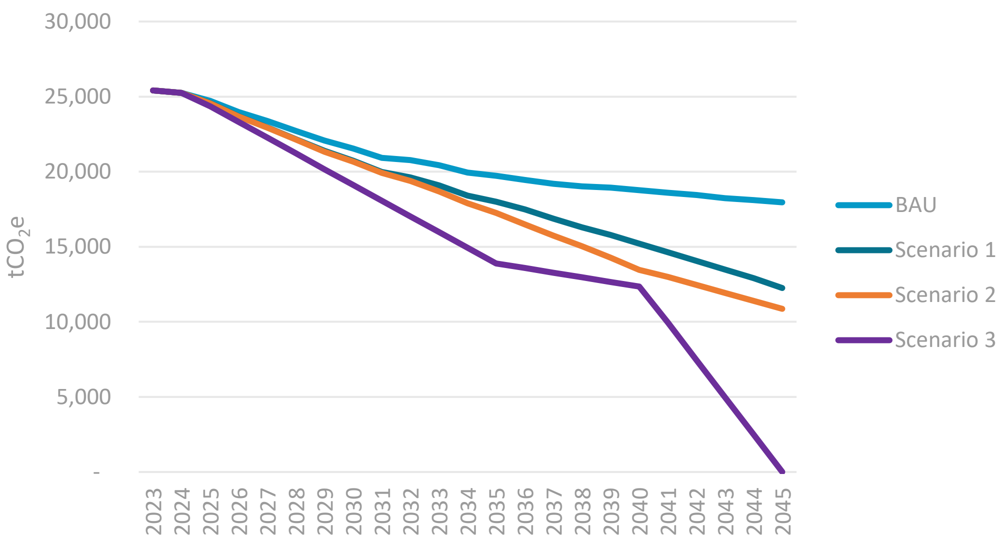
Those measures collectively would reduce emissions by up to 95% compared to 2023 levels. All of them fit within the broader objective to **phase out the use of fossil fuels** – a transition that will require a combination of energy demand reduction, renewable energy supply, and supporting infrastructure in order to be successful. The next chapter of this report describes the priority actions for OIC to achieve this outcome.

3.5.4 Implications for OIC target setting

The pathways analysis presented above has implications for OIC when considering how to set a target date for net zero, along with any interim targets.

As shown in **Figure 8** (below), the three decarbonisation scenarios result in emissions roughly halving by 2045, but none of them achieve further reductions unless there is a solution introduced for the marine services. Within that constraint, OIC could still make good progress in reducing cumulative emissions by accelerating interventions in buildings and road vehicles, for example. From an environmental perspective, it is not just the emissions in a given target year, but the pace of change that is also important. This is because climate change is driven by cumulative emissions rather than emissions at a single point in time.[25] A slower pace of decarbonisation allows more carbon to build up, making it harder to stay within safe temperature limits. Therefore, rapid and sustained emissions reductions are essential to limit total atmospheric GHG concentrations and avoid breaching critical climate thresholds.

Figure 8. Comparison of total GHG emissions in each scenario modelled



[25] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf

Table 6. Modelled % GHG reduction in different scenarios

Scenario	% reduction by...			
	2030	2035	2040	2045
BAU	-15%	-22%	-26%	-29%
Scenario 1	-18%	-29%	-40%	-52%
Scenario 2	-19%	-32%	-47%	-57%
Scenario 3	-25%	-45%	-51%	-99%

Caution should be used when setting interim targets based on percent (%) reductions in GHG emissions given that OIC anticipates adding additional sources of Scope 3 emissions in future (see **Appendix B**). For example, the embodied carbon emissions from constructing new social housing are not currently reported, but could equate to an extra 3,500 tCO_2e per year[26], or 35,000 tCO_2e over the next 10 years. Similarly, there would be large effects from reporting the emissions from procurement, pensions, or roads and infrastructure works.[27]

For those reasons, **OIC should consider setting targets for individual sources or types of emissions, rather than only using a single metric such as 'net zero by 2030'**. The pathway definitions used above provide examples of how this could be expressed.

Note that none of these three scenarios achieve the scale and pace of GHG reductions necessary for OIC to be able to claim that it is following a 1.5°C-aligned trajectory to net zero. This would require very steep near-term GHG reductions which are realistically not achievable based on current levels of funding and practical constraints such as lack of charging infrastructure. More information is provided in **Appendix J**. However, as explained previously, this is primarily due to the sources of emissions included within OIC's GHG inventory; it is an important consideration, but it is not the only way to judge OIC's level of ambition or the success of its approach to mitigating climate change. This should therefore be seen as a call to action rather than discouragement. The council's efforts still play a critical role in driving down emissions, demonstrating leadership, and building an enabling environment for deeper future reductions. The challenge is significant, but it also presents an opportunity to accelerate innovation, partnership, and momentum towards a low-carbon future.

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[26] Assuming an average of 35 tCO_2e per dwelling. OIC advises approx. 100 will be built each year for the next 10 years.

[27] OIC is already considering some of these topics; the council has a Responsible Investment Policy (https://www.orkney.gov.uk/media/drupdlj5/oicpf-responsible-investing-policy.pdf) and has made a Statement of Investment Principles for the Pension Fund (https://www.orkney.gov.uk/media/kytggyjr/item-07__statement-of-investment-principles.pdf)

4 Priority interventions for net zero

Building on the pathways analysis presented in the previous section, this chapter discusses the highest priority actions for OIC to reach net zero. This can be used to support the development of OIC's forthcoming Climate Action Plan.

4.1 Approach to identifying and prioritising GHG reduction measures

Aether's approach to identifying suitable actions for OIC included the following steps:

- First, Aether examined OIC's activity data and baseline GHG inventory and identified mitigation opportunities at different stages of the GHG mitigation hierarchy, based on a review of national, regional and local policy documents such as the OIC Carbon Management Programme.
- The initial list was validated through discussions and an in-person workshop with OIC staff and supplemented with suggestions from sector experts.
- A list of options was distributed to officers in the Council for written feedback. They were requested to comment on the feasibility of these measures and supply any available data regarding costs and implementation timelines.
- Finally, the Aether team held meetings with individual stakeholders to ask follow up questions.

The next step was to prioritise the identified actions. This has been done qualitatively, accounting for several different factors:

- **Scale of GHG impact**, based on the pathways analysis presented in **Section 3**.
- **OIC's level of influence**, differentiating between emissions that are within OIC's operational control (scopes 1 and 2) versus those where OIC has indirect influence (scope 3).
- **Timescales in which the action could potentially be implemented,** assuming that cost barriers could be overcome.

Because OIC is aiming to reach net zero, rather than simply reduce emissions compared to the BAU scenario, it will be necessary to adopt measures that have a small GHG impact as well as those that have a large impact. It will also be necessary to adopt measures where OIC has indirect or limited influence, and/or where the timescales are uncertain. In other words, actions that are not 'top priorities' will still need to be implemented.

There is some flexibility when it comes to the specific choice of technological, operational or behavioural interventions that are selected. Furthermore, judgments will need to be made about how much emphasis should be placed on different stages of the GHG mitigation hierarchy.[28] For example, decarbonising a single building can be achieved through different combinations of retrofitting measures and renewable energy technologies, even if the total GHG impact is the same. In those circumstances, higher

[28] The GHG mitigation hierarchy is a priority order for addressing emissions. It can be expressed in different ways and the precise wording may vary depending on the context, but the broad principles are to first avoid emissions wherever possible, e.g. through behavioural or operational changes, energy efficiency measures or retrofitting; and then reduce or replace high-carbon activities with cleaner alternatives, e.g. heat pumps, electric vehicles, and renewable energy. Only after those measures are implemented should carbon offsetting be considered for unavoidable, residual emissions. For more information, see https://www.isepglobal.org/articles/ghg-management-hierarchy-updated-for-net-zero

priority has been given to options that are likely to be lower cost and/or offer greater cost savings and other co-benefits.

4.2 GHG reduction measures for consideration by OIC

The following measures have been grouped by theme. For more detailed descriptions of individual measures, please refer to **Appendix F** (provided as a separate spreadsheet). For more detailed information about the estimated cost of mitigation measures, please refer to **Appendix G** and **Appendix H**.

4.2.1 Decarbonising marine services, including ferries, harbour craft and tugs

Ferries, tugs and harbour craft collectively account for roughly half of OIC's emissions as reported in 2023, and are therefore a top priority in terms of GHG mitigation. By 2045 at the latest, the use of fossil fuels will need to be entirely phased out in order to reach net zero. The specific solutions that are available to do this depend on the type of vessel and the type of journeys or routes that it serves.

A separate study has been carried out that explores options for mitigating emissions from the Harbour Services[29] which has informed the recommendations in this section.

For marine services, the types of GHG mitigation actions that are needed include:

- **Behavioural/operational changes:** Identifying measures to improve fuel efficiency, e.g. relocating berths or reducing vessel speeds. These measures could be considered quick wins as they would not necessarily incur any capital costs, and instead would be expected to reduce operational costs due to lower fuel use.
- **Energy efficiency:** Ensuring that any new vessels are designed to improve efficiency e.g. by optimising the hull design. For existing vessels there may be maintenance or retrofit options e.g. engine repowering (which could include newer fossil fuel engines or hybridisation), propellor and nozzle upgrades, or hull coatings.
- **Switching to alternative sources of energy:** Battery or hybrid electric technologies are already in use in Norway and trials are underway in Orkney[30], but other options that have been raised include fuels such as green hydrogen, ammonia, wind assist, etc. This could be achieved with vessels that use low carbon energy from the outset, but another key opportunity for OIC which is already under consideration is whether new vessels can be designed to have flexible spaces for engines/machinery. This gives the option of replacing the propulsion system in future while recognising that the preferred technological solution(s) are not yet clear.

The above list aligns with wider plans and suggestions from the Scottish Government which is exploring opportunities to decarbonise the wider ferry fleet. [31]

[29] Based on the findings of a 2024 report by Sealand Projects, 'Orkney Island Harbours GHG Emissions Inventory Report' (unpublished) and notes from a workshop carried out as part of that study, provided by OIC to Aether via email.
[30] https://www.theengineer.co.uk/content/news/zero-emissions-artemis-ef-12-ferry-begins-trials-in-orkney
[31] https://www.transport.gov.scot/publication/analysis-report-consultation-on-the-islands-connectivity-plan-strategic-approach-vessels-and-ports-plan/low-carbon-and-environmental-impact/

Table 7. Summary of key information relating to decarbonising marine services

Capital cost: £308-447m[32]	**Carbon saving:** Up to 12,100 tCO_2e	**Energy saving:** Depends on technology selected
Wider impacts and co-benefits: Quieter vessels can improve passenger comfort; potentially lower running costs and exposure to volatile fuel prices; reduces marine pollution (NO_x, SO_x, particulates); stimulates investment in low and zero emission marine infrastructure, supports a low carbon economy.		
Key stakeholders: OIC Marine Services team, Orkney Ferries		

The general challenges of securing funding and procuring new vessels are well known to OIC so have not been restated here. From the standpoint of reaching net zero emissions, there are some broader challenges and dependencies to consider:

- At the time of writing (autumn-winter 2025/26), the Council has already initiated the early phases of design and project scoping associated with a multi-phase programme to replace the aging ferry fleet and upgrade harbour/port/shore infrastructure, subject to funding.[33] Designs for new hybrid ferries for Orkney have recently been commissioned.[34] This is a very positive step. However, assuming the vessels are designed to have a lifespan greater than 20 years, they would not be replaced again before 2045. Unless the vessels are designed with flexible space that facilitates the propulsion system being replaced in future, this will effectively lead to technological 'lock in' as OIC is restricted to the use of existing technologies due to the timescales. A similar issue applies to tugs which were recently replaced within the last 10 years. This would prevent OIC from fully decarbonising its marine services by 2045 and therefore presents a major risk to the overall net zero target. Realistically the council therefore needs to plan for this outcome when evaluating offsetting options (discussed further in **Section 5**).
- It is unclear what will be the preferred technological pathway(s) to decarbonising marine vessels.[35] In the UK, zero emission ferries are not widely in use although battery and hybrid electric vessels have been successfully rolled out in Norway.[36] Trials of electric hydrofoil ferries are underway in Orkney but the OIC marine services team advised that their wider applicability is yet to be determined.
- OIC will need to maintain its frontline services, which makes it risky to trial new technologies even if these become available.
- A key challenge in switching to alternative fuels is the lack of supporting infrastructure and the risk of investing in unadopted solutions. Broader adoption of new shipping technologies could drive demand for shore charging

32 Includes ferries, tugs and harbour craft. Please refer to Appendix G for more details.
33 https://www.gov.scot/news/orkney-ferry-funding/
34 https://www.cleanshippinginternational.com/knud-e-hansen-to-design-new-hybrid-ferries-for-orkney-islands/
35 https://www.transport.gov.scot/publication/analysis-report-consultation-on-the-islands-connectivity-plan-strategic-approach-vessels-and-ports-plan/low-carbon-and-environmental-impact/
36 https://businessnorway.com/articles/norway-showcases-award-winning-electric-ferry-technology

and fuel bunkering at ports, but such a transition depends on adequate infrastructure—creating a classic chicken-and-egg dilemma.[37]

- Some journeys and cargo transport can be made either by sea or air. A shift in technology for one mode of transport could have an impact on the decarbonisation pathway for the other. For example, if heavy lift drones become the preferred option for transporting some cargo, this could impact the design or operational schedules for some ferries. The interdependencies are highly complex and would need to be explored as part of a separate study to identify the most likely low-cost, low-regret options.

Although out of scope of the current study, OIC should note that the wider global transition to a low carbon economy may have impacts on the harbour and port operations. For example: increased electrification or hybridisation might lead to much higher demand for shore power; vessels utilising alternative fuels might require new bunkering options; and changing global demands for fossil fuels might change the patterns of shipping movements needed to transport them.[38,39] Climate change itself might also impact harbour infrastructure, e.g. with more extreme weather events and flooding. A separate Coastal Change Adaptation Plan (CCAP) is being produced[40] and it is recommended that OIC integrate the results of the CCAP into a longer-term adaptation plan for the marine services, where relevant.

Based on these considerations, priority interventions are to:

- Continue to demonstrate leadership in this field by engaging with opportunities to trial new/innovative low carbon technologies and solutions.
- Implement the operational and energy efficiency measures that have been identified through the separate project examining decarbonisation of OIC's marine services.
- Ensure that any new vessels use the lowest carbon technology that is practical to procure and/or include provision for the vessels to be retrofitted. However, alongside this, OIC needs to plan for the likelihood of vessels not being net zero by 2045, assuming they will not be replaced before the end of their lifespan.
- Keep informed of new technological developments, taking lessons from electric hydrofoil trial as relevant, and initiate longer-term planning for how climate change and the net zero transition might impact the marine services, so that this can be factored into investment decisions.

A significant amount of prior work has been done to assess decarbonisation opportunities for OIC's Marine Services, and develop a strategy for the Scottish maritime sector more broadly, including but not limited to:

- OIC Marine Services GHG Inventory and supporting research into decarbonisation options for the port operations (2025)

[37] https://assets.publishing.service.gov.uk/media/67f4dcb3c2fea2548f4eff64/dft-maritime-decarb-strategy-25.pdf
[38] https://www.orioncleanenergy.com/about/projects-and-studies/neptune-project
[39] According to a UCL study, *'Over one third of the global shipping capacity is used to transport fossil fuels.'* https://www.shippingandoceans.com/post/existing-ships-and-those-on-order-would-produce-twice-the-emissions
[40] https://storymaps.arcgis.com/stories/65e1d882227749e48afb564e8aba401c

- Orkney's Electric Future Feasibility Study (2015)[41]
- Project Neptune[42]
- UK government Maritime Decarbonisation Strategy (2025)[43]

4.2.2 Decarbonising buildings, including OIC-operated and tenanted properties

The key priority for buildings is to continue to phase out the use of fossil fuels, and ensure that any remaining energy demand is met via renewable energy, whether supplied via the decarbonised electricity grid or on-site. That transition needs to be supported by a variety of demand reduction measures, although demand reduction on its own is not sufficient to deliver net zero and will have a smaller impact than fuel switching.

OIC has already undertaken various energy audits and feasibility studies and developed comprehensive plans to support decarbonisation of its built assets in line with relevant regulatory standards.[44] These include, but are not limited to, the OIC Carbon Management Plan (CMP), Local Housing Strategy, Property Asset Management Plan, and the forthcoming Local Heat and Energy Efficiency Strategy (LHEES) work. OIC has also worked with the community in the production of the Orkney Energy Action Plan (OREF 2022). There are specific regulatory standards the council must meet, such as the Energy Efficiency Standard for Social Housing 2 (EESSH2) which mandates that all social housing should meet an Energy Performance Certificate rating of 'B' by 2032 (with some exemptions).

For buildings, the types of GHG mitigation actions that are needed include:

- **Behavioural/operational changes**: Installation or upgrades to building management systems and controls, which would be included in routine maintenance. For example, changing the time of use for streetlighting could help reduce emissions, although it must be balanced against safety and accessibility considerations.
- **Energy efficiency**: For electricity efficiency, this may include routine maintenance upgrades such as installation of appliances with higher energy ratings, LED upgrades in buildings and street lighting and replacing boilers with more efficient models. Some measures would be new capital costs, including fabric efficiency (i.e. retrofitting) measures and, for leisure centres, potential installation of wastewater heat recovery (WWHR) systems.
- **Switching to alternative sources of energy**: New capital costs would be required for these measures, including installing ZDEH systems e.g. electric heating or heat pumps, exploring opportunities for a heat network(s) and implementing small scale renewables and battery storage.
- **Other**: When upgrading buildings to reduce emissions from energy use, there may be opportunities to reduce emissions from refrigerant leakage (f-gases) or water consumption at the same time. Those opportunities should be identified

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[41] https://www.oref.co.uk/wp-content/uploads/2015/12/20150703-Orkneys-Electric-Future-Feasibility-Study.pdf
[42] https://www.transport.gov.scot/publication/strategic-framework-of-options-for-the-chfs-network-project-neptune/an-introduction-to-project-neptune/
[43] https://www.gov.uk/government/publications/maritime-decarbonisation-strategy
[44] For example, the Energy Efficiency Standard for Social Housing 2 (EESSH2) which mandates that all social housing should meet an Energy Performance Certificate rating of 'B' by 2032 (with some exemptions. The Scottish Government's Climate Change Plan and Heat in Buildings Strategy also indicate that publicly owned buildings should have zero direct emission heating (ZDEH) by 2038.

as part of maintenance and upgrade works to capitalise on the opportunity and minimise future re-work, though noting that these are comparatively small sources of emissions compared to energy use.

OIC has already implemented many of the above changes (for example, 95% of streetlighting has already been replaced with LEDs) so the recommendation would be to complete those works if not already concluded.

From a purely GHG emissions standpoint, it is not necessarily the case that buildings need to undergo significant fabric efficiency measures in order to achieve net zero operational emissions.[45] However, the ‘fabric first’ approach helps to mitigate higher energy bills and reduce demands on electricity grid infrastructure – both of which are important for OIC and its tenants. Energy efficiency is also typically a requirement to obtain funding through the Public Sector Decarbonisation Scheme (PSDS).

Similarly, if and when the national electricity grid is decarbonised, adding further renewables will cease to have a GHG emissions impact. This is because the GHG saving is calculated based on the extent to which local renewables displace fossil thermal power generation. Therefore, in future, local renewables – whether these are large-scale standalone wind or solar arrays or smaller scale building-mounted systems – will be relevant primarily from the standpoint of reducing energy bills.

The measures listed above broadly apply to OIC’s operational buildings, as well as social housing and other tenanted properties. However, the specific practical actions that OIC will need to take will differ depending on the occupancy. For tenanted properties, lease agreements dictate which party is responsible for repairs or improvements and what notice or consent is required. The council’s actions will extend beyond physical works to include supporting tenants to adopt energy-saving measures, training them in the use of any new systems or controls, and giving permission where tenants wish to install upgrades themselves.

Capital cost: £27.5-57m[46]	**Carbon saving:** Up to 8,329 tCO_2e	**Energy saving:** 50-75% reduction[47]

Wider impacts and co-benefits: Warmer, healthier workplaces and homes; lower energy use and potentially lower energy bills; improving air quality; providing skills and green jobs in the construction and renewables sectors; contributing to a green, low carbon economy; energy efficiency eases strain on electricity networks; potential increase in rental value for commercial properties.

Key stakeholders: Property, Asset Management and Facilities teams, Planning and Community Protection, social housing and commercial tenants

[45] https://discovery.ucl.ac.uk/id/eprint/10184750/
[46] OIC buildings, tenanted properties and social housing. Please refer to Appendix G for more details.
[47] Depending on the level of retrofitting and the heating system specification. A heat pump typically uses 60-75% less energy (in kWh) than the equivalent fossil fuel or direct electric heating system. This may or may not translate to cost savings due to the difference in price between electricity and other fuels.

The general challenges of securing funding and the practicalities of upgrading buildings are well known to OIC so have not been restated here. From the standpoint of reaching net zero emissions, there are some broader considerations:

- Some like-for-like heating system replacements are still ongoing due to cost considerations (e.g. arising from the high cost of electricity compared to oil), so for any buildings with newly installed boilers, they will be subject to technological lock-in unless replaced again before OIC's net zero target date.[48] As is the case with OIC's marine services (see previous section) this presents a risk to achieving net zero by 2045.
- All the measures listed above rely on technology that is already mature and commercially available, although within the UK, there are relatively fewer trained installers for heat pumps which can cause issues.
- For some measures, electrical grid capacity is a key consideration where it is suggested to switch from certain fuels to electricity, although it is noted that planned renewable energy projects could help to meet the demands.
- Certain measures may require planning permission, and there may be constraints within buildings themselves e.g. space for pipework etc.
- Retrofitting can be disruptive during works. This is particularly relevant for social housing tenants who may need alternative accommodation.

Looking at this in the context of OIC's GHG inventory, collectively, buildings account for the second biggest category of emissions after marine services. Because of this, and because they can be decarbonised using existing technologies, a key opportunity for OIC to minimise its total GHG emissions over time (i.e. its cumulative GHG emissions) would be to rapidly accelerate the process of decarbonising its buildings.

Based on these considerations, priority interventions are to:

- Implement the works set out in the CMP, although first re-assessing whether lower cost options are available with different combinations of 'fabric first' measures and renewable/ZDEH technologies. From a GHG reduction standpoint, this is arguably the highest priority for OIC when weighing up the potential GHG savings, OIC's level of influence, and the availability of zero emission technologies. It is acknowledged that funding is not available at present; OIC will therefore need to take a decision on whether it is possible to obtain or divert funds from elsewhere.
- For tenanted properties which are already electrically heated, a top priority will be to continue to upgrade social housing. This is less important from a GHG emissions standpoint but has important wider benefits on tenants' bills along with their comfort and welfare. Tenanted commercial properties should also be upgraded where costs allow, although again the primary benefit will be lower energy use and bills rather than GHG emissions reduction.
- When carrying out upgrades, evaluate whether there are also opportunities to install systems that will reduce f-gas emissions and decrease water demand. There is separate legislation which will limit f-gas emissions over time, but in the meantime, OIC could introduce a policy to choose lower GWP options where available.

[48] Still to be confirmed.

4.2.3 Switching to an electric vehicle and bus fleet

Note: This section addresses emissions from road vehicles, including OIC's own fleet and public transport/buses, with some additional information relevant to business travel and staff commuting by road. These have been grouped together, recognising that they span different categories and scopes of emissions, because the broad types of behavioural, operational, energy efficiency and technological solutions are similar.

OIC has already worked extensively on identifying opportunities and implementing measures to decarbonise their fleet and public transport. Prior work includes, but is not limited to, the OIC Fleet Decarbonisation Study, Local Transport Plan, and Electric Vehicle Infrastructure Strategy (2014). Adopting the measures set out in those plans would result in these categories of emissions being decarbonised, so the headline finding, as is the case for buildings, is that OIC should proceed with the initiatives that have already been proposed.

As with the above measures, reducing reliance on fossil fuels will be key to decarbonising road vehicles. In addition, relatively low cost options, such as promoting modal shifts and active travel, can reduce emissions from commuting and business travel while also providing co-benefits such as improving air quality, promoting healthy lifestyles, and reducing traffic.

For road vehicles, including OIC's fleet, the types of GHG mitigation actions that are needed include:

- **Behavioural/operational changes**: such as eco-driving and reducing idling times, route optimisation to reduce milage, and reducing vehicle speeds for both OIC's fleet and public transport vehicles. No capital costs would be required, although some training would be needed for drivers and OIC personnel.
- **Energy efficiency**: replacing vehicles with more efficient models, which will be relatively easy to achieve as it is part of the natural replacement cycle.
- **Switching to alternative sources of energy**: this would involve switching from fossil fuels to electric vehicles, and potentially using biofuel or biofuel blends or green hydrogen in the longer-term.
- **Other**: A strategic review of travel options is needed to decide measures that result in modal shift e.g. additional subsidies for buses may increase demand for buses and reduce reliance on car trips. In addition, providing micro-mobility options e.g. e-bikes and bike sharing schemes, can complement the bus service particularly for the 'last mile' of travel.

Capital cost: £40-50m[49]	**Carbon saving:** Up to 3,609 tCO_2e	**Energy saving:** 20-70% reduction[50]

[49] Includes OIC vehicles and buses. Please refer to Appendix G for more details.
[50] Hybrid vehicles use around 20-30% less energy (measured in kWh) than combustion engines, whereas electric vehicles may use 70% less. Whether this translates to an overall reduction in operational costs depends on the systems selected, due to the difference in price between electricity and other fuels. The 2024 EST report 'Fleet decarbonisation report for Orkney Council' indicated that there could be £100,000+ savings in annual fuel costs if the heavy duty goods vehicles were replaced with battery electric alternatives.

Wider impacts and co-benefits: Improving air quality, reducing noise, improving public health and wellbeing, potentially lower running costs and reduced exposure to volatile fuel prices; fleet operators can save on insurance and maintenance; stimulates investment in EV infrastructure, supports a low carbon economy.

Key stakeholders: OIC Transportation team, Infrastructure and Organisational Development Team, HiTrans, Stagecoach and other bus operators, and the HR team (if there are any measures aimed at promoting EV uptake for staff commuting and/or training)

Key challenges and dependencies include:

- To support the infrastructure around electric vehicles, additional electric charge points will need to be installed on council-owned properties and car parks, which will require a capital investment. In particular, it is understood that a new rapid charger was necessary for successful operation of the electric bin lorry trial, which highlights the need for infrastructure to be suitable for heavy-duty applications.
- It is understood that OIC has received funding to install chargers but may not receive funding to renew or maintain these. Although the provision of EV chargers does not have a direct GHG impact on OIC's annual emissions, it is a key enabler for the transition to an EV fleet and therefore obtaining funding for these should be considered a priority.
- As noted above, capacity of the electrical grid in Orkney will need to be considered to ensure the additional load on the grid can be accommodated.
- Certain types of alternative fuels, such as hydrogen and biofuel blends are still an emerging technology and may in the short term be more expensive or not commercially available or viable until the mid-2030s onwards. This poses a challenge for decarbonising some vehicles and plant, notably HGVs.
- While biofuels such as hydrogenated vegetable oil (HVO) offer a potential route to decarbonising these, the source is also important to take into account. While, in principle, HVO can deliver significant reductions in GHG emissions, it is necessary for it to be sourced sustainably to ensure that its production is not indirectly driving demand for virgin oil production at the expense of either food production or natural habitats.[51,52] It is understood from OIC officers that there is already a commercially available supply in Orkney.
- Much of the behavioural and operational changes will require training and awareness campaigns, and the efficacy of these measures can be hard to monitor.

For the fleet owned by OIC, the BAU already considers the substitution of diesel vans with EV models as part of the natural replacement cycle (see **Section 3.3**). However, as buses are procured through private companies, OIC will need to ensure the procurement process and contracts include provisions (including funding) to reflect the OIC's ambition to transition to low/zero emission vehicles.

[51] https://www.zemo.org.uk/work-with-us/fuels/the-renewable-fuels-assurance-scheme.htm
[52] https://www.transportenvironment.org/articles/how-sustainable-are-advanced-and-waste-biofuels

Regarding buses, the Scottish Government is exploring options to prohibit non-zero-emission buses from as early as 2030, but the current contract with Stagecoach runs to 2029, i.e. before a formal ban is likely to be in place. OIC will need to engage in discussions with the bus operators to ensure these requirements are transparent and there is sufficient buy-in for operators to upgrade their fleet as needed.

Based on these considerations, priority interventions are to:

- Continue with the transition to an EV fleet for light commercial vehicles.
- Ensure that the procurement of public transport services sets emission standards for vehicles that align with OIC's net zero target.
- Work to ensure the continuing roll-out, and maintenance, of EV charging infrastructure. These do not need to be Council-owned, provided that they can support the Council's service needs.
- Keep informed of new technological developments relevant to vehicles such as HGVs and other construction plant, taking lessons from the electric bin lorry trial as relevant.

For staff travel and commuting, there are some prerequisite steps before more specific mitigation actions can be identified:

- Undertake a staff travel survey to obtain better insight into commuting and business travel patterns.
- A strategic review of OIC's travel options and policies should then be undertaken, to identify ways to reduce the need for travel and provide incentives for more sustainable travel modes. Incentive schemes may be required to promote modal shift.

4.2.4 Priority cross-cutting measures: Providing renewable electricity

To support the transition away from fossil fuels, OIC can also choose to invest in additional renewable energy technologies.

As discussed in more detail in **Appendix D**, the specific contractual arrangements determine whether OIC can claim this as a GHG reduction measure under the GHG Protocol guidelines. Conceptually however, if OIC has phased out the use of fossil fuels and produces as much renewable energy as it uses, this is clearly aligned with the aim of achieving a systemic shift to a zero-carbon energy system; in that sense the council could be seen as doing its 'fair share' towards that aim.

More widely, OIC can help to facilitate electrical infrastructure upgrades to support the transition to a decarbonised electricity system within Orkney. This would not directly impact OIC's organisational GHG inventory, but nonetheless would have wider benefits.

By actively coordinating with developers, regulators, and communities, OIC can support the transition to a more resilient and sustainable energy system. Further details will be set out in the forthcoming Orkney Energy Action Plan.

4.2.5 Other GHG reduction measures

The following sources of emissions are comparatively smaller within OIC's GHG inventory but would still need to be mitigated in order for the council to reach net zero.

Air travel: 412 tCO_2e for the Inter-Isles air service, 363 tCO_2e for OIC business travel

Within the UK government's Jet Zero Strategy for aviation, the outlook for reducing emissions from air travel in the short to medium term focuses on improving the efficiency of aircraft and the use of sustainable aviation fuel (SAF).[53] SAF can be used as a 'drop-in' substitute for conventional jet fuel, with current certification standards allowing it to be blended in mixtures of up to 50% by volume.[54] The UK government has introduced an SAF Mandate, a policy mechanism that requires aviation fuel suppliers to include a growing share of SAF in their supplied jet fuel mix.[55] It is expected that hybrid or zero emission technologies could become available in the 5-10 year timeframe, but the precise solution depends on factors such as the size of the plane, length of journey and other operational requirements.

It is understood that the planes currently in use by Loganair for the Inter-Isles air service use piston engines, rather than turbine engines, and therefore cannot use SAF without modification or replacement. For short-hop journeys such as those occurring within Orkney, there are currently hybrid and electric planes in development which could be suitable for adoption. Loganair has previously partnered with Heart Aerospace to establish use cases for hybrid aircraft on similar routes.[56] Loganair is also now working with ZeroAvia to explore opportunities for hydrogen engines.[57] The Sustainable Aviation Test Environment (SATE), based in Orkney, undertakes research and trials for emergent aviation technologies as a 'living laboratory' which means that Orkney is in a unique knowledge-leading position.[58]

When low- or zero-emission aviation technologies become commercially available, OIC should seek to procure those for the Inter-Isles air service. In the short term **OIC should work with Loganair to understand the likely technologies that would be suitable for those routes along with the potential timescales for market adoption, costs, and supporting infrastructure or other practical requirements**.

OIC also uses commercial flights for business travel, to the mainland and elsewhere. Those planes could also potentially be replaced with hybrid or electric options in future, subject to further development of those technologies (this would ultimately be Loganair's responsibility but OIC can influence it through procurement). Routes that utilise turboprop aircraft could also use SAF if available. However, there are some key issues to consider:

- The GHG savings from SAF depend on how the fuel is produced. If it is produced with waste oil/fats, it can reduce emissions by 60-80% compared to conventional jet fuel.[59] However, the supply of waste oil globally is low, so in practice SAF may be produced with purpose-grown crops.[60] These crops compete with food production and, if land use change occurs (e.g. clearing

[53] https://assets.publishing.service.gov.uk/media/62e931d48fa8f5033896888a/jet-zero-strategy.pdf
[54] https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/saf-handbook.pdf
[55] https://www.gov.uk/government/publications/about-the-saf-mandate/the-saf-mandate-an-essential-guide
[56] https://heartaerospace.com/newsroom/heart-aerospace-and-loganair-enter-exclusive-partnership-to-advance-hybrid-electric-aviation-in-the-uk
[57] https://www.shetlandtimes.co.uk/news/loganair-plans-for-hydrogen-only-aircraft-developments-417162/
[58] https://sate.scot/
[59] https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet-sustainable-aviation-fuels/
[60] https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/saf-handbook.pdf

forests or draining peatlands), the resultant emissions may partially or fully negate the fuel's GHG benefits.
- SAF does not usually replace 100% of jet fuel (see above), so the actual savings are lower. A 50/50 blend of SAF and jet fuel would only reduce emissions by 30-40%.
- SAF is currently concentrated on major airports and hubs rather than remote or small regional airports like Kirkwall. Therefore, the amount that is actually available in Orkney may be limited.

Whereas SAF is produced using biological materials, it is also possible to synthesise fuel using hydrogen and carbon. This is known as e-fuel. In principle, the hydrogen could be produced locally using renewable electricity (i.e. green hydrogen). The Orcadian company iGTL, partnering with Zero Petroleum, achieved a Guiness World Record for the first flight powered entirely by a synthetic e-fuel using green hydrogen produced in Stromness.[61] The Flotta terminal has been proposed as a potential site for a new green hydrogen hub[62], so in this could become an option for aviation in Orkney in future.

Longer term, the aviation industry is likely to rely on carbon capture and storage (CCS) or other forms of offsetting to mitigate its emissions.[53] However, the timescales for CCS adoption (and its long-term success) are uncertain. Therefore, **the current best option for OIC to reduce emissions from business air travel is to avoid flights where possible**. This could be achieved by reviewing its existing travel policies to identify journeys related to events that can be done remotely rather than in person.

In the longer term, the decision to fly or travel by sea will depend on when aviation and marine transport options decarbonise. If zero emission planes become available faster than zero emission ferries, OIC should ensure that its travel policies reflect the lower carbon option.

Waste: 290 tCO_2e

Note: To date, OIC has only reported emissions from its operational waste within its GHG inventory, so this section focuses on measures to reduce those emissions. Since this analysis was prepared, new guidance now requires OIC to report on all area-wide waste. Opportunities to decarbonise waste management for Orkney more widely have not been explored in this study but are addressed in the council's updated Waste Strategy.[63] The recommendations in this study relating to OIC's operational waste still apply, but actions relating to area-wide waste management have been omitted.

The CCC considers waste a 'hard to abate' sector. Reducing the amount of waste that is produced in the first place, increasing rates of recycling and composting, and diverting waste from landfill are expected to enable the sector to achieve approximately a 40% reduction in emissions by 2045. In the long term however, the waste sector is expected to rely on CCS to achieve net zero emissions in the longer term.[64]

There is currently limited data on OIC's operational waste. OIC currently estimates its waste emissions by assuming that 15% of the area-wide total is associated with the

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[61] https://iuk-business-connect.org.uk/news/raf-delivers-worlds-first-flight-using-100-net-zero-synthetic-fuel/
[62] https://www.bbc.co.uk/news/uk-scotland-north-east-orkney-shetland-58882752
[63] https://www.orkney.gov.uk/media/djvfmlkn/item-5-waste-strategy-ia.pdf
[64] Emissions reduction calculated from dataset underpinning Figure 7.8.2 of the CCC 7th Carbon Budget report. https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf

council's operations. This is based on an outdated study. In order to more accurately identify current emissions from waste, and suitable waste reduction measures, it is recommended that OIC update the study when possible.

The lack of data on waste streams from OIC operations also makes it challenging to identify detailed mitigation measures in detail, although the policy review undertaken as part of this project, along with discussions with OIC officers, demonstrate that there is strong institutional awareness of relevant sustainability measures. The council should therefore continue to primarily focus on managing its operational waste in line with the waste hierarchy and continuing to support the local community to do the same.

There may be opportunities to provide composting for food waste at some OIC sites, subject to available space, which would avoid the need for additional infrastructure or collection vehicles. This would avoid emissions associated with biodegradable waste being shipped to the incinerator in Shetland. In principle, there is also the potential to introduce small-scale anaerobic digestion (AD) on some of OIC's tenanted farms, but evidence suggests that this is rarely cost effective unless additional feedstocks are available; the business case could improve if this was part of a consolidated waste management system although it is understood that this has already been explored and discounted for Orkney.[65] These opportunities (composting and AD) should still be considered in future iterations of Orkney's waste management strategy because it represents an opportunity to reduce emissions from transporting waste by land and sea, and can also provide material (compost) or energy that can be used locally.

OIC also sends waste to the Energy Recovery Plant (ERP) in Shetland for incineration. Shetland Islands Council have recently invested a significant amount to upgrade their incinerator, which has improved its efficiency, so further upgrades are not likely in the short to medium term. However, SIC is aware of the potential need to have CCS fitted in coming decades. OIC should keep informed of emerging technological developments and engage with SIC where necessary to encourage adoption of this solution if and when it becomes commercially available.[66] This would then need to be reflected within the councils' contractual arrangements for waste disposal.

F-gases: 14 tCO_2e in 2023

The decarbonisation pathway is primarily influenced by broader regulations regarding the Global Warming Potential (GWP) of refrigerants.[67] OIC's main responsibility will be to carry out leak detection, and specify appliances with lower GWP options, when purchasing new systems. These alternatives may incur higher capital costs, but they can offer operational energy savings due to improved energy efficiency in some cases.

In terms of leak detection, this can be carried out as a manual inspection by a certified engineer (most common for small/medium installations), as a fixed detection system that monitors the refrigerant concentration in the air (most common for larger plant rooms), or through indirect monitoring such as checking system pressures and

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65 https://www.climatexchange.org.uk/wp-content/uploads/2023/12/CXC-Assessing-the-Scottish-anaerobic-digestion-market-based-on-agricultural-waste-Nov-2023-1.pdf
66 https://www.shetland.gov.uk/downloads/file/6461/shetland-islands-council-net-zero-route-map
67 The Kigali Amendment to the Montreal Protocol is the key global framework for phasing down high-GWP refrigerants, and would result in an 85% cut by 2036.

refrigerant charges. Properties with larger HVAC or refrigeration/chiller systems should be prioritised in the first instance.

Note, although F-gases currently comprise a relatively small portion of OIC's emissions, it should be noted that heat pumps also contain refrigerants. Therefore, the issue of leak detection will apply to a higher number of OIC properties in future as the council installs more heat pumps.

A note on the impacts of climate change and the wider transition to net zero

In addition to the BAU and other mitigation measures modelled in this study, there are a variety of ways in which climate change itself may impact OIC's future emissions. Those are outside the scope of this study, but to give some examples:

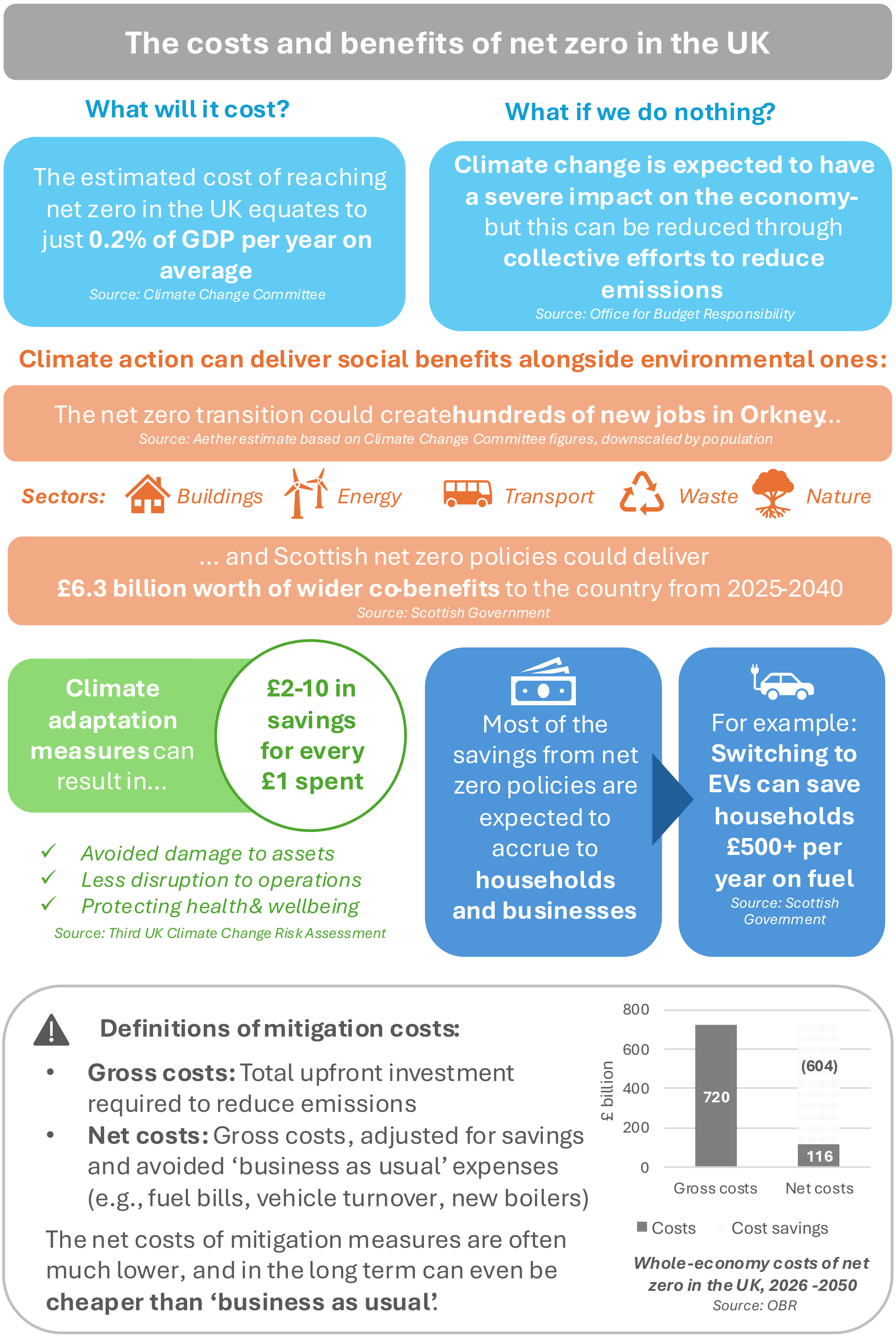
- Increased frequency of severe weather events will affect service delivery, putting pressure on housing support, roads, transport and welfare provision. Impacts on the local economy could have knock-on effects on OIC's budget e.g. through reduced income or higher expenditure.
- Embodied carbon from the materials used for repair and maintenance of roads, flood defences and other infrastructure is not currently included in OIC's inventory as it is not a statutory requirement and requires more resource to collect data and calculate emissions, but may be included in the future. These emission sources would potentially have a material impact on OIC's GHG emissions profile – and with more severe weather events, could increase further.
- A wider transition to a zero carbon economy will affect demand for services. For example, a large proportion of global shipping movements are currently associated with fossil fuel supply chains. The global trends and transition in the maritime sector therefore must be a key consideration in current and formative planning for port/harbour operation.

Therefore, OIC's developing Climate Change Strategy will have to consider the range of risks and opportunities of the changing climate and how to support resilience, adaptive capacity and adaptation pathways. OIC can build on existing work it has undertaken within its Coastal Change Adaptation Strategy and participation in the Scotland Public Sector Climate Change Adaptation Partnership.

4.4 Putting the costs into context

Although the costs associated with GHG mitigation can be significant, there is strong evidence that the net zero policies can provide a range of economic and social benefits, as summarised below. For more information and references, see **Appendix H**.

Figure 9. Costs and benefits of net zero in the UK



4.5 Identifying economic, social and wider environmental benefits of decarbonisation

Aether's wider impacts database has been applied to the priority mitigation measures described above. The wider impacts matrix has been customised for OIC and qualitatively assesses potential economic, social and environmental impacts of their mitigation actions, both positive and negative. By undertaking this analysis, it is possible to broadly identify co-benefits for delivery areas such as transport or business, as well as specific co-benefits for each action or intervention identified within the delivery areas.

Measures that are expected to have similar impacts have been grouped together, although the scale of impact will of course depend on the project design and implementation.

The strength of score illustrates the degree to which each measure will likely deliver positive or negative impacts, based on evidence from academic literature and reports, and supplemented with local context research and insights. The scoring approach is as follows:

Symbol and colour coding	Description
++	3 - Significant positive effect likely
+	2 - Minor positive effect likely
0/+	1 - Mixed minor positive and minor negative effect likely
0	0 - Negligible effect likely
0/-	-1 - Mixed minor negative and minor positive effect likely
-	-2 - Minor negative effect likely
- -	-2 - Significant negative effect likely

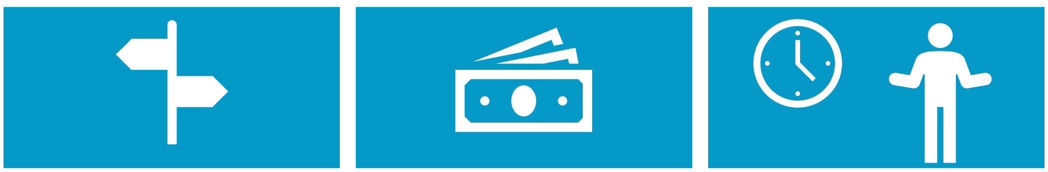
Table 8. Overview of key co-benefits for different types of mitigation measures

		Providing skills and green jobs	Improving health and wellbeing	Biodiversity	Sustainable resource and water use	Resilience	Improving air quality	Supporting wider research	Notes
Energy efficiency	Energy efficiency retrofit	++	++	0	+	+	0/+	0	Green skills/jobs in insulation, ventilation, and retrofit coordination. Retrofits can improve occupant comfort and reduce the risk of cold conditions and mould. Bill savings can lower costs and reduce fuel poverty. Lower demand for energy reduces natural resource consumption.
	Energy saving behaviour and operational measures, in buildings and transport	0	+	0	+	0/+	0/+	0	Behaviour to reduce the use of electricity, heating and fuel in buildings can reduce bills and outdoor air pollution. If energy saving measures include avoiding private vehicle journeys and using active travel, this can improve health and wellbeing. Lower demand for energy reduces natural resource consumption.
Switching away from fossil fuels	Replacing fossil fuel space heating and cooking with electric options	+	+	0	++	+	+	0	Green skills/jobs in heat-pump manufacturing, installation, and servicing. Less habitat impact from fossil-fuel extraction. Far more efficient energy use. Greater resilience through electrified, flexible heating. Replacing cooking systems improves indoor air quality, lowering NOx and particulate emissions.
	Replacing petrol/diesel vehicles and vessels with electric vehicles	0/+	+	0/+	+	+	+	0	Green skills/jobs in battery manufacturing, EV maintenance, charging network installation. Reduced noise, lower exposure to tailpipe pollutants. Reduced roadside pollutants and quieter habitats. Much more efficient use of energy and lower demand contributes to energy system resilience. Lower NOx and particulate matter emissions from vehicles. Less water pollution from fossil fuel vessels reduces impacts on marine ecosystems.
Renewables and grid upgrade work	Upgrade to grid infrastructure including battery storage	++	0	0/-	0	++	0	0	New jobs in clean energy sector, increased energy security and resilience due to a diverse energy supply. Potential negative impacts on biodiversity depending on the location of grid infrastructure, so requires careful design and siting. Battery production can have negative environmental impacts due to material extraction, but on balance their impact is neutral or positive if paired with responsible sourcing and recycling they shift away from fossil fuels.
	Solar PV	++	0/+	0/+	0	++	0/+	0	Green skills/jobs in panel manufacturing, installation, and system maintenance. Reduced noise and cleaner indoor/outdoor environments. Minimal habitat disturbance (and potential biodiversity improvements) when sited well. Renewable energy generation lowers fossil-fuel demand. Supports grid resilience through distributed generation.
	Wind	++	0/-	0/-	0	++	0/+	0	Benefits largely as above, however, the construction and operation of wind turbines can negatively impact wildlife and can create noise pollution in some circumstances so requires careful design and siting.
Nature based solutions	Peatland restoration and tree planting	++	+	++	+	++	+	0	Green skills/jobs in ecological surveying, nurseries, planting, restoration, and long-term land management. Improved wellbeing via access to healthy natural spaces. Habitat creation and biodiversity gains. Better water regulation through retention and filtration. Increased landscape resilience to heat, drought, and flooding. Significant carbon benefits (peatlands: avoiding large emissions; trees: long-term sequestration).
	Blue carbon projects	+	0	++	0	+	0	+	Green skills/jobs in coastal restoration, monitoring, sustainable aquaculture. Improved wellbeing through enhanced coastal protection. Habitat creation for marine biodiversity. Potential better water quality via filtration e.g. by seagrass. Increased resilience to storms and erosion. Potential carbon sequestration.
Waste management and resource use	Increasing reuse and recycling	+	0/+	0	++	0	0	0	Reduced consumption of natural resources. Potential new green jobs within the context of a circular economy. Potential benefits to human wellbeing through reuse/repair shops and similar community-based initiatives.
	Composting and anaerobic digestion	0	0	0	++	+	0	0	Composting would provide a source of locally produced compost. Biogas or energy produced from anaerobic digestion can contribute to a lower carbon energy system, improving energy resilience.
	Water saving measures such as greywater recycling	0	0	0/+	++	+	0	0	Saving water reduces utility bills and represents efficient use of natural resources. It increases resilience to variable weather patterns by reducing reliance on mains water supply and can reduce indirect emissions associated with wastewater management. Potential indirect benefits on biodiversity/ecology due to less water abstraction.
Innovations	Zero emission aviation and ferries; CCS	++	*Varies depending on technology*					++	Several of the mitigation measures would involve R&D or pilot projects that could benefit the wider UK and elsewhere, e.g. when exploring aircraft and ferries that use zero carbon technology. Green hydrogen and CCS are also considered important for mitigation in hard-to-abate sectors This would create green jobs within Orkney which could be positioned as a leader in these areas.

4.6 Enabling measures

Effective governance and supportive institutional arrangements are essential to turn OIC's climate ambitions into measurable results. While direct measures such as energy-efficient retrofits or transitioning to electric vehicles cut emissions at source, their success depends on robust internal processes and leadership.

Discussions with council officers revealed a strong awareness of the practical measures required to reduce emissions. However, feedback from a dedicated workshop (see **Appendix I**) indicated that these actions often struggle to gain day-to-day priority amid competing demands, particularly the pressures of delivering front-line services within constrained budgets. At an organisational level, officers highlighted the need for clearer strategic direction from senior political and executive leadership, together with additional resources (money and time), to enable effective implementation.



Clear direction from senior leadership that climate change is a priority in practice day-to-day	Availability of **funding**, and greater flexibility in **budgeting and financial** planning	**Time and resources** for officers to plan, trial and implement climate change measures

In addition to the practical actions that directly reduce GHG emissions, it will be key for the council to create an enabling culture and environment to reach net zero. Key areas of cross-cutting action to help create this environment within the council, but also more broadly within partner organisations and the general public, include:

- **Continuing to monitor and report** on the council's own organisational GHG emissions, to ensure progress can be tracked. If not already in place, a simple way of using this reporting to feed back into institutional awareness would be to present the results in a way that highlights the relative contribution of different departments or service areas, similar to the GHG summary charts shown in **Section 2**. Optionally, OIC could adopt GHG budgets or GHG reduction targets for different service areas, but this would need to be accompanied by providing officers with more resources to implement changes.
- **Developing processes to ensure that decision making and governance within the council, including procurement, account for decarbonisation and attach sufficient priority to it compared to other factors such as cost.** This is already underway, with sustainability considered in various procurement practices. Including GHG emission estimates in business cases and as input into other decision making would help to ensure environmental impacts are considered alongside economic impacts.

- **Strategic budgeting and financial planning** that integrates carbon considerations into investment decisions, with revised approaches to capital and Service revenue budget setting to allocate funds to priority mitigation projects. This will in many cases require additional revenue and capital funding to address the initial cost uplifts and interim service budget deficits associated with net-zero technologies compared to fossil-fuel or oil-based solutions, for example through a supplemental "net zero budget deficit allowance" to cover the gap until market conditions change.
- **Clear governance structures** with defined responsibilities for climate action across departments, ensuring that decision-making is coordinated and transparent. This should include having a climate change champion or champion(s) at the most senior level of executive and political leadership, who hold responsibility for driving climate change action across the organisation in collaboration with the climate change officer.
- **Allocating responsibilities for different service areas to deliver on OIC's overall GHG reduction targets**, which could include specific carbon budgets and/or a requirement to seek funding and develop pipelines of GHG reduction projects. Those would need to be developed based on evidence about the timing of potential interventions, rather than top-down targets being imposed without consideration of technological and other practicalities.
- **Communications, education and awareness raising** of roles and responsibilities for climate action for residents and businesses across the county, as well as internally within the council on issues such as staff travel and waste reduction.
- **Ensuring that climate action planning is joined up** across the council, employing networks and governance structures to join up relevant service areas and ensuring climate action planning is consistent with and complementary to wider policies, plans and strategies and vice versa.
- **Continuing to identify and access grants and funding** for implementation of measures by the council, as well as supporting partner organisations to access funding. OIC has already developed an excellent track record of accessing funding and participating in innovative pilot schemes.
- **Training for staff** on sustainable practices and increasing availability of green skills and training opportunities, as well as ensuring that sufficient staff resources are available to deliver decarbonisation actions. It is noted that, during this project, OIC officers expressed a high level of awareness of sustainable practices, which suggests that there is a good level of institutional training or awareness-raising already available. It is important for this to continue. If there are skills gaps in any specialist areas (for example in project level carbon accounting, should it become a wider requirement in future) these will also need to be addressed.
- **Continuing with and strengthening partnership working** with other external organisations that may be able to influence and assist with OIC decarbonisation. This would include engaging with key industry sector actors to understand technology innovations that may be relevant to OIC's decarbonisation ambitions, and engaging with OIC's supply chain to reduce Scope 3 emissions.

The Scottish Government has introduced new draft guidance for Scottish Authorities which sets out how they can put climate change duties into practice, which OIC can refer to for more information.[68]

[68] https://www.gov.scot/binaries/content/documents/govscot/publications/consultation-paper/2025/02/consultation-draft-statutory-guidance-public-bodies-putting-climate-change-duties-practice.pdf

5 Neutralising and compensating for residual emissions

Even after accounting for a range of GHG mitigation measures, reaching net zero emissions will remain a challenge for OIC. This chapter therefore sets out the potential means to address the remaining (or 'residual') emissions that would need to be compensated in order to reach net zero emissions. These compensating measures focus on Nature-Based Solutions (NbS) and engineered carbon dioxide removal (CDR) methods.

5.1 Overview of carbon offsetting / insetting

5.1.1 Definitions and concepts

Achieving net zero involves both reducing emissions and then compensating for any emissions that remain ('residual' emissions) through measures that are commonly termed carbon 'offsetting' or 'insetting'. More detailed definitions of key terms are provided below. These definitions have been taken from draft guidance for Scottish public bodies, published in February 2025, which provides advice for public bodies on how to put their statutory climate change duties into practice.[68]

Table 9. Definition of key terms from the draft statutory guidance for Scottish public bodies

Term	Definition
Residual emissions	*'In the net zero carbon context, unavoidable residual emissions are those emissions which remain after a body has taken all reasonable steps to reduce or remove them. They may include emissions related to specific processes or technologies for which no viable alternative currently exist.'* (p. 25)
Carbon offsets	*'Carbon offsets are used to counterbalance emissions of carbon dioxide or other greenhouse gases (GHGs) generated by an organisation's operational activities. Measured in tonnes of carbon dioxide equivalent (tCO_2e), offsets reduce or remove from the atmosphere the equivalent amount of CO_2 or other GHG generated by the organisation. Offsetting allows organisations to balance emissions within their boundary with carbon savings realised elsewhere, for example carbon sequestered in woodland on a third party's land, to achieve overall net zero emissions. Offsets can take various forms: the most common are carbon credits'*. (p. 20)
Carbon insets	These are *'carbon and GHG management and reduction activities within the organisation's operational boundary on their own landholdings or, by agreement, on the wider public estate. While a wide range of insetting activities exist, this guidance focuses on nature-based insetting projects, for example peatland restoration or woodland creation'*. (p. 20)
Carbon credits	*'Measured in tonnes of carbon dioxide equivalent (tCO_2e), carbon credits reduce inputs to or remove from the atmosphere the equivalent amount of CO_2 or other GHG and can be used to offset emissions generated by an organisation.'* (p. 20)

Other definitions exist in other guidance documents and standards, but the ones listed above are relevant to OIC and suitable in the context of this study. A more detailed discussion of different definitions and concepts is provided in **Appendix K**.

Beyond the definitions of key terms, the draft guidance sets out the following principles in approaching offsetting/insetting in relation to residual emissions:

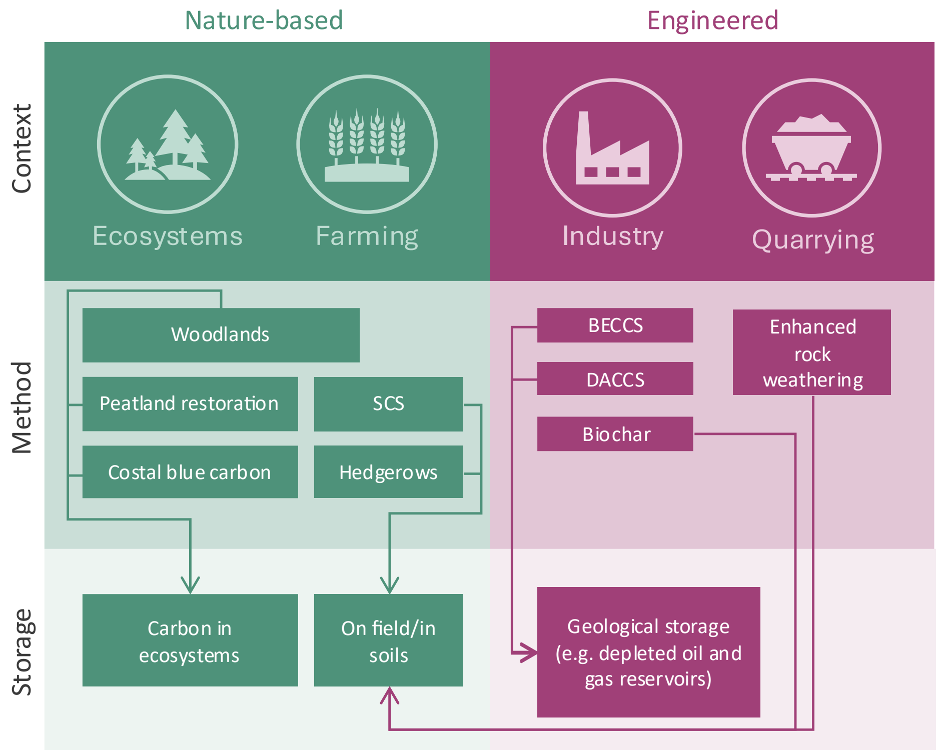
- **Offsetting as a last resort:** The draft guidance details that '*offsetting should only be used as a last resort and, in most cases, as an interim measure while solutions to emissions that bodies are currently unable to eliminate are developed*'. This highlights that the assessment of residual emissions requires revisiting periodically, to assess progress in the decarbonisation of hard-to-abate sources against the need for offsetting/insetting. Similarly, in practice, offsetting projects can require planning to meet the necessary scales required in the net zero year, which would need to be coordinated in parallel to emission reduction measures.
- **Local projects first:** The draft guidance details that *'where insetting and or offsetting have been deemed appropriate, public bodies with landholdings should maximise opportunities for nature-based insetting projects on their own land. On the route to organisational net zero carbon, investment in insetting projects should be prioritised ahead of the purchase of carbon offsets from elsewhere*'. Similarly, in relation to offsets, the guidance advises that 'there is a strong preference for public money to benefit communities and high integrity projects within Scotland, as opposed to investing in international offsets'. This suggests an approach whereby Orkney is first prioritised, followed by projects local to Scotland, before the use of the international voluntary carbon market (VCM).
- **Use high-integrity nature-based schemes:** The draft guidance advocates that '*public bodies should ensure that any carbon credits obtained for offsetting purposes meet quality criteria […] Credits should be high-integrity and verified under Scottish Government supported carbon codes such as the Peatland Code and the Woodland Carbon Code*.' It is important to note that this is only guidance; OIC is not required to obtain formal carbon credits, and in practice the council has flexibility in how it approaches offsetting/insetting. However, if OIC chooses to pursue projects that do not meet these requirements, there would need to be an understanding within the Council that it may not be able to claim the GHG benefits in its annual inventory.
- **Coordinate with other policy objectives and realise co-benefits:** The draft guidance suggests that '*opportunities for insetting projects on a public body's landholdings should be balanced with other local, regional and national priorities including food security, housing and energy. Care should be taken to promote, and not to harm, other objectives especially climate adaptation and nature recovery*'.

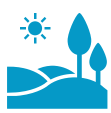
In line with these principles, this report focuses on the potential for nature-based solutions (NbS) and carbon dioxide removal (CDR) projects that could be undertaken local or near to Orkney, ahead of considering the procurement of carbon credits from projects elsewhere.

5.1.2 Carbon dioxide removal (CDR) methods

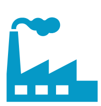
CDR methods are typically divided into two groups: nature-based and engineered, for ease of reference. The diagram below summarises different types of CDR methods, and further descriptions are provided on the following pages.

Figure 10. Examples of CDR methods, split by class





Nature-based methods refer to methods such as tree planting, woodland management, peatland restoration, and soil carbon sequestration (SCS).[69] These methods are well-established, widely deployed, and already reported by national governments when estimating carbon stock changes owing to land-use activities. Guidance similarly exists towards their accounting at the organisational scale, such as the GHG Protocol's Land Sector and Removals Guidance.[70] 'Nature-based solutions' or 'NbS' is a similar and connected term, intended to recognise the additional benefits of these methods towards climate adaptation, and their benefits to people and nature.[71] In recognition of these additional benefits, this report uses the term NbS.



Engineered methods include bioenergy with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), enhanced rock weathering (ERW), and biochar.69 Engineered removal methods are, by contrast to NbS, less established and currently deployed at smaller commercial scales.

The tables on the following pages provide further descriptions of NbS and engineered removals in turn.

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[69] https://www.stateofcdr.org/
[70] https://ghgprotocol.org/land-sector-and-removals-guidance
[71] https://doi.org/10.1098/rstb.2019.0120

Table 10. Descriptions of key nature-based removal methods

Category	Description
Peatland Projects	GHGs are emitted when the carbon that was previously sequestered in the peat soil is exposed to air, for example when land is drained. The benefits of peatland restoration projects are primarily due to avoiding the emissions that would otherwise continue to occur. Peatland restoration involves a variety of different techniques depending on the condition and current land use. It could include activities such as blocking and re-profiling drainage channels, re-profiling the land, clearing trees, managing grazing, and planting sphagnum moss as well as re-establishing other native vegetation on the blanket bog surface.[72] These are all aimed at managing the site hydrology, re-wetting the soil and preventing further erosion.
Woodland Projects	Woodland projects would involve identifying areas of low ecological or agricultural value, such as degraded pasture or bare land, that could support woodland creation. In this report, 'woodland projects' are assumed to encompass tree planting on a variety of scales, including small clusters of trees. Another approach would be enhancing existing woodland through natural forest management. This could involve diversifying tree species to improve ecological resilience, introducing native species to support biodiversity, and managing forest structure to optimise carbon sequestration.
Agro-forestry	Agroforestry would involve integrating trees into existing cropland and grazing systems, using designs such as alley cropping or scattered tree planting. Native and climate-resilient species should be selected to aid effective growth of trees in the landscape and which avoid competition with crops. Implementation requires careful planning of tree spacing, species mix, and maintenance schedules to ensure compatibility with agricultural productivity. These practices help to increase the carbon sequestration potential of farmland, alongside providing potential benefits such as improved soil fertility and promoting pollination.
Grassland Projects	Projects involving restoring degraded grasslands would improve soil health and vegetation cover to enhance carbon storage and ecosystem services. This could be achieved by reseeding native grasses in appropriate degraded land, and reducing overgrazing through rotational grazing systems. Restoration efforts should be tailored to local conditions, with baseline assessments of soil carbon and biodiversity guiding interventions. The rate of carbon sequestration by grassland varies depending on how the grassland is managed, e.g. whether it is periodically ploughed and reseeded or left as permanent pasture. Note that some grassland is periodically ploughed and reseeded which would result in periods of net emissions followed by net sequestration (therefore variable and non-permanent carbon storage).
Coastal Projects	Coastal restoration projects include saltmarsh, sand dune and mudflat restorations. These act as a carbon store, helping to mitigate climate change through carbon sequestration whilst simultaneously improving climate change adaptation by potentially helping to manage flood and erosion risk. Along with marine projects (see below), these are sometimes referred to as 'blue carbon' projects due to their association with watery environments. Saltmarsh restoration can involve allowing saltmarshes to form, alongside promoting management practices such as low-density grazing. Saltmarsh restoration can involve instances where new sea defences inland from the coast

[72] https://cairngormsconnect.org.uk/peatland-restoration

	were built and a new intertidal area was allowed to form seaward of the new defences, combined with low density grazing. There are limited examples of mudflat restoration projects, however these are likely to involve similar implementation procedures. Sand dune restoration is another key coastal restoration project that may be relevant to Orkney. There is limited implementation throughout the UK, however it can involve reconstruction of dune areas, followed by res-establishing a diverse range of native plants, providing carbon sequestration opportunities, improving coastal dune resilience and reducing erosion and flood risk.
Marine Projects	Marine ecosystem enhancement, restoration and creation projects include those involving kelp, seagrass, maerl beds, native oysters and brittlestar beds. These habitats, when healthy, can provide carbon sequestration benefits, often termed as blue carbon storage, as well as promoting ocean ecosystem biodiversity and flood protection. There is limited research, funding and implementation of marine NbS throughout the UK, making their effectiveness difficult to quantify and implementation of projects more complex. Kelp and seagrass restoration projects are currently gaining traction. Projects can also involve passive restoration methods that reduce pressures on habitats to enable natural ecosystem recovery e.g. by reducing nutrient enrichment from land run off or managing adverse impacts from fishing. These types of projects also tend to involve protecting areas from trawling and other seabed impacts, combined with facilitating natural ecosystem recovery and active restoration initiatives. Native oyster projects have the potential to provide large environmental benefits, however their potential to provide net carbon sequestration requires further research. Maerl and brittlestar bed restoration projects pose greater challenges, due to their specificity, low data availability and lack of implementation.
Fresh-water projects	Wetland projects are another potential option. These would focus on preserving existing wetland habitats and restoring degraded ones to improve water quality, support biodiversity, and sequester carbon. Restoration may involve rewetting drained land, and reintroducing native wetland vegetation. Hydrological assessments are essential to guide interventions, ensuring optimal and appropriate water flow and retention. Wetlands also offer co-benefits such as flood mitigation.
Sustainable agricultural practices	Conservation techniques within agriculture could be adopted to aid in reducing emissions and improve soil health. Practices include reduced tillage, cover cropping, and nutrient management. Planting and/or managing hedgerows within farms can also act as a carbon store; this overlaps with other project types above related to tree planting.

Table 11. Descriptions of key engineered removal methods

Category	Description
BECCS	BECCS is a term used to describe a range of processes through which biomass is converted by combustion, gasification, digestion or fermentation to produce electricity, heat, biofuels or hydrogen[73]. The resulting biogenic CO_2 released is captured and subsequently stored away from the atmosphere. BECCS requires biomass as an input, which could include dedicated energy crops such as

[73] https://www.gov.uk/government/publications/ability-of-bioenergy-with-carbon-capture-and-storage-beccs-to-generate-negative-emissions

	miscanthus, short rotation coppice willow (SRC) or residues from crops or waste wood.[74] The captured CO_2 is compressed and injected into geological storage in deep saline aquifers or depleted oil and gas fields.
DACCS	DACCS is a chemical process by which CO_2 is captured directly from the ambient air and subsequently compressed and injected into geological storage.[75] The chemicals used to capture the CO_2, known as sorbents and solvents, are regenerated using heat. DACCS is notably energy-intensive, so to achieve net negative emissions, low-carbon or renewable electricity is required, either through dedicated infrastructure or by grid connection.[76] High (around 900°C) or low temperature heat (100°C) may be required to regenerate the sorbent and solvent, releasing the CO_2 to storage. This may be supplied by natural gas or waste heat from neighbouring industrial processes depending on the design.[76] Geological storage then takes place in deep saline aquifers or depleted oil and gas fields.
ERW	Enhanced Rock Weathering (ERW) aims to increase the removal of CO_2 from the atmosphere by applying crushed rocks, rich in calcium and magnesium, to agricultural land.[77] As an input, it requires silicate fines, such as basalt or olivine, either directly mined and ground at a quarrying site, or sourced from quarrying fines, construction and demolition wastes. This is then spread on agricultural land. The crushed rocks react with the carbon dioxide dissolved in rainwater entering the soil. The resulting carbonates are transported by rainwater into rivers, then estuaries, and into the ocean, where the carbonates may remain stable for 1000s of years.
Biochar	Biochar is produced by partially combusting biomass in a low oxygen environment through a process known as pyrolysis, producing char, which is then added as a soil amendment to agricultural land.[78] As an input, it requires biomass, including dedicated energy crops such as miscanthus, or residues from crops or waste wood. Biochar can persist in soil over centuries, storing the carbon in the biomass away from the atmosphere.[79]

Different CDR methods offer different advantages in terms of permanence (i.e. how long the CO_2 is stored for), cost, and wider environmental co-benefits, as outlined below.

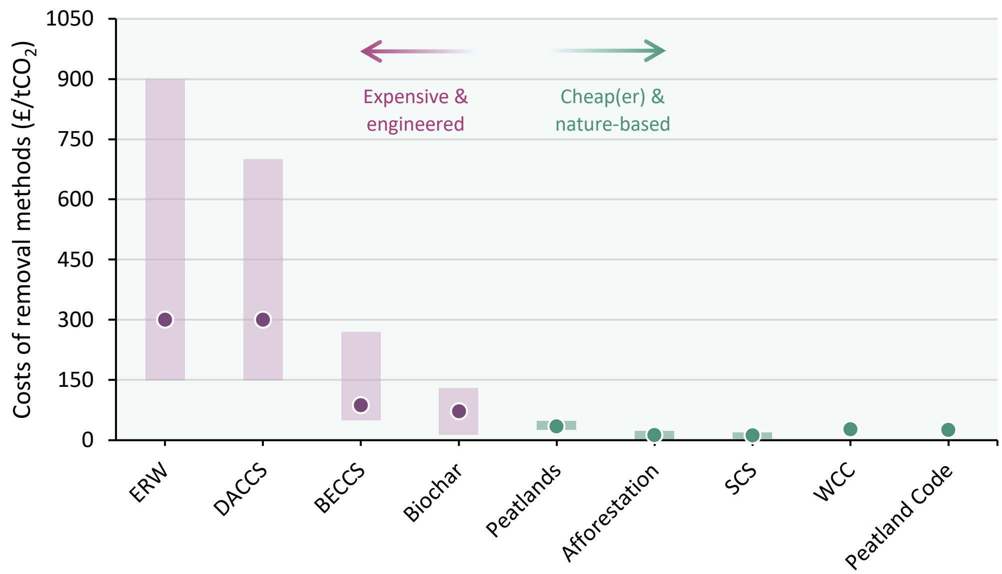
Cost: Owing to their more limited deployment[69,80] engineered methods are currently prohibitively expensive, with costs ranging between £70 to £900 t/CO_2 removed depending on the method.[81] This is notably more expensive compared to the credits certified under the Woodland Carbon Code (WCC), which, in recent years, ranges from £11 to £27 t/CO_2 (see **Figure 11**).[82] Engineered removals are therefore unlikely to be widely available or cost competitive until the mid-century, although modelling by the UK Government, Climate

[74] https://www.sciencedirect.com/science/article/pii/S0961953421002002
[75] https://www.theccc.org.uk/publication/assessing-the-feasibility-for-large-scale-daccs-deployment-in-the-uk/
[76] https://pubs.acs.org/doi/full/10.1021/acs.est.1c03263
[77] https://post.parliament.uk/research-briefings/post-pn-0726/
[78] https://www.nature.com/articles/s43247-025-02228-x
[79] https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.70092
[80] https://www.woodlandcarboncode.org.uk/statistics
[81] https://www.gov.uk/government/publications/greenhouse-gas-removal-methods-technology-assessment-report
[82] https://www.woodlandcarboncode.org.uk/uk-carbon-prices

Change Committee and National Energy System Operator all suggest that engineered removals could rival the scale of the land sector in the UK by then.[182]

Note that the cost of these projects may be higher in Orkney. For example, with peatland restoration projects, there is currently less contractor experience, and machinery may need to be shipped to the islands to carry out the work, which can add to the expense and complexity.

Figure 11. Projected costs in 2030 for a range of both NbS and engineered CDR methods



Note: WCC and Peatland Code prices reflect 2024 volume weighted averages for pending issuance units while other peatland and afforestation projects are based on modelled values from literature.

Permanence: Carbon stored through NbS can be long-lasting, but its permanence depends on ecological stability and long-term management commitment. Events such as wildfires, storms, droughts, or disease can disrupt woodland and peatland, and result in carbon being re-released to the atmosphere. Compared to NbS, engineered CDR methods are potentially more permanent in the means of carbon storage. For example, it has been estimated that the injection of CO_2 into geological storage could sufficiently store CO_2, with minimal leakage, for over 10,000 years in the right conditions.[83] Greater permanence mirrors the longer residence time of CO_2 in the atmosphere.[84] Engineered removal methods, therefore, when used to compensate for ongoing residual emissions, are considered a more ‘durable’ net zero claim.[85]

Environmental co-benefits: NbS offer a range of wider co-benefits beyond climate mitigation, including benefits to biodiversity and flood risk, along with recreational and

[83] https://www.nature.com/articles/s41467-018-04423-1
[84] https://www.gov.uk/government/publications/monitoring-reporting-and-verification-of-ggrs-task-and-finish-group-report
[85] https://www.nature.com/articles/s43247-024-01808-7

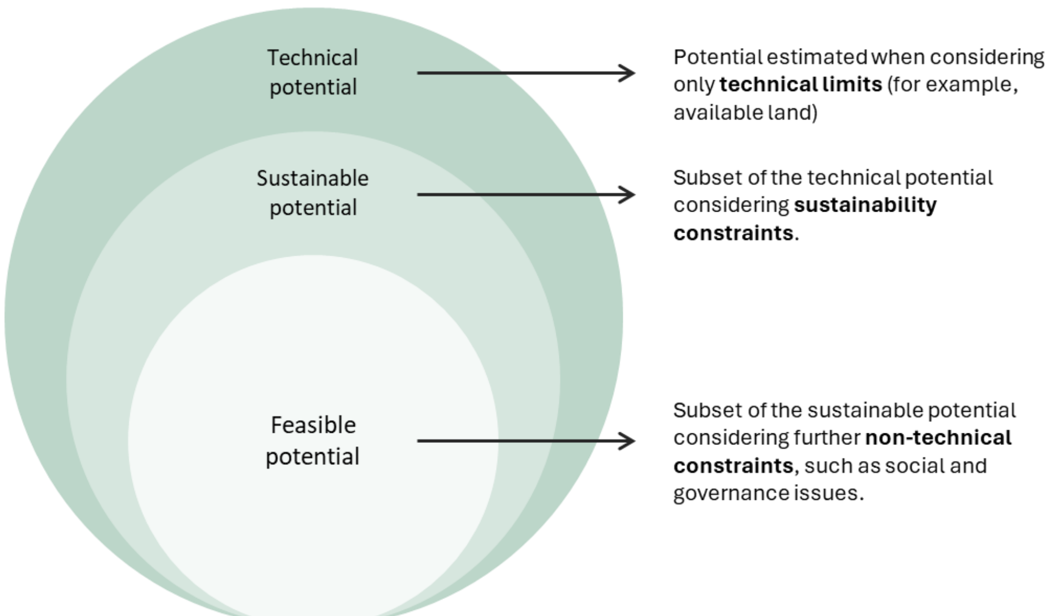
amenity benefits towards human health and wellbeing. By contrast, engineered removals tend to have more limited environmental co-benefits.[86] On the other hand, NbS may have more of an impact in other respects (e.g. land use and visual impacts) if they have a larger physical footprint, requiring more land, compared to engineered solutions.

5.2 Assessment of project opportunities in Orkney

5.2.1 Overview

A high-level assessment of the technical potential for different CDR projects within Orkney has been undertaken as part of this study. The results can be used by OIC to understand how the scale of potential GHG reductions from these projects might compare to the council's residual emissions, and therefore make decisions about which to focus on as a means of offsetting/insetting. However, it is important to note that project-specific feasibility studies, including site surveys and soil sampling (where relevant) would be required before any initiatives are taken forward.

Figure 12. Potentials by class. Source: Redrawn from Grant et al. (2021), see Footnote 87



To assess opportunities, the first step was to conduct a literature review of past studies and publicly available evidence of the suitability of Orkney towards NbS and engineered CDR. Next, a set of project assessment criteria (referred to as the 'assessment schema') was developed based upon the literature review, the principles of the draft offsetting guidance from the Scottish Government (introduced in **Section 5.1)** and local planning policies. The assessment schema is presented below and further details on how it was developed are provided in **Appendix N**.

86 https://doi.org/10.1038/s43247-024-01365-z
87 https://www.sciencedirect.com/science/article/pii/S2542435121004323

Table 12: Assessment schema used to evaluate CDR methods

Heading	Criterion	Description
Scale of potential	Technical potential	Potential estimated when considering only technical limits (for example, available land)
	Sustainable potential*	Subset of the technical potential considering sustainability constraints.
	Feasible potential*	Subset of the sustainable potential considering further non-technical constraints, such as social and governance issues.
Costs	Marginal cost	The cost per tonne removed in £/tCO_2.
Environmental impacts	Biodiversity	The likely impact of the method, positive or negative, on Orkney's biodiversity. This will consider the scale implied in the calculation of the potential.
Permanence	Durability	The durability of storage over a specified period considering the risk of full or partial reversal.
Social context	Heritage and landscape	The likely impact of the method on the wider areas character and cultural heritage assets.
	Public perception	The perceived public support for the method.
Policy support	Available funding and support in policy	The availability of grants or incentives to establish projects.

* Note, this study focuses on technical potential.

The approach to estimating technical potential can be summarised as follows:

- For **NbS**, the broad approach was to estimate annual CO_2 removal or avoidance rates, typically expressed as an annual rate (tCO_2e/ha), and the potential land area (ha) in Orkney that might be suitable for each type of project. These were multiplied together to produce a preliminary quantitative estimate of the annual scale of potential carbon removals for different project types. More information is provided in **Appendix L.**
- **Engineered CDR** projects, unlike NbS, involve a variety of inputs, processes, and outputs that may occur in different locations. They require inputs in terms of energy and materials in order to deliver a net negative emission, which can then be procured as a removal credit.[88] Similarly, to enable permanent storage, engineered methods are typically paired with geological storage – subsurface injection into either deep saline aquifers or depleted oil and gas fields.[89] Engineered removal methods were therefore assessed across the whole supply chain, from input to storage, in order to be credited. OIC could potentially play a role in supporting different parts of each supply chain for a given project type. Because of that, and because engineered CDR methods are at an earlier stage of deployment, the results of this assessment are primarily qualitative towards these methods. More information is provided in **Appendix M**.

88 https://www.cell.com/one-earth/fulltext/S2590-3322(24)00422-6
89 https://royalsociety.org/news-resources/projects/low-carbon-energy-programme/geological-carbon-storage/

5.2.2 Assessment results

Evaluation against assessment schema

The following matrix evaluates the options for CDR methods across Orkney as a whole (not just on OIC-owned land or assets). Each project type was ranked against each criterion using a traffic-light colour scheme:

- Red: Negative impact, low potential or major barrier to implementation
- Orange: Moderate impact or mixed feasibility, requiring further investigation or technological/supply chain development
- Green: Positive impact or strong feasibility, supportive of implementation

All ratings assume environmentally appropriate land is chosen for project implementation, accounting for conservation of existing important species and habitats.

Project type	Potential	Cost	Environ-mental impacts	Permanence	Social feasibility	Policy
Nature-based solutions						
Peatland restoration	Green	Orange	Green	Orange	Orange	Green
Woodland creation*	Orange	Orange	Green *	Orange	Red	Green
Agroforestry	Orange	Orange	Green	Orange	Red	Green
Sust. agri. practices	Green	Orange	Green	Orange	Orange	Green
Marine Restoration	Orange	Red	Green	Orange	Red	Green
Grassland restoration	Orange	Orange	Green	Orange	Orange	Green
Engineered removals						
ERW	Red	Red	Green	Orange	Orange	Orange
BECCS	Red	Red	Orange	Green	Orange	Orange
Biochar	Red	Orange	Green	Orange	Orange	Orange
DACCS	Orange	Red	Orange	Green	Orange	Orange

**This should be understood to include small and/or dispersed clusters of trees being established, not just large-scale woodland creation.*

For more detailed descriptions of the rationale for each ranking, refer to **Appendix O**.

Potential GHG impacts

The table below summarises the technical potential for CDR projects in Orkney in terms of GHG impact, measured in $ktCO_2e$/year.

When interpreting the figures below, it is important to note the difference between technical potential, which represents the theoretical maximum, versus the sustainable or feasible potential. A detailed assessment of the sustainable or feasible potential would require additional stakeholder consultation and investigation beyond the scope of this work.

Table 13. Estimates of technical potential for projects across Orkney; see notes for context

Project type	Technical potential $ktCO_2$/year	Notes
Peatland restoration on peat soil without existing peat habitat (not including class 4 soils)	7 – 198	The lower range value represents the sequestration possible per year if peatland rewetting and restoration was applied across suitable soils (not including class 4), excluding grasslands and built areas, alongside the lowest value for the sequestration per hectare per year. Whereas the upper range value includes that for grasslands and built areas, and the upper value for sequestration per hectare per year.
Peatland restoration on class 4 soils without existing peat habitat	14 – 600	The lower range and upper range value are represented in the same way as in the row above. Class 4 soils have been separated out as although they are not confirmed peaty soils, peatland restoration may still be applicable.
Condition improvement on existing peat habitat	14 – 285	The lower and upper ranges have been calculated from the lower and upper ranges for peatland sequestration per hectare per year respectively, assuming condition improvement on all pre-existing peatland is conducted.
Woodland creation	2 – 124	The lower range represents an estimate that $9km^2$ of low value agricultural land is converted to woodland, with the upper range representing the potential based on estimates of land suitability for forestry across Orkney. The theoretical potential may be higher, however it is constrained by relevant economic/social/environmental factors.
Sustainable agricultural practices	0 – 250+	A large range is present due to sequestration potential being based on the uptake of different options for sustainable agricultural practices. The lower range value represents the uptake of only 1 option with the lowest sequestration potentials, whereas the upper range value represents the uptake of all sustainable agricultural practices.
Hedgerows	25-68	These values are based on the assumption that 5% of agricultural land is dedicated to hedgerows.

Agroforestry	2 – 55	Sequestration values vary based on the agroforestry methods that are used.
Seagrass bed creation	70 – 90	There is low confidence in this estimate due to the lack of quantifiable data available for estimating the area possible for seagrass bed creation surrounding Orkney.
Kelp bed creation	0 – 65	There is low confidence in this estimate due to a lack of data availability on the long term sequestration potential of kelp beds.
Maerl bed creation	N/A	Lack of data available on suitable habitat areas to provide an estimate for creation initiatives. See **Appendix L** for more information.
Native oysters	N/A	An effective habitat restoration option in terms of environmental benefits, however there are uncertainties as to whether these provide net carbon sequestration. See **Appendix L** for more information.
Coastal habitat creation	N/A	Lack of data availability on suitable coastal land in Orkney to provide an estimate for restoration. See **Appendix L** for more information.
Grassland conservation	0 – 110	The upper and lower range values are dependent on the level of grassland conservation management that is appropriate based on pre-existing grassland conditions. There is therefore a large range due to the lack of data available on grassland habitat quality across Orkney. Note that information provided by stakeholders during interviews (see **Appendix S**) suggested a view that grasslands are likely to be close to equilibrium with relatively low opportunity for additional sequestration.
Conversion of arable land to grassland	0.1 – 0.5	This is based on the assumption that 18% of arable land is dedicated to grassland conversion, as discussed further in **Appendix L**, Table 31. Note there is a risk that the net GHG benefit is reduced if this would result in lower locally produced food having to be made up for with imports.
BECCS	N/a	Excluded on the basis that there is limited biomass in Orkney; there will be competition for sustainable biomass from other sectors, and it would not make sense to import to the islands.
Biochar	N/a	
ERW	N/a	Excluded on the basis that silicate fines would need to be imported and it would make more sense to undertake ERW closer to the point of origin.
DACCS	10+ (See notes)	Theoretical potential in future, once technology is mature and if CO_2 can be transported to geological storage sites in North Sea, which would require repurposing or building new transmission pipes.

Limitations of this assessment

The estimates presented above are derived solely from a desk-based assessment. They are intended to give OIC a broad understanding of the potential scale of carbon removal possible and also which types of projects may be suitable in the Orkney context and the key characteristics of each option. These results should therefore be viewed as indicative only, and used to guide decisions about which project types merit more detailed investigation in future. Any project that OIC chooses to pursue may require a dedicated feasibility study – including technical assessment, cost-benefit analysis, and evaluation of risks and dependencies – before a decision to proceed could be taken. This is particularly true of large-scale projects. There are however, likely to be a number of smaller scale projects which may be possible to investigate and progress in the near term and to gain experience in project implementation.

For NbS, refining the estimates of available land area and the likely carbon sequestration or avoidance rates across Orkney as a whole would require more granular feasibility work. This would include site-specific assessments such as field surveys, soil sampling, and evaluation of existing land uses and constraints.

For engineered carbon removal options, the level of uncertainty is higher. Several of these technologies are still emerging and are not widely deployed, meaning that information on achievable carbon removal rates, energy and material requirements, operational constraints, and local applicability remains limited. As a result, any future assessment would need to draw on updated evidence as the technologies mature and more real-world performance data becomes available.

5.2.3 Carbon credits

Aside from local CDR project opportunities (described above), another option for OIC would be to engage with formal carbon credit schemes such as the Woodland Carbon Code (WCC) or Peatland Code (PC). If OIC wishes to consider this option, the council should refer to relevant Scottish Government guidance on offsetting / insetting projects. The draft guidance[90] published in 2025 contains several points of advice that are particularly relevant to this study, which are presented below, alongside Aether's commentary on the potential implications.

Relevant extract	Implications for OIC
"Public bodies with landholdings should maximise opportunities for nature based insetting projects on their own land. Investment in insetting projects should be prioritised ahead of the purchase of carbon offsets." (p. 1)	OIC should **pursue NbS projects on its own land (carbon insetting) as a first preference**, in preference to purchasing carbon offsets.
"Key to reporting insetting activities is the need to have an organisational inventory of land-based emissions and carbon capture. If carbon	**If OIC wishes to carry out NbS projects on its own land and claim the carbon benefits, then if following the guidance it must *also***

[90] https://www.gov.scot/publications/climate-change-duties-draft-statutory-guidance-public-bodies-consultation/pages/0/

reductions are to be reported and the benefit claimed, such as through woodland creation, other land-based emissions must also be included, such as losses from change of land use or from degraded peatland." (p. 4)	**assess and report other emission sources from its landholdings.** There would otherwise arguably be a loophole in the guidance, whereby organisations could omit land use emissions from their inventory, but claim the carbon benefits of reducing land use emissions. The guidance indicates that is acceptable for this reporting to be phased in.
"Carbon reductions from insetting projects should be externally verified. Bodies may choose to verify carbon reductions through one of the Scottish Government supported carbon codes; however there is no requirement to do so, assuming that any carbon reductions are intended for internal use. Carbon credits intended for sale should be verified through one of the codes." (p. 4)	**OIC is not required to verify projects under a supported carbon code, but it is recommended that the council should do so, particularly for larger projects.**
"Public bodies may sell or otherwise allocate carbon from insetting projects, surplus to their own operational requirements, to other organisations, either other public bodies or private investors/end-users of the credits." (p. 5)	Although OIC is not required to verify NbS projects under a recognised carbon code, doing so would offer OIC the option to sell the carbon credits in future. As noted elsewhere, the cost of carbon credits is expected to increase, so this would potentially provide a financial benefit to the council. To retain that option, **it is recommended that projects should be verified under the WCC or other relevant codes.**
"Public bodies with coastal holdings should also consider blue carbon: the carbon captured and stored in marine and coastal ecosystems. With their ability to sequester and store carbon, to provide natural coastal protection, and to support complex biodiverse ecosystems, such habitats offer a small but important role in climate change mitigation, adaptation and resilience." (p. 2)	Although it is difficult to quantify the potential scale of GHG impact, **OIC should seek to protect blue carbon habitats and pursue blue carbon projects where possible** as the Scottish Government has recognised the wider environmental benefits these can provide.

Because the Scottish Government endorses the use of the WCC and PC, and for the other reasons outlined above, it is recommended that OIC validate and verify projects to the relevant codes. It is important to note that the draft guidance and other carbon reporting requirements may change over time. Such changes could influence the volume of carbon credits that OIC is able to claim or sell from a given project, as well as the processes required to do so. Nevertheless, using these recognised codes provides the council with greater flexibility and more routes to gain formal recognition for any NbS projects it invests in.

5.3 Recommendations regarding offsetting / insetting project options

5.3.1 What is the role of NbS?

Nature-based solutions (NbS) are important as part of a holistic response to the climate and biodiversity emergency. NbS offer a range of wider benefits beyond climate, including benefits to biodiversity, soils, and flood risk, along with recreational and amenity benefits towards human health and wellbeing. NbS can be effective mechanisms for carbon sequestration and combine benefits such as providing climate adaptation. Although their carbon removal potential is modest compared with OIC's annual emissions, NbS remain an important complementary measure that can make a contribution and be undertaken alongside direct GHG reduction projects.

OIC can deliver NbS on its own land and encourage other local landowners to do the same. Mapping suggests tree planting and hedges or small woods / shelter belts are the primary opportunities on Council-owned sites, while peatland restoration is particularly relevant for major landholders such as the RSPB. Additional options across Orkney include further peatland restoration and potential "blue carbon" projects in the marine environment, though the GHG impact of the latter is less certain.

Even small-scale NbS can deliver meaningful environmental and social benefits. However, these projects alone (and within Orkney) cannot easily offset or inset OIC's full emissions. The Council should therefore pursue NbS for their wider co-benefits and contribution to overall mitigation, while recognising that achieving net zero will require substantial emissions reductions in advance of and beyond what NbS can offer.

There are formal accreditation schemes for woodland creation (the Woodland Carbon Code) and peatland restoration (the Peatland Code). The Scottish Government endorses the use of these codes, and it is recommended that OIC validate and verify projects to the relevant code; this is particularly important for large projects. This will help provide assurance of the GHG impact, as the codes are considered robust, and will also provide OIC with flexibility to determine whether it wishes to claim the carbon credits itself, or sell them to other entities.

When calculating GHG reduction benefits from peatland or woodland projects, note that the codes use standard calculator tools which do not necessarily reflect situation in Orkney. For example, the rates of tree growth, and therefore carbon sequestration, are expected to generally be lower due to the highly exposed maritime setting. Example site calculation carried out by OIC (see **Appendix L.5**) indicate that conditions may result in rates of carbon sequestration that are 20-30% lower on a per hectare basis compared to projects undertaken on the Scottish mainland. Although the situation will vary across locations, woodland projects can deliver a positive impact in terms of carbon sequestration and other NbS benefits.

The next steps for NbS would be for OIC to identify suitable sites on council-owned land, and undertake feasibility studies to assess their suitability. Although offsetting is often described as a 'last resort' that should only be undertaken once other direct GHG mitigation options have been exhausted, the reality is that many NbS take time to mature and deliver benefits. In the context of the UK and Scottish net zero targets, some NbS projects, especially peatland restoration, will need to be implemented regardless of whether OIC or other organisations initiate those projects and who claims the GHG benefits. The CCC's advice on the 7th Carbon Budget indicates that in a balanced net zero pathway, 'the proportion of UK peatlands in natural or rewetted conditions rise from 26% to 55%,' i.e. more than doubling. It further emphasises that, 'Most of this scale-up needs to take place this decade.'[91] Therefore, OIC should start planning and implementing peatland support and woodland projects in the short term, whilst also recognising that these must not be used a substitute for other mitigation measures.

OIC should note that draft guidance from the Scottish Government would require the council to report wider emissions and removals from its landholdings in order to be able to claim the carbon benefits from NbS insetting projects. This would add to the current annual GHG reporting requirements for the Council but can be phased in as information becomes available.

Key recommendations on NbS:

- Recognise that NbS projects can offer many wider environmental co-benefits
- Review available NbS high integrity carbon credit values, and potentially use these to develop a shadow carbon price as additional information within any financial evaluations of OIC decarbonisation projects
- Start pursuing NbS projects on the Council's landholdings as soon as possible and collaborate with key stakeholders to support appropriate NbS projects in Orkney
- Develop any OIC NbS projects in line with recognised carbon code methodologies and where appropriate have projects validated / verified under relevant carbon codes (at this time the two recognised codes are for peatland and woodland)
- Consider adding OIC land emissions and removals into the OIC GHG inventory, noting that this is likely to be required under SSN guidance if OIC wishes to claim carbon benefits from NbS on its own landholdings
- In relation to marine habitats and their role in NbS, continue to engage with key agencies, academic partners, stakeholders and developers, to protect and reduce pressures on blue carbon habitats and to enable their continuing contribution toward climate mitigation and adaptation

5.3.2 What is the role of engineered removals?

In regard to engineered removals, DACCS could present opportunities for Orkney in future. DACCS is not a mature technology, so this conclusion is primarily based on the observation that it is an energy-intensive process and that there is a large amount of renewable electricity available in the region which could be used to power it. However, even if the technology was mature, there would be a variety of obstacles to overcome to transport the CO_2 to geological storage sites, which would likely require repurposing or building new transmission pipes, and changes in current licensing arrangements for storage.

Engineered removals are unlikely to be widely available or cost competitive prior to 2030. Methods such as DACCS, BECCS and ERW are likely to remain more expensive than the carbon abatement costs for synthetic fuels and maritime electrification.

[91] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf

OIC should therefore revisit engineered removals as a means to compensate for ongoing residual emissions in future, e.g. in 2030, at which point there may be improvements in cost and/or supply.

Key recommendations on engineered removals:

- Continue to keep abreast of technological developments and pilot projects and engage with local energy stakeholders to understand future potential.
- Revisit the potential for engineered removals in the medium term (e.g. 2030)

5.3.3 Should OIC consider investing in carbon credits or projects outside Orkney?

Investing in carbon credits or offsetting projects outside of Orkney is not considered a reliable approach for delivering meaningful local benefits. Such purchases do not directly support the community or environment in Orkney and are therefore not fully aligned with current Scottish Government guidance on climate action and carbon management. There is also the potential for costs to increase in the future, making this option financially uncertain.

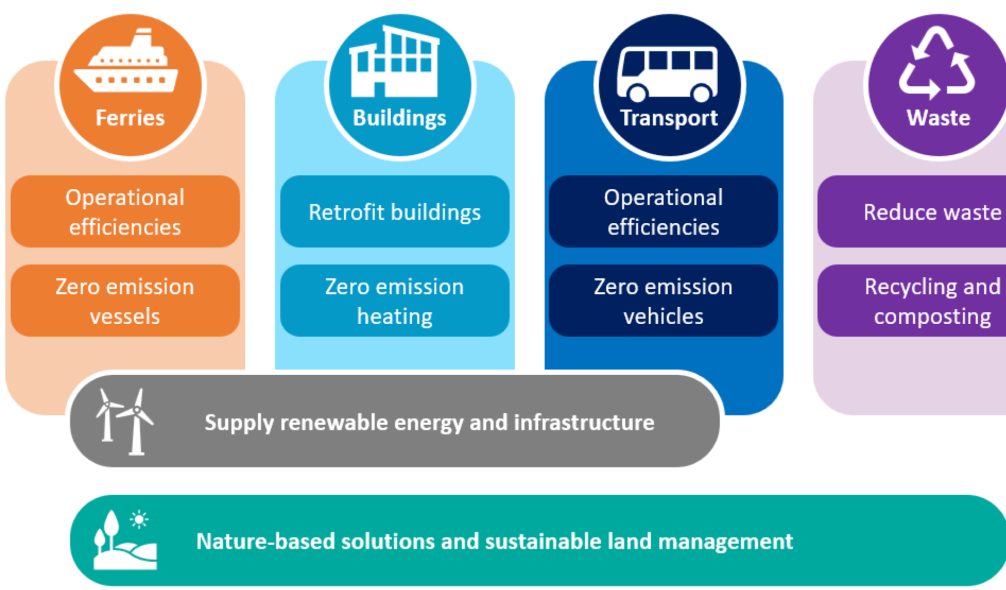
Overall, purchasing external carbon credits is not recommended, particularly if it would divert funding away from direct greenhouse gas reduction measures or offsetting / insetting projects that provide tangible benefits locally, such as nature-based solutions or community-scale decarbonisation initiatives. However, it is possible for OIC to collaborate with public sector partners in both Orkney and Scotland when it comes to carbon insetting projects on the wider public estate and this should be investigated. Scottish Government guidance does indicate that carbon credit purchases might be used in relation to certain specific emissions sources (such as business travel).

6 Conclusion

6.1 Overview: What would it take for OIC to reach net zero?

In order for OIC to mitigate all of its reported sources of GHG emissions this report identifies that :

- The use of fossil fuels would need to be entirely phased out in favour of zero emission alternatives.
- All buildings (including those operated by OIC, social housing and other tenanted properties) will likely switch to electric alternatives such as heat pumps, electric heating and cooking systems.
- All vehicles (fleet, buses, construction plant), aircraft and marine vessels would also need to be fully decarbonised, either using EV technologies, other fuels such as green hydrogen or sustainably-sourced HVO, or hybrid combinations.
- Technologies like heat pumps would need to switch to using refrigerants with a lower global warming potential, to reduce f-gas emissions.
- There would need to be a reduction in waste, with as much material as possible being reused, recycled or composted.
- Emissions from waste transport will also need to be mitigated by following the waste hierarchy, and through use of zero emission vehicles and vessels to transport any unavoidable waste. Emissions from waste that is sent to the incinerator in Shetland, though not included in OIC's inventory, would need to be mitigated through carbon capture and storage (CCS) technologies which would be the responsibility of Shetland Islands Council.
- Any residual emissions (e.g. from wastewater treatment or other Scope 3 emissions sources) would need to be offset, either via CCS or nature-based solutions.



In order to align with the national net zero target for Scotland, the above changes would need to be achieved by 2045 at the latest. This needs to be taken into account for any goods or services with a long lifespan (20+ years) that OIC is planning to purchase, lease or otherwise procure between now and then, to avoid the risk of technological lock-in and minimise the amount of offsetting that is needed.

Achieving these goals will require a transformational shift in the way that OIC operates, both in terms of strategic planning and day-to-day decision-making. This might include, for example:

- Considering specific service / departmental GHG reduction targets, with different areas of the council building these into their own delivery plans
- Re-assessing the way that budgets are set, ensuring that these reflect the cost uplift associated with decarbonisation initiatives and potentially budgeting for this at a Corporate level to enable different services to deliver solutions.

Ultimately, OIC is likely to have to offset some of its residual emissions, using a combination of nature-based solutions and, potentially, engineered removal technologies. The council will need to start planning for that possibility now, because many of the project opportunities will take time to plan, implement, and start delivering environmental benefits.

On the positive side, the unique characteristics of Orkney and OIC as a council mean that there are unique opportunities for GHG reductions that might not be feasible elsewhere. For example, Orkney has a large amount of renewable energy potential and there are a number of innovative technological trials underway for systems ranging from low carbon aviation, to hydrofoil ferries, to green hydrogen production. The council is in a good position to implement some of these solutions ahead of the curve.

6.2 Summary of key messages

OIC has a solid foundational understanding of GHG mitigation and has already implemented a number of GHG reduction projects. The council has also explored a wide range of further options for decarbonising its operational buildings, council housing, vehicle fleet, bus services, and marine services, improving the sustainability of its waste management systems and generating renewable electricity. If taken forward, those projects would put OIC on the right track to make major reductions in emissions using available technologies.

The Council Plan and Delivery Plan establish climate change as a high strategic priority, but the key next step is to ensure that it is fully embedded in both day-to-day decision making and particularly important in medium / longer-term planning. OIC officers demonstrate strong knowledge and support for GHG mitigation and the net zero agenda, and as detailed in Tasks 1 & 2, OIC already has robust systems for GHG data collection and reporting. However, major challenges include limited funding, resources, and staff capacity, with competing priorities sometimes taking precedence over climate action. Further progress will require changes in institutional ways of working, budgeting and objective-setting, steered by political and executive leadership.

Most of OIC's quantified GHG emissions are associated with fossil fuels, which need to be phased out in order to reach net zero. This report has outlined a range of mitigation measures, but that is the core overarching theme. The transition to renewable energy needs to be supported by various demand reduction measures (behavioural, operational, energy efficiency, etc.) and will also require supporting infrastructure.

However, OIC cannot reach net zero based on available technologies, which will inherently limit the council's ability to meet this target. OIC would rely on some emerging technologies, such as zero emission ferries and planes, and carbon capture and storage (CCS), to address its residual emissions. The timescales for those technologies becoming available are not certain. In the interest of transparency, OIC will need to acknowledge this challenge when reviewing and setting targets.

Another key risk is technological 'lock in' due to ongoing procurement and replacement/upgrade work. This includes purchasing new fossil fuel-based heating, vehicles and marine vessels. Unless OIC intends to replace these again before 2045 (or an alternative net zero target date), the council will not be able to decarbonise those sources of emissions by then. OIC will therefore need to review its existing capital, operational and maintenance plans to identify opportunities to reduce lock-in risks. OIC should also plan for the eventuality that some significant sources of emissions are likely to remain by 2045.

The overall GHG reduction that can be achieved, based on currently available solutions and mature technologies that could theoretically be implemented in the short term, is estimated to be between approximately 50-60%. This assumes full decarbonisation of buildings, buses, vans and staff commuting or business travel by car. With partial electrification or hybridisation of ferries and aviation, the reduction could be higher, around 65%.[92]

This suggests that, to reach net zero, OIC would potentially need additionally to offset thousands of tonnes of CO_2e per year (until services are fully decarbonised). It is unclear how such offsetting could be funded. Moreover, if doing so diverted funds away from direct GHG reduction, offsetting would not be recommended as a solution. However, the potential cost of future offsetting does offer an opportunity for the Council to include a carbon price into decarbonisation projects, which may improve the financial case for near term mitigation measures.

OIC may choose to extend its net zero target from the current 2030 ambition to a later year (e.g. 2045, in line with the Scottish Government) in recognition of the fundamental technological and practical barriers that it faces when it comes to decarbonising some of its activities. However, whether or not it changes the target year for reaching net zero overall, the Council should aim to achieve the most ambitious future GHG scenario.

OIC should also seek to accelerate GHG reductions for sources of emissions that *can* be addressed using existing solutions. From a climate science standpoint, it is the pace of emissions reduction and the cumulative emissions over time, not just the annual emissions in a future target year, that are important for mitigating the impacts of climate change. OIC should therefore also focus on front-loading GHG savings that can be achieved using existing technologies. The key ones would be measures relating to buildings and road vehicles. Aside from funding challenges, key issues to address would be:

[92] Indicative values based the BAU and Scenarios 1 and 2 pathway modelling.

- How to address more challenging buildings in the Council's estate, in switching to zero emission heating and renewable energy? In particular, this might require a re-evaluation of the right balance between fabric measures and heating replacements.
- How to ensure that future contract renewals (e.g. in public transport, vessels etc.) are framed towards zero emission technologies and avoid lock-in?
- How to ensure that there is enough EV charging infrastructure?
- How best to work towards improving electrical grid capacity and supplying, generating and using renewable electricity?
- How to trial and test new technologies and approaches?

It is recommended that OIC consider adopting GHG reduction targets that differentiate by the source or scope of emissions, rather than rely on a single overarching 'net zero by X year' target. OIC should consider focusing less on the headline GHG reductions and more on the question, 'Is the Council doing the best it practically can to address each source of emissions?' This approach would allow OIC to retain high levels of ambition, but better responds to the mitigation measures that can be adopted. This approach is in line with the principle endorsed by the Council in 2023 to be transparent in addressing the climate emergency and in setting both interim and longer-term targets.[93] Further reasons for this approach include:

- Firstly, the scope of OIC's GHG inventory is likely to change in future. The inclusion of additional scope 3 emissions such as the embodied carbon of OIC-funded road, infrastructure or housing projects could have a big impact on the total. This may require a re-appraisal of whether it is even possible to achieve net zero within that timeframe, and if there are any interim reduction targets, those percentages would need to be recalculated.
- Secondly, because 'net zero by X year' might not be achievable based on available technologies, it is (a) inherently less evidence-led and (b) risks obscuring positive progress that OIC could make in reducing emissions from sources like buildings and transport.

Other project types that are not critical to OIC's organisational decarbonisation pathway, but should still be pursued due to their contribution and wider benefits include, for example:

- **Investing in large-scale renewables** – this does not necessarily impact OIC's emissions as reported within its inventory but contributes towards the wider goal of a decarbonised energy system, and potentially offers cost savings and energy resilience to OIC and its tenants if directly connected to OIC's properties.
- **Peatland restoration and other nature-based solutions** – these projects can offer a range of benefits in terms of biodiversity, soil, air and water quality, and should be pursued on that basis, alongside their future carbon contribution.

Achieving these aims will require changes in the way that funding is allocated and budgets are set, supported by a clear steer from OIC leadership. Even though OIC officers express a high level of awareness of GHG mitigation, anecdotal evidence from the workshop suggests that it is not considered high on the list of day to day priorities, suggesting the need for

[93] https://www.orkney.gov.uk/media/akqorobh/item-24-climate-change-strategy.pdf

clearer political and executive leadership on this issue. Because of the high costs of reaching net zero, it will clearly not be possible without a major strategic re-assessment. In doing this, OIC needs to consider its obligations, public commitments, and the wider cost of societal inaction.

It is likely that OIC will not be able to fully mitigate all sources of GHG emissions, so some form of offsetting or insetting would be required to meet the net zero target. Key opportunities include nature-based solutions (NbS) and engineered removals.

- **OIC should start pursuing NbS projects on the Council's landholdings as soon as possible**, and develop these in line with recognised carbon code methodologies where relevant. Nature-based solutions (NbS) are important as part of a holistic response to the climate and biodiversity emergency. NbS offer a range of wider benefits beyond climate, including benefits to biodiversity, soils, and flood risk, along with recreational and amenity benefits towards human health and wellbeing. These projects can be undertaken on OIC landholdings, elsewhere in Orkney, or in the wider Scottish public estate. This analysis has identified that tree planting and hedges or small woods / shelter belts are the primary opportunities on Council-owned sites, while peatland restoration is particularly relevant for other major landholders in Orkney such as the RSPB. Even small-scale NbS can deliver meaningful environmental and social benefits; however, it takes time to develop these projects, so OIC should now start planning for these well in advance of a net zero target date.
- **Engineered removals are unlikely to be widely available or cost competitive prior to 2030.** Methods such as DACCS, BECCS and ERW are likely to remain more expensive than the carbon abatement costs for synthetic fuels and maritime electrification. OIC should therefore revisit engineered removals as a means to compensate for ongoing residual emissions in future, e.g. in 2030, at which point there may be improvements in cost and/or supply. The key opportunity that may be relevant to Orkney is DACCS, due to the availability of renewable energy and proximity to geological storage sites. It would be appropriate to keep abreast of developments and opportunities in this developing sector.

Investing in carbon credits or offsetting projects outside of Orkney and Scotland is not recommended, particularly if it would divert funding away from direct GHG reductions. Such purchases do not directly support the community or environment in Orkney and are therefore not fully aligned with current Scottish Government guidance on climate action and carbon management. There is also the potential for costs to increase in the future.

OIC also should note that, where it makes investments with a lifespan of 20 years or more (for example, oil-fired boilers), there is a risk that some or all of the associated GHG emissions could be subject to future mitigation or offsetting requirements as Scotland progresses towards its statutory net zero target. Accordingly, while certain fossil fuel technologies may appear lower-cost in the short term, over their operational lifetime they may give rise to additional costs associated with emissions mitigation or offsetting. In this context, **OIC should consider reviewing current market values for high-integrity nature-based solutions (NbS) carbon credits and using these, on a shadow-pricing basis, as an additional input to the financial appraisal of decarbonisation options.**

Reaching net zero will require a high level of ambition and significant changes in the way that the council makes strategic decisions and operates day-to-day. On the positive side, the unique characteristics of Orkney and OIC as a council mean that there are unique opportunities for GHG reductions that might not be feasible elsewhere. For example, Orkney has a large amount of renewable energy potential and there are a number of innovative technological trials underway for systems ranging from low carbon aviation, to hydrofoil ferries, to green hydrogen production. The council is in a good position to implement some of these solutions ahead of the curve.

At the same time, there is a bigger picture to consider: Climate change itself, along with the transition to net zero, will not only affect OIC's services, but have wider social and economic impacts on Orkney as a whole. For example, more frequent extreme weather events exacerbate flooding issues, which affect OIC's assets (e.g. damage to buildings, vehicles and infrastructure) and operations (e.g. due to increased demands on public services combined with operational disruptions). **Going forward, it is advised that OIC adopt a twin track of GHG mitigation and adaptation planning. This will give the best chance of minimising the impacts and delivering the greatest benefits for the community.**

6.3 Priority mitigation measures and actions

A summary of key interventions is provided below (see Section 4.2 for further information).

Description	Timescales
Decarbonising marine services, including ferries, harbour craft and tugs	
Continue to demonstrate leadership in this field by engaging with opportunities to trial and phase in new/innovative low carbon technologies and solutions.	Ongoing; continue until GHG reduction targets are achieved.
Implement the reporting, operational and energy efficiency measures that have been identified through the separate project examining decarbonisation of OIC's marine services	Develop and implement these as soon as practical to track progress and to achieve near-term GHG reductions. Aim for short to medium term (within 5 years).
Ensure that any new vessels use the lowest carbon technology that is practical to procure and/or includes provision for the vessels to be easily retrofitted.	Top priority. Needs to be addressed within procurement / ongoing discussions about ferry replacement.
Keep informed of new technological developments, taking lessons from electric hydrofoil trials as relevant, and initiate longer-term planning for how climate change and the net zero transition might impact the marine services, so that this can be factored into investment decisions.	Integrate findings of this study, the Coastal Adaptation Plan and other relevant work into planning, ideally in the short term. Keep informed of ongoing developments until GHG reduction targets are achieved.
Decarbonising buildings, including OIC-operated and tenanted properties	
Implement the works set out in the CMP, also re-assessing whether lower cost options are available with different combinations of 'fabric first' measures and renewable/ZDEH technologies. With the CMP expiring in 2026, ensure that measures are reflected in any future equivalent documents.	Seek to implement these as soon as practical to achieve near-term GHG reductions.

Progress and implement LHEES Delivery Plan.	As per LHEES Delivery Plan.
For tenanted properties which are already electrically heated, a top priority will be to continue to upgrade social housing. This is less important from a GHG emissions standpoint but has important wider benefits on tenants' bills along with their comfort and welfare. Tenanted commercial properties should also be upgraded where costs allow, although again the primary benefit will be lower energy use and bills rather than GHG emissions reduction.	Social housing: Timescales are driven by EESH regulations; implement as and when practical, noting important social benefits Tenanted properties: These are comparatively less urgent due to electricity grid decarbonisation; implement as and when practical
When carrying out upgrades, evaluate whether there are also opportunities to install systems that will reduce f-gas emissions and decrease water demand.	To be done on an ongoing basis in the context of the capital works / maintenance programme.
Continue to engage with a range of innovations, partners and funding opportunities. Track developments and opportunities both locally and via wider innovations (e.g. regional developments such as ICNZ, heat developments and LHEES, fuel substitution potential with partners etc).	Ongoing; continue until GHG reduction targets are achieved.
Switching to an electric vehicle and bus fleet	
Continue with the transition to an EV fleet for light commercial vehicles.	Ongoing; continue until GHG reduction targets are achieved.
Ensure that the procurement of public transport services sets emission standards for vehicles that align with OIC's net zero target. This would require using zero emission technologies, or ones that can be retrofitted, for any vehicles that would be in use at or beyond the net zero target date.	Contract renewal expected in 2029; needs to be addressed before then.
Work to ensure the continuing roll-out, and maintenance, of EV charging infrastructure.	Ongoing; continue until GHG reduction targets are achieved. Needs to be front-loaded where possible, to support the wider EV transition.
Continue to investigate new developments relevant to vehicles such as HGVs and other construction plant, taking lessons from the electric bin lorry trial (and wider trials) as relevant. Could include interim opportunities such as fuel substitution (if sustainable sourcing is addressed).	Ongoing; continue until GHG reduction targets are achieved. In short term continue to explore and engage on innovations (e.g. trial opportunities)
Nature-based solutions and carbon offsetting / insetting	
Start pursuing NbS projects on the Council's landholdings as soon as possible. Develop any OIC NbS projects in line with recognised carbon code methodologies and where appropriate have projects validated / verified.	Review opportunities within 1 year and commence implementation as soon as possible
Review available NbS high integrity carbon credit values, and potentially use these to develop a shadow carbon price as additional information within any	Short term (within 1 year)

financial evaluations of mainstream decarbonisation projects (buildings, vehicles etc.)	
Continue to engage with key agencies, academic partners, stakeholders and developers, to protect and reduce pressures on blue carbon habitats	Ongoing; continue
Track developments and revisit the potential for engineered removals such as DACCS in future	Medium term (e.g. 2030)
Enabling Measures	
Ensure that the climate change agenda is championed by all Directors, with net zero transitions integrated into Directorate and service plans.	Initiate in the short term; continue in the long term.
Corporate leadership team to assess capacity and resourcing, in light of this report and also the new draft statutory guidance.	Short term.
Require services associated with the main emission sources to track progress and plan for decarbonisation within their own delivery plans. To include preparing for change (e.g. with internal support and external sectors, building capacity and investigating trials and project pipelines).	Initiate in the short term; continue in the long term.
Strategically re-assess the way budgets are set, ensuring these reflect and address the near-term cost uplift associated with some decarbonisation initiatives and do not leave a financial (offsetting) burden for the Council and communities in the coming decades.	Initiate in the short term; continue in the long term.
Bring forward enhanced policy and impact assessment approaches to support the transition. These can use a shadow carbon price and address key risks such as emissions lock-in and wider impacts such as lifecycle emissions associated with major projects. Integrate these into corporate procurement and capital programme.	Initiate in the short term; continue in the long term.

Appendix A List of tasks requested in the ITT

The following extract from the Invitation to Tender (ITT) provides an introduction to OIC's requirements for this study.

*"1.1 Orkney Islands Council ("the Authority") has a requirement for a specialist consultancy to undertake an **independent and fast track study** to identify indicative organisational transition pathways towards net-zero. **Achieving net zero is a clear aim for the Authority** and the scale of this task requires **independent information to support future decision making and funding decisions** (directly but also potentially for supporting external funding applications that can test and support elements of the Authority's transition)."*

The ITT requested that the work be carried out in two stages, split into a total of six tasks. The following table sets out how the contents of this report relate to the requested tasks. For more information, please refer to the ITT.

Task number	Task description	Section of report
Task 1	Review Proposed Inventory Scope	Appendix B (see in particular Appendix B.4)
Task 2	Review and Confirm Baseline Emissions	The review is presented in Appendix B (see in particular Appendix B.5) and results are presented in Section 2
Task 3	Develop BAU for Baseline Emissions	Section 3 (see in particular Section 3.3)
Task 4	Develop Transition Pathways	The pathways are described in Section 3 (see in particular Sections 3.4 and 3.5) and priority interventions are described in Section 4
Task 5	Neutralise/Compensate for Residual Emissions	Section 5
Task 5 (extension)	Additional Research to Support Task 5	Appendix S
Task 6	Final Report	This report presents consolidated outputs from all tasks as described above

Appendix B Review of proposed scope and confirmation of baseline emissions for Orkney Islands Council

Note: The information below was prepared in winter 2024/25 and reflects available guidance at that time. Along with guidance developments, outcomes from this work were considered by OIC Policy and Resources Committee in November 2025 and initial amendments have been made to OIC's reported emissions scope.

B.1 Introduction

The services that the Orkney Islands Council provides, and the potential solutions that it could adopt to mitigate greenhouse gas (GHG) emissions, are almost unique among UK Local Authorities due to the island's remote nature which often demands additional infrastructure, resilience and forward-planning, alongside the need to optimise the use of existing assets. Hence, this project aims to provide a tailored evidence base, trajectory and transition scenarios and action options to inform future decision-making.

To support that aim, OIC commissioned Aether to undertake a review of OIC's baseline emissions, considering both the scope and data quality, informed by best practice principles of GHG accounting and national reporting requirements in Scotland. These activities are together referred to as **Tasks 1 and 2** within the original ITT.

- **Task 1** involved conducting an independent **review of the scope of OIC's GHG inventory** in line with guidance set out in the internationally-recognised GHG Protocol Corporate Reporting Standard and the related Scope 2 Standard and Scope 3 Emissions Reporting Standard.[94,95,96] Those documents underpin the guidance for the Scottish Public Bodies Climate Change Duties Annual Reporting co-ordinated by the SSN although there are some minor differences.

- **Task 2** was to review the data sources used to inform OIC's Carbon Management Plan (CMP) and Public Bodies Climate Change Duties Report (PBCCDR) to check for gaps and issues, and validate the assumptions made. This provides an **independent review of OIC's inventory**.

This work has identified a number of recommendations for improving the OIC GHG inventory. Some of those improvements have been incorporated into the GHG baseline data and pathways analysis presented in Sections 2 and 3 (see main body report), while others are for OIC to consider for subsequent years.

This Appendix sets out core principles of carbon accounting, before describing Aether's approach to undertaking the review, key findings, and recommendations for OIC's future GHG inventory compilation and reporting.

[94] https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf
[95] https://ghgprotocol.org/scope-2-guidance
[96] https://ghgprotocol.org/corporate-value-chain-scope-3-standard

B.2 Core principles of GHG accounting

In simple terms, a GHG inventory is produced by collecting data on OIC's activities ('activity data') and applying a relevant emission factor to convert this to GHG emissions. For example, calculating emissions from the use of electricity involves multiplying data on kilowatt-hours (kWh) of electricity used by the emission factor ($kgCO_2e/kWh$) for electricity, which will depend on the technology or type of fuel used to generate the electricity. The formula in that case would be:

$$\text{Electricity use (kWh)} \times \text{Emission factor } (kgCO_2e/kWh) = \text{Emissions } (kgCO_2e)$$

Where primary data are unavailable, it is acceptable to use alternative estimation methods, provided that the assumptions are clearly documented. In those instances, stakeholders should be made aware of the limitations of the chosen methodology, and where possible plans should be made for data collection improvements.

Estimating GHG emissions from an organisation's activities is inherently complex due to the different ownership and operational structures involved, and the need to collect data from a range of stakeholders both within OIC and along the supply chain. Inevitably there will be uncertainties and gaps in the data, and judgment will need to be applied to determine how to address those challenges. The GHG Protocol Corporate Standard sets out best practice principles for carbon accounting that act as a framework for doing this.

Relevance	Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of users – both internal and external to the company.
Completeness	Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.
Consistency	Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.
Transparency	Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.
Accuracy	Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Note: All definitions are taken from the GHG Protocol Corporate Standard.

B.3 What sources of emissions do Scottish Local Authorities need to report?

Guidance from the Sustainable Scotland Network (SSN) states that all relevant Scope 1 and 2 emissions[97] must be reported in the Public Bodies Climate Change Duties annual reporting.[98]

There is currently no mandatory list of Scope 3 emissions to be included, but SSN recommends that as a minimum, emissions from waste, water supply, water treatment and business travel should be reported.

Following an investigation by Environmental Standard Scotland (ESS) into how well Local Authorities are supported with their Public Bodies Climate Change Duties Reporting (PBCCDR), Scope 3 reporting requirements will change in the coming years.[99] In addressing this incoming requirement, Scope 3 emissions categories have been collated by ESS into three groups:

- Those that are more practical and feasible to report (Group 1: fuel and energy related activities not in scopes 1 or 2; waste generated in operations; business travel; employee commuting including homeworking);

- Those where more collaboration and resource will be required (Group 2: purchased goods and services; capital goods; upstream leased assets; downstream leased assets; investments); and

- Those that require further research (Group 3: downstream distribution and transportation; processing of sold products; use of sold products; end-of-life treatment of sold products; franchises).

It is anticipated that, in 2025, mandatory reporting of Group 1 will be taken forward as part of wider legislative amendments of an Amendment Order. A focus group will be established in spring 2025 to share best practices and create a standardised methodology for reporting Group 2 categories. In spring 2026, work will begin with local government partners to develop a training program for emissions reporting. Finally, in autumn 2025, independent researchers will be commissioned to evaluate the value for money of reporting Group 3 categories and develop data-gathering methods if needed.

Given these developments nationally, the above group 1+2 (indirect) emissions will need to be reported by OIC in future. At this stage, there is no requirement for these to be automatically included into LA targets. It would, however, be appropriate for OIC to prepare for these additions and to consider if these should also be included in the net zero targets.

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[97] Definitions are provided in Section 1.3 of the main body report

[98] https://sustainablescotlandnetwork.org/uploads/store/mediaupload/1879/file/PBDR%20Guidance%202022%20Final%20pdf.pdf

[99] https://www.gov.scot/publications/scottish-government-improvement-plan-response-environmental-standards-scotland-investigation-climate-change-delivery-improvement-report/pages/1/

B.4 Review of the proposed scope of the inventory

B.4.1 Methodology

To determine which activities should be included in the inventory, beyond the mandatory reporting requirements for Scope 1 and Scope 2 emissions outlined above, a materiality assessment can be undertaken to determine which sources of emissions are relevant and could feasibly be included in the inventory. This takes into account the likely scale of emissions, OIC's level of influence over the activity, and data availability. OIC commenced an assessment internally and provided Aether with a draft scoping document which Aether has reviewed and supplemented. The recommendations in this report build on the contents of that scoping document and complete this assessment.

B.4.2 Defining an organisational boundary

The organisational boundary determines which entities and assets are included in an organisation's GHG inventory. Within the GHG protocol guidance, there are three possible approaches that can be taken to defining organisational boundaries:

1. **Equity share approach** – Under this approach an organisation accounts for GHG emissions from operations according to its share of equity in the operation. For example, emissions from any asset the organisation owns partially or wholly would be included in scope 1 as direct emissions, whereas emissions from an asset owned by another organisation and leased by OIC would fall into scope 3.
2. **Financial control approach** – An organisation accounts for 100 percent of the GHG emissions over which it has financial control within its scope 1 and 2 emissions. The organisation has financial control over an operation if it can direct the operation with a view to gaining economic benefit. It does not account for GHG emissions from operations in which it owns an interest but cannot gain economic benefit although those can be reported within scope 3.
3. **Operational control approach** – An organisation accounts for 100 percent of the GHG emissions over which it has operational control within its scope 1 and 2 emissions. It does not account for GHG emissions from operations in which it owns an interest but does not have operational control although those can be reported within scope 3. For example, in this case, investments would fall into scope 3 as they are not controlled by the organisation but if the organisation is operating a facility it would generally be able to implement policies there and hence has operational control.

Under either the financial or operational control boundary it will be possible to report the same range of emissions overall, but there may be differences in whether emissions are classified as Scope 1, 2 or 3.

- *As an example, consider energy use associated with buildings that are owned by OIC and leased out, where OIC pays the bills but the tenant operates the building. Under a financial control approach, those emissions would be classed as Scope 1 or 2 because the Council exerts control via its spending power. Under an operational control approach, those emissions would be classed as Scope 3, reflecting that the Council only has indirect influence over operations.*

In choosing the boundary, consideration should be given to how the inventory data will be used to set and measure progress against targets, how it will be used to inform and evaluate policy, and whether sufficient data is available for the relevant sectors.

Following discussions with OIC officers and review of datasets in light of future emission reduction policy and action generation, **it is recommended that OIC takes an operational control approach to their GHG inventory**. This should allow the Scope 1 and 2 inventory classes to best represent the widest range of assets and operations that OIC has control over and hence is able to most directly reduce emissions from.

Under this approach, emissions from tenanted assets would be included in the inventory under Scope 3, thus allowing data to be used and collected to inform policy around the aspects of these assets where OIC does have some control – for example building retrofit – but also allowing more flexibility where data are not available.

B.4.3 Sources of emissions included in the inventory

Having proposed the organisational accounting approach, the next step in producing the inventory requires identifying direct and indirect emissions associated with OIC's operations. Here we have built on OIC's draft GHGI scoping document to produce recommendations. In addition to following the principles of the GHG protocol (see **Appendix B.2**), this activity has sought to:

- Include, as a minimum, all GHG sources that are within the existing Carbon Management Programme along with all sources that are within the annually reported disclosures by OIC for Public Bodies Climate Change Duties Reporting (the latter being more extensive).
- Address known gaps relative to the public bodies' requirement (for example water).
- Consider for inclusion other / indirect sources where OIC has strong control or influence, in line with the GHG Protocol Corporate Standard and other requirements in Scope 3 reporting.
- Also (as far as possible) to reflect developments underway by the Scottish Government in terms of forthcoming Scope 3 requirements and also the developing statutory Climate Change guidance for public bodies.

Suggested changes are listed in **Table 14** below. These assume that an operational control approach is taken. For brevity, we have not listed areas where the scope is expected to remain the same, such as vehicle fleet emissions.

Note: The information below was prepared in winter 2024/25 and reflects available guidance at that time.

Table 14: Recommended changes to Scope 1, 2 and 3 reporting for OIC

Source of emissions	Recommendation	Rationale
Scope 1 & 2 emissions:		
Emissions associated with electricity used at council provided EV charge points	This is currently included in OIC's Scope 2 as emissions from energy consumption in council owned property. If the data can be sufficiently disaggregated, it is recommended that OIC seek to differentiate between electricity used in buildings vs. vehicles. Electricity use in non-OIC vehicles should then be deducted from the OIC inventory calculation. A further example of information to be subtracted from total electricity consumption, is OIC's provision of electricity (cold ironing) to the MV Hamnavoe Northlink ferry, at its mooring in Stromness.	OIC is effectively serving the function of an energy retailer, selling EV charge to the public; it does not operate all of the vehicles that use the electricity.
Fugitive emissions of f-gases (refrigerants)	Currently f-gases are not recorded as a full inventory by OIC. Emissions from equipment leakage are collected via maintenance contracts. These are to be reported in the baseline year. This should be included in OIC's Scope 1. OIC should establish an inventory of equipment / installations where f-gases are used. It should establish / formalise monitoring and collecting of data. Note that the contribution from f-gases would be expected to increase in future due to a) increasingly formalised monitoring and b) further uptake of heat pumps and possibly air conditioning in coming decades. Note, these are generally only reported for equipment that require re-gassing (such as air conditioning) and not items such as domestic refrigerators.	These are direct emissions from OIC facilities and arguably should be included for the sake of completeness. It is acknowledged that this may be a small source of emissions and data may not be available, and therefore it may not be a high priority in terms of future improvements.

Source of emissions	Recommendation	Rationale
Scope 3 emissions:		
Energy consumption in selected Council owned tenanted buildings – excluding council housing	As far as data allows, all tenanted buildings including the farms should be included in the GHG inventory, for the sake of completeness.	A consistent approach is needed for including tenanted buildings in the inventory, whilst acknowledging data limitations. This approach would allow for the impacts of any OIC action to reduce emissions (e.g. via building upgrades) to be captured in Scope 3.
Renewables	For the purpose of PBCCD reporting, OIC should continue to follow SSN guidance on how to account for renewable energy generation. For other purposes, it is recommended that OIC follow GHG Protocol Scope 2 guidance on this topic. See Appendix D for further information.	This approach ensures that OIC's GHG inventory within the PBCCDR is consistent with the Scottish Government's requirements, while also ensuring that the current study is aligned with international standards.
Water consumption across Council Buildings (non-domestic properties)	Include in Scope 3 for all properties operated by OIC. Where data is available, OIC can optionally report on water consumption by tenants. Note, this refers to emissions from water supply and wastewater treatment. Emissions from water heating will be included with emissions from other heat supply (fossil fuels or electricity).	Data has been made available and SSN guidance recommends that emissions associated with water consumption and water treatment should be included in annual statutory reports as Scope 3 emissions.
Council housing	Include council housing emissions from electricity and heating supply in Scope 3. Consider also including emissions associated with water use (water supply and wastewater treatment) if possible.	If based on metered data, this would be useful as a way to track the impacts of policies implemented to improve housing, e.g. building retrofits and heating system replacements. If it is based on an estimate (as is currently the case) then the impacts of mitigation measures may or may not be captured. However, its inclusion is still recommended as a way of reminding decision-makers that they should take action on these emissions.

Source of emissions	Recommendation	Rationale
Marine services	Included as per existing OIC emission reporting but consider the situation regarding Scope 3 emissions / any developments. Where there are sources of emissions reported in the Orkney Island Harbours GHG Emissions Inventory that are not included in the OIC PBCCDR, then confirm with Marine Services team whether this will be included in public reporting by Marine Services in future years. It will be important for any reporting to be transparent and cross referenced with OIC reporting.	Since marine services are a major source of emissions, it is important to try to understand in more detail.
Transport services	Include school bus data into Scope 3 if further data becomes available.	Further refinement of transport emission source.
Waste	One recent addition by OIC within the PBCCDR has added a separate calculation of emissions from shipping waste to Shetland. Aether has checked the OIC approach used in 2022/23. The methodology for calculating emissions from waste transportation is acceptable but there are two points that merit attention: (a) The OIC PBCCDR inventory only includes an estimate for waste produced by OIC's own operations, which assumes that it is a set percentage of total area-wide waste. That estimate is now out of date. OIC should look to test the accuracy of this assumption and update it where possible. However, given that OIC has overall responsibility for waste collection in the islands, it could report the emissions from all waste collection and management for which it has responsibility within its own Scope 3. The key point is that any future action plan should to consider opportunities to reduce OIC's own operational waste, and reduce emissions from waste management processes that OIC is responsible for. (b) The Shetland Islands Council (SIC) PBCCDR for 2022/23 says that the reported waste emissions include "Total waste into ERP incl. Orkney, Mainland Scotland (RDF), all waste from Shetland" which means that these emissions may be double-counted when SSN aggregates the GHG emissions estimates	Waste is a minimum requirement for Scope 3 reporting under SSN guidance. Orkney wide domestic and commercial waste are currently included in the Carbon Management Plan but not in the OIC inventory for PBCCRD.

Source of emissions	Recommendation	Rationale
	for public bodies. OIC does not need to change its own calculation approach but this should be noted within the PBCCDR in the interest of transparency and, optionally, OIC officers could make SIC officers aware of the issue.	
Procurement	In future, OIC should seek to include procurement emissions within its inventory, subject to available data. Aether has spoken with the procurement team and has been sent their sustainability criteria and documents for assessing priority contracts. Procurement have confirmed spend data will be provided to Aether to identify the largest areas of spend – due January 2025. This will be used to estimate the scale of emissions from different contracts using spend-based emission factors in the first instance. Those, in turn, will be used to establish which sources of emissions are likely to be the largest and therefore aid in prioritising which ones should be the focus of more detailed analysis by OIC in future years.	Target areas where emissions are likely to be highest in the first instance and identify data availability. As set out in **Appendix B.3**, in future the Scottish Government will expand Scope 3 emissions reporting for public bodies so undertaking this analysis now puts OIC in a good position to respond to those requirements once they are introduced.
Pensions	OIC already reports on its pension fund annually. As part of this work, Aether will provide an order of magnitude estimate of the potential scale of emissions associated with this source, drawing on published evidence from Make My Money Matter.[100] It is acknowledged that this will only provide a rough estimate; there is relatively little published data on carbon emissions from pension providers. However, the information can be used by OIC to engage with decision-makers and pension provider to seek better data and explore sustainable options.	This often represents one of the largest areas of Scope 3 emissions, and OIC may have an ability to influence it through choice of pension provider.

[100] https://makemymoneymatter.co.uk/wp-content/uploads/2022/09/FTSE100-hidden-emissions-report-MMMM_SW_R2_.pdf

Source of emissions	Recommendation	Rationale
Joint ventures	Under the operational control approach, if OIC has operational control over any joint ventures, the GHG emissions should be reported under Scope 1 or 2 as appropriate. Otherwise, they should be reported under Scope 3 and prorated according to OIC's share of the joint venture, subject to data availability.	These should be included in the inventory in the interest of completeness. It is acknowledged that OIC's level of influence may be minimal.
Other scope 3	Working from Home (WFH): National average benchmarks per FTE working hour are available and these are pre-populated within the PBCCDR spreadsheet so OIC should continue to use those for that purpose. Recognising that they may not be relevant to the Orkney context, OIC could voluntarily choose to derive an uplifted factor for the purpose of its own internal information. This could be done by comparing typical annual emissions from residential properties in the UK as a whole against those in Orkney, drawing on sub-national fuel consumption statistics and/or Home Analytics data. Commuting: It is recommended to include commuting where data allows. This would require a staff travel survey to be carried out (possibly a survey in combination with home working). It is recommended that OIC keep abreast of future developments following from the Scottish Government on Scope 3 reporting.	For WFH and commuting, the Scottish Government's view is that reporting these could increase their visibility and help contribute to organisational and national GHG reduction targets. Furthermore, estimating these emissions is considered by the Scottish government to be 'practical and feasible' and is proposed (planned) to become a mandatory requirement in future.[101]

Although the Scottish Government has developed guidance on land-based carbon[102], public bodies are not required to report emissions from land management, land use change and carbon removals (e.g. from woodland creation or peatland restoration) within their PBCCDRs. The GHG Protocol has developed a pilot version of guidance on this topic which is expected to be finalised in 2025.[103] At the time of writing (winter 2024/25), it is not necessary for OIC to assess and report those emissions or removals at present. However, this may become necessary in future – particularly if OIC wishes to make claims about the GHG benefits of NbS projects.

[101] https://www.gov.scot/scottish-government-improvement-plan-response-environmental-standards-scotland-investigation-climate-change-delivery-improvement-report.pdf
[102] https://sustainablescotlandnetwork.org/news/offsetting-guidance-published-for-public-bodies
[103] https://ghgprotocol.org/land-sector-and-removals-guidance

B.4.4 Baseline year

It is best practice to use the most recent year when setting up a baseline for emissions projections as this ensures the accuracy and relevance of the proposed GHG reduction pathways.

In the case of Orkney Islands Council, the most recent reviewed and submitted inventory year at the time of writing (winter 2025) is 2023/24. Therefore, 2023/24 has been used as the basis for the pathways analysis presented in this report.

However, it is important to recognise that OIC has previously reported GHG emissions reductions against a different baseline year. Because the 2023/24 inventory would have a different scope, it would not provide a like-for-like comparison against earlier documents. For organisations that have a GHG reduction target of *less than* 100%, the baseline year makes a significant difference in the ability to track progress. However, if the target is net zero (i.e. a 100% reduction) then this is not as relevant because it is easy to determine whether or not the target has been met. For the purpose of reporting against earlier GHG reduction targets, OIC can therefore:

- Accept that the change in scope makes a like-for-like comparison difficult and explain why this is the case, noting that it will not inhibit the ability to track progress against a net zero target;
- Retrospectively calculate GHG emissions in previous years in line with the scope of the 2023/24 inventory (noting this will only be possible with estimates being added on the additions to the inventory); or
- Produce an alternative (shadow) version of the 2023/24 inventory that matches the scope of the previous baseline. Council Officers would be able to continue to report progress based on the former inventory and method. Note that this would be out of scope of the current study.

Given that OIC's target (and that of the Scottish Government) is to achieve net zero emissions, it is suggested that recalculation is not necessary, but as above can be informative for broader progress monitoring by OIC.

B.4.5 Implications for OIC

The above changes have some implications in terms of target setting and progress monitoring which OIC stakeholders should be aware of.

- **Target setting:** As new sources of emissions are scoped into OIC's inventory (for example as national reporting requirements change), the Council will need to make a determination as to whether or not they are subject to a net zero target. Most targets set in advance of 2045 will be voluntary targets, in which case it will be up to OIC to decide what to include, although it is recommended to include Scopes 1 and 2 at minimum. When setting targets, OIC is advised to refer to relevant guidance for Scottish public bodies in the first instance, and may also refer to the principles set out in the Science-Based Target Initiative (SBTi), or the GHG Protocol which underpins it. Note that if OIC decides to sign up to a scheme such as SBTi, then those schemes may have additional, specific requirements about what the target should cover. The next stages of this project will evaluate decarbonisation pathways, which can be used to inform that decision.

- **Progress monitoring:** OIC has previously reported GHG emissions savings as a percent (%) reduction compared to emissions in 2004-05. As discussed in the previous section, there are a few ways OIC can address this. Stakeholders will need to be made aware that a different baseline year has been used for the purpose of this study. This will be clearly explained in Aether's reporting as part of Tasks 3, 4 and 5.

- **Accounting for renewable energy:** Different standards take different approaches on how to account for renewable electricity within GHG inventories (for more information, see Appendix B). In simple terms, some standards would allow OIC to subtract the renewable electricity it generates and exports (e.g. from solar PV or wind turbines) from the total amount of electricity that it consumes, and some do not. There is a discrepancy between current SSN guidance, which takes the former approach, and the GHG Protocol Scope 2 standard, which takes the latter approach. The key implication for OIC is that the choice of accounting method could affect estimates of OIC's GHG emissions and therefore affect the apparent feasibility of achieving different GHG reduction targets. If carbon savings from renewables *are* included, a net zero target might appear to be easier to achieve, even if there is no difference from a practical or cost standpoint. On one hand, this would allow OIC to claim credit for the renewable energy it funds, which some might see as an advantage. On the other hand, OIC could be criticised if it uses renewable energy projects to claim that it has achieved net zero, if there are still avoidable emissions occurring within its own assets and services. This issue will be clearly explained in the Task 3&4 report so that readers can correctly interpret the recommendations and any accompanying figures.

B.5 Review of available data and confirmation of OIC baseline emissions

B.5.1 Methodology

OIC provided Aether with spreadsheets containing the activity data and calculations that have been used to produce the GHG inventory as part of OIC's Public Bodies Duties Reporting. The activity data and emission factors used in the OIC Historic Emissions inventory were reviewed based on Aether's in-house QA procedures. Observations and queries were recorded in a summary sheet which Aether and OIC staff reviewed together via Teams to resolve issues. This section provides a brief summary of the main outcomes.

B.5.2 Data quality

An assessment of the data quality, methodology and calculations was undertaken. **Table 15** below summarises the GHG emissions data emissions in the OIC historic emissions inventory. All the activity data collected by OIC were analysed by Aether and categorised using the following definitions (listed from highest to lowest quality):

- Primary data – measured activity data that can be used to estimate emissions with minimal assumptions (e.g. metered data).

- Secondary data – measured activity data that can be used to estimate emissions with assumptions (e.g. mileage).
- Modelled data – other data is used to create an estimate of activity data through assumptions, conversions and mathematical modelling (e.g. linear extrapolation, pro rating).
- Estimated data – total activity data is estimated using individual judgment.

Table 15: Data quality analysis for each of the Orkney Islands Council historic emission categories.

Category	Sub-category	Scope	Units	Data quality
Electricity	Metered	Scope 2	kWh	Primary data source
Electricity	Unmetered	Scope 2	kWh	Estimated/modelled data until 2021, primary metered data from 2021/22
Fuel Use	Heating oil	Scope 1	Litres	Primary data source
Fuel Use	LPG	Scope 1	Litres	Primary data source
Transport	Construction and Waste processing	Scope 1	Litres	Primary data source
Transport	Ferry Fleet	Scope 1	Litres	Primary data source
Transport	Tugs	Scope 1	Litres	Primary data source
Transport	Harbour Craft	Scope 1	Litres	Primary data source
Transport	Inter-island air transport	Scope 1	Litres	Estimated data
Transport	Public Transport Bus Fleet	Scope 1	Litres	Estimated data
Business Travel	Domestic Flights	Scope 3	Passenger km	Secondary data source
Business Travel	Long-haul Flights	Scope 3	Passenger km	Secondary data source
Business Travel	Ferry	Scope 3	Passenger km	Secondary data source
Business Travel	Business Mileage	Scope 3	km	Secondary data source
Waste	-	Scope 3	kg	Primary data source
Water	-	Scope 3	m^3	Primary data source

This review indicated that the majority of data used in the Orkney Islands Council Historic Emissions inventory is of good quality, either primary or secondary data.

B.5.3 Calculation methods

Overall, the calculation methods were found to be robust, with clear audit trails within the spreadsheet provided. There were some issues found in the data aggregation and calculation methodologies which should be addressed:

- Firstly, it was common for different fuel or activity types to be aggregated before applying emission factors, resulting in a loss of accuracy of emissions estimates. For example, the category “Construction and Waste processing” includes detailed information on gas oil, kerosene, DERV and unspecified fuel usage. However, in the final emissions estimate, a diesel emission factor is used for all the activity data. This has relatively little impact on the emissions estimate for these activities because these fuels have similar emission factors; however, if the same categories are aggregated in future, it is anticipated that the error will increase as some activities are electrified and/or switch to renewable energy sources. It also represents a loss of information from high-quality activity data.

- Another issue identified in several categories was the inclusion and exclusion of Orkney College at different points in the timeseries. For example, for Electricity Metered Orkney College is excluded from 2018/19 and for Fuel Use Heating Oil Orkney College is excluded from 2016/17. This exclusion is related to the introduction of Public Bodies Climate Change Duties reporting, with UHI and OIC making separate disclosures. Moving forward, OIC and the College will need to clarify which organisation reports emissions from the College. The College should report its own emissions as this is required by the Scottish Government, but optionally both organisations could include it in their PBCCDR if this is clearly explained, with OIC reporting it as Scope 3 and the College under Scopes 1, 2 and 3 as relevant. An alternative option would be for OIC to exclude the college in PBCCDR returns but to include the college in net zero progress reporting. Whichever option OIC chooses to take, to minimise confusion, this would require a transparent narrative explanation in the respective reports.

B.5.4 Emission factors

All the emission factors used for the Public Bodies Climate Change Reporting were reviewed. Although they were compared to the UK GHG Conversion factors, there was not a consistent match across years (see accompanying spreadsheet).

B.5.5 Documentation and transparency

There are some key areas where documentation should be added to improve transparency, consistency, comparability and completeness, notably:

- Recording units for all the activity data throughout the document.
- In the interest of longevity, documenting the main source of data and contact details ensures that activity data can be collected in the future.
- Documenting assumptions for any estimated or modelled data, as well as data aggregation techniques and the rationale behind these.

Good documentation and transparency are important as a way of ensuring that OIC's current GHG reporting processes can be maintained in the event of staff absence or turnover.

B.5.6 Data management

At present, responsibility for compiling the GHG emissions inventory largely sits with one individual. Going forward, OIC should review this arrangement and consider whether the responsibility for managing and compiling data can or should sit with a wider group and/or have a more formal structure for data reporting processes. There would be a few benefits of doing this, notably:

- Having a broader structure and more individuals responsible for data management can often raise the profile of climate change reporting. Being more involved in the data compilation and reporting can increase stakeholders' sense of urgency and ownership of the sources of emissions that they are responsible for.

- It also helps to ensure that systems and processes are maintained in the event of staff turnover or unavailability.

B.6 Conclusion

This study provides suggestions and recommendations regarding the organisational boundary of the inventory, proposed and possible changes to inventory scope and to the baseline year. A review of baseline data for 2023/24 has also been carried out.

Through this process, it was evident that OIC has relatively advanced in-house procedures for GHG accounting, and that a considerable amount of detailed consideration had been given to the GHG inventory re-scoping exercise. That puts the Council in a very good position to undertake more detailed climate action planning going forward.

This review has identified some areas for improvement, primarily in relation to the need for further documentation, which would improve transparency and ensure that the inventory can be maintained in the event of staff changes etc.

Appendix C Summary of relevant measures in the 2020 Scottish Climate Change Plan Update (CPPu)

The 2018 Climate Change Plan for Scotland[104] set out the Government's plans for transition towards a zero carbon economy. It contains a list of targets, funding initiatives, policy measures and other supporting actions the Scottish Government will take to achieve emissions reductions across all sectors.

This was first refreshed in 2020 via the Climate Change Plan Update (CCPu), in response to the global climate emergency with bold actions needed in the wider economy and society to achieve net zero.[105] The CCPu contained a number of transformational commitments that are relevant to OIC, including but not limited to:

Transport: Ending the sale of new combustion engine vehicles in favour of ones with zero tailpipe emissions, implementing measures to promote sustainable travel modes to contribute towards a 20% overall reduction in car kilometres, and supporting alternative fuels for vehicle types that are impractical to run on batteries, such as HGVs.

Buildings: Improving the energy performance of the existing building stock, phasing out fossil fuel heating systems in favour of ones with zero direct (i.e. onsite) emissions, and increasing the proportion of heating that is supplied via heat networks.

Notably, while most buildings must have a zero-emission heating system by 2045, for public sector buildings this target is 2038. Council housing is also required to meet higher standards of energy efficiency than the rest of the housing stock by 2032 – achieving a minimum EPC rating of 'B' while the minimum for other homes is a 'C' rating.

Waste: Reducing the amount of food waste that is produced, ceasing to send biodegradable waste to landfill by 2025, taking action to reduce emissions from closed landfill sites, and increasing recycling rates.

Energy: Promoting renewable energy uptake, including an expansion of offshore wind capacity, and providing support to community and locally owned schemes. There is a target for renewable energy generation to account for the equivalent of 50% of energy demand for heat, transport and electricity by 2030.

Negative emission technologies: Supporting research and development into direct air carbon capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS), both of which are needed to mitigate 'hard-to-abate' sources of emissions such as waste.

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104 https://www.gov.scot/policies/climate-change/reducing-emissions/
105 https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/

Appendix D Accounting for renewable energy

This section provides a brief explanation of the difference in approach between the GHG Protocol Scope 2 Guidance, and SSN guidance which supports the PBCCDRs.

D.1 GHG Protocol Scope 2 guidance

Under the GHG Protocol Scope 2 guidance, renewable electricity is accounted for differently depending on several factors, as summarised in Table 6.1 of the GHG Protocol Scope 2 guidance.[106] Some of the key considerations are:

- Does the renewable electricity feed into the grid?
- Is it connected to OIC's premises via a private wire?
- Are renewable energy certificates produced, and if so, are they sold or retained/retired by OIC?

There is a key distinction made in the GHG Protocol Scope 2 guidance between the following two methods:

- **location-based method**, which reflects the average emissions intensity of grids on which energy consumption occurs (using mostly grid-average emission factor data); and
- **market-based method**, which reflects emissions from electricity that companies have purposefully chosen (or their lack of choice). This derives emission factors from contractual instruments, which include any type of contract between two parties for the sale and purchase of energy bundled with attributes about the energy generation, or for unbundled attribute claims.

It is understood that OIC-owned wind farms will feed into the grid, with no private wire connection to OIC premises, and that the REGO certificates[107] will be sold to a third party. If that is the case, then under the GHG Protocol, OIC would not be able to claim the carbon savings from those wind farms, based on the market-based method. However, this would not prevent OIC from reporting and publicising the fact that it has invested in renewable electricity, which is a positive measure that can help to support wider decarbonisation of energy and reduce reliance on energy imports while also raising awareness of climate change issues.

If the energy from OIC-owned wind farms is not grid distributed, but is instead consumed by OIC, with no certificates produced, or with certificates being retired/retained by OIC, then OIC could count that specific electricity consumption as being effectively zero carbon, using the market- based method.

Table 16 below, taken from the *GHG Protocol Scope 2 Guidance: An amendment to the GHG Protocol Corporate Standard*, Table 6.1, presents the details of different options for energy consumed from owned/operated generation, direct line and grid distribution. OIC is advised to refer to this table, and the associated guidance, to determine how renewables should be accounted for within its GHG inventory in future years.

[106] https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf
[107] Renewable Energy Guarantee of Origin (REGO) certificates are an example of a renewable energy certificate, which can be used to demonstrate that electricity has been generated from renewable sources. https://www.ofgem.gov.uk/environmental-and-social-schemes/renewable-energy-guarantees-origin-rego

Table 16. Replicated from GHG Protocol Scope 2 Guidance, Table 6.1

Table 6.1 Accounting for scope 2 with and without certificates sales

	Scope 2 with location-based method	Scope 2 with market-based method
Energy consumed from owned/operated generation (e.g. a company owns a solar panel and consumes the energy)		
No certificates generated or sold	No scope 2 reported for consumption from owned generation	
Certificates from generation facility retired/retained by the generation facility's owner who consumes the energy	Should report certificate retention separately, but no scope 2 reported for consumption of on-site generation	
Certificates sold to 3rd party	Use location-based emission factor hierarchy	Use market-based emission factor hierarchy
Direct line (e.g. a company receives power directly from a generator, with no grid transfers)		
No certificates generated or sold	Use source-specific emission factor from direct line	
Certificates from generation facility purchased and retired/retained by the energy consumer	Use source-specific emission factor from direct line (same as certificate emission factor)	Use certificate emission factor (same as source- specific emission factor)
Certificates sold to 3rd party	Use location-based emission factor hierarchy	Use market-based emission factor hierarchy
Grid-distributed		
No certificates generated or sold from any generation facilities on the grid	Use location-based emission factor hierarchy	Use market-based emission factor hierarchy
Certificates purchased from grid generation facilities, or included in a supplier-specific emission factor	Use location-based emission factor hierarchy	Use market-based emission factor hierarchy
Certificates from grid generation facilities sold to 3rd parties	Use location-based emission factor hierarchy	Use market-based emission factor hierarchy

D.2 SSN guidance

Although the SSN guidance is generally informed by the GHG Protocol, the current guidance would allow OIC to claim carbon savings from renewables in the following way: *"If the organisation exports electricity (e.g. generation exceeds consumption) this can be 'netted off' (up to the total amount of electricity purchased and consumed) and deducted from the footprint."*

It is unclear whether this guidance would apply to renewables that are owned by OIC but feed into the grid with no direct connection to the council's other properties. Aether has sought advice from SSN on this point (expected in January 2025) and will feed it back to OIC to inform future PBCCDRs.

D.3 Comments

In relation to the Council as an organisation, if GHG savings from renewables *are* reflected in OIC's inventory, a net zero target will be easier to achieve, assuming OIC windfarm projects proceed. On one hand, depending on how contracts are set up, this could allow OIC to claim credit for the renewable energy it invests in. On the other hand, OIC could be criticised for using renewable energy projects to help claim that it has achieved net zero, if there are still avoidable emissions occurring within its own assets / services. One possible option is for 'dual reporting' whereby emissions are presented using both methods, with two different totals and a clear explanation for readers.

Appendix E BAU Mitigation Measures

The table below presents the mitigation measures that were modelled as part of the BAU pathway. For more information, refer to Section 3.3.

Mitigation measure	Timescales	Rationale	Modelling approach
Buildings			
Refurbishment of St Margaret's Hope Primary School	2024-2025	Information provided by OIC	Current energy use for the buildings is based on energy consumption data provided as part of OIC's GHG emissions baseline. The 'Management Programme and Updates Review' document provided by OIC states that refurbishment work will include replacement boiler plant and indicates that this may include a heat pump. The energy saving associated with switching from a boiler to a heat pump has been calculated based on the relative efficiency of typical boilers (assumed to be 85% efficient) and heat pumps (assumed to have a COP of 3.0) as set out in the Scottish Government's CPPu GHG Impact Assessment.[108] The total emissions reduction is due to both the energy saving and the difference between emission factors for natural gas and grid electricity.
Refurbishment of Stromness Academy	2024-2025	Information provided by OIC	Current energy use for the building is based on energy consumption data provided as part of OIC's GHG emissions baseline. Expected GHG reductions are taken from the 'Management Programme and Updates Review' document shared by OIC. These have been scaled over time to reflect changes in the GHG intensity of the electricity grid.
Replace 1 in 5 boilers with heat pumps	2025-2045	Information provided by OIC	As part of the BAU it has been assumed that 1 in 5 boilers are replaced with heat pumps at end of life, with the remaining 4 in 5 being replaced like-for-like. The energy saving is then calculated assuming that, by 2045, 20% of existing fossil energy consumption (representing 1 in 5 boilers) is displaced by electricity. The latter is calculated using the same approach and data sources as for the heat pump in St Margaret's Hope Primary School (see above).
LED lighting upgrades: - South Pier, Stromness - Kirkwall Pier, Marina Breakwater	2025-2045	Information provided by OIC	Expected GHG reductions are taken from the 'Management Programme and Updates Review' document shared by OIC. These have been scaled over time to reflect changes in the GHG intensity of the electricity grid. In terms of timescales, it is understood that remaining fittings will be replaced as part of the ongoing maintenance programme.

[108] https://www.gov.scot/publications/greenhouse-gas-emissions-projections-scotland-results-phase-1-phase-2-modelling/

Mitigation measure	Timescales	Rationale	Modelling approach
Assume that estate rationalisation will result in the sale of the following properties: - Garden House (sold) - Stromness Community Centre - Egilsay School (sold)	2025-2028	Information provided by OIC	Energy consumption for these buildings* is included in the data underlying OIC's GHG baseline. In the BAU scenario, the sale of those buildings has been represented by removing that quantity of energy use from the total.
New 40-bed care facility under construction, assumed to be completed in 2025	2025	Information provided by OIC	This building will replace an existing care home, and therefore for the purpose of this assessment it was assumed that energy demand would be similar but that heating requirements would be met with a heat pump rather than a boiler. See above for a description of how the switch from boiler to heat pump has been estimated. Note that this approach is a simplifying assumption as a review of publicly available planning documentation did not appear to include a detailed energy statement.
New nursery with places for up to 51 children, assumed to be completed in 2025	2026	Information provided by OIC	Annual electricity demand, added to the total demand modelled in the BAU, has been estimated as c. 150 KWh/m^2; this is an indicative value based on good practice CIBSE benchmarks for school buildings.[109] The floor area is indicatively assumed as 500 m^2 and the property is assumed to be electrically heated.
Assume that, where possible, buildings are brought up to an EPC rating of 'B' when they become void	2025-2045	Information provided by OIC; see also Scottish Gov't CCPu policies relating to social housing	It is understood from OIC that most buildings meet EESSH1, a milestone in energy efficiency standards that requires housing to target a minimum EPC rating of C or D by 2020, but around 60% require further work to meet EESSH2, which aims for minimum ratings of B by 2032. It is assumed that approximately 1 in 3 of those buildings (i.e. 20% of the total) will be convenient and cost effective to retrofit, and that a retrofit will achieve a 10-15% reduction in energy use for space heating for each building where it occurs. This aligns with the approach taken in the Scottish Government's CPPu GHG impact assessment.[108] The precise works required will depend on the building. Interventions are assumed to take place linearly up to 2045.

[109] https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/benchmarking-registration

Mitigation measure	Timescales	Rationale	Modelling approach
Tenanted Properties			
Assume new homes built at a rate of 20 per year for the next 10 years, all with zero direct emission heating systems (ZDEH)	2025-2035	Information provided by OIC	This BAU measure evaluates the impact of operational energy use from new homes. Embodied carbon is excluded as OIC does not currently report emissions from capital projects as these are not routinely included in annual organisational reports at present. It is assumed that all new homes are energy efficient and utilise electric heating systems or heat pumps. Annual electricity demand is based on Ofgem's 'medium' Typical Domestic Consumption Values (TDCVs)[110] adjusted to account for the delivery of heat using a heat pump instead of a gas boiler (for which the estimation method is described above). This measure results in an increase, rather than decrease, in energy demand and GHG emissions, but the impact in future years is minor as a result of electricity grid decarbonisation.
Public Transport			
No change in aviation emissions; however please refer to explanatory notes for additional context	2025-2045	As advised by HiTrans	The BAU assumes no significant change in aviation emissions. Advice from HiTrans was that, unless there is a paradigm shift in aviation technology, a reasonable BAU scenario would see no major change in demand and no major change in emissions although in practice there could be small increases or decreases. Potential variables that would affect this assumption would include the size and efficiency of aircraft, their level of utilisation, whether the service operates on a similar timetable or not, and changes in air fares. Note that Loganair has a target of achieving net zero emissions by 2040 but, based on Aether's review of publicly available information, it was unclear what specific and committed BAU measures are in place to achieve this, so it has been excluded on that basis.[111]
Construction & Fleet			
Replace vans with electric vehicles (EV) as part of natural replacement cycle	2025-2045	Information provided by OIC	OIC has advised that vans are being replaced with EV models as part of the natural fleet replacement cycle. The impact of switching from diesel to electric vans has been estimated by referring to the DESNZ GHG Conversion Factors for Company Reporting, which record typical fuel consumption (kWh/km) for different vehicle types.[112] Current diesel fuel usage was taken from OIC's GHG baseline data and the DESNZ Conversion Factors were used to estimate the electricity that would be needed if the same routes were served by EVs. The total emissions reduction is due to both the energy saving and the difference between emission factors for diesel and grid electricity.

[110] https://www.ofgem.gov.uk/information-consumers/energy-advice-households/average-gas-and-electricity-use-explained
[111] https://www.loganair.co.uk/flying-with-us/greenskies/
[112] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023

Mitigation measure	Timescales	Rationale	Modelling approach
Business Travel & Commuting			
Majority of employees expected to switch to electric vehicles eventually, particularly from the early/mid 2030s onwards	2035-2045	UK Government policy would prohibit the sale of new petrol and diesel cars from 2030	The methodology is the same as the one used for OIC's fleet (see above) but with reference to DESNZ Conversion Factors for cars rather than vans.
Waste and Waste Processing			
Higher proportion of material being recycled; lower proportion being sent to landfill in Shetland	2027-2045	Information provided by OIC	Discussions with OIC indicate that the following BAU changes are expected to impact waste emissions: Extended producer regulations; Deposit return scheme; Code of Practice from Scottish Government and Zero Waste Scotland; ETS regulations. This has indicatively been modelled as about 2-3% reduction in emissions from waste.
Electricity Grid			
Changes in line with National Grid 5-year forecasts	2025-2030	Electricity emission factor based on industry projection	Emission factors for 2023 and 2024 are taken from the DESNZ GHG Conversion Factors for Company Reporting, which are used within Scottish PBCCDR reporting templates.[112,113] Future electricity emission factors are predominately based on figures published by the National Grid as part of the Future Energy Scenarios (FES), as set out within the 5-year forecast and 'Electric Engagement' trajectory.[114] However, because the 2023 and 2024 year emission factors are taken from a different source, there is a discontinuity in the time series. This has been resolved by using DESNZ figures for 2023 and 2024, and National Grid FES figures from 2029 onwards, with linear interpolation in the intervening period (2025-2028).

[113] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
[114] https://www.neso.energy/publications/future-energy-scenarios-fes

Appendix F List of mitigation actions

[See Excel file provided separately.]

Appendix G Estimated costs and GHG impacts of mitigation measures

This appendix presents an overview of the potential costs associated with different categories of mitigation measures, where data were available within the scope and timescale of this study. Each section below describes indicative total capital costs, operational costs (or savings), and the GHG impact of measures. It also indicates which stakeholders would be responsible for the capital costs or operational costs.

Note: The capital and operational costs here represent preliminary estimates, developed through desk-based analysis, including market research by Aether and OIC project experience. They are intended as high-level guidance only. Comprehensive techno-economic assessments for each measure will be necessary to support informed decision-making by the Council. For wider context and understanding of decarbonisation costs and benefits, please also refer to Appendix H.

G.1 OIC buildings

The cost of upgrading buildings, and the potential impact on energy consumption and bills, depends on various factors including the size and type of building and the package of measures selected.

From a GHG emissions standpoint, the priority for buildings is to phase out the use of fossil fuel heating systems. OIC has previously estimated that the extra-over cost of installing ground source heat pumps (GSHPs) in the remaining operational buildings that do not already use electric heating systems would be roughly £18m.[115] This is just the additional cost compared with like-for-like replacement, i.e. it is not the total capital cost that would need to be paid. It also does not include the cost of additional fabric upgrades to make the buildings more efficient, which is important from the standpoint of reducing energy demand and bills but would show as having no GHG impact if the buildings utilise 100% renewable energy, e.g. from a decarbonised electricity grid.

For non-domestic buildings, assuming a typical cost[116] of £900/m^2 (as advised by OIC) and based on GIA for the entire stock as per the 2024 Property Asset Management Plan[117] would suggest a total capital investment requirement upwards of £100m if upgrading all of OIC's operational buildings and installing heat pumps, but the actual cost would be much lower as not all require upgrades. OIC officers have advised that focusing solely on the buildings that require heat pumps would be approximately £54m.

In terms of operational costs, energy efficiency upgrades could typically be expected to reduce heating energy use by 5-15%. This measure on its own could equate to savings of £30K-£100K per year. The overall change in energy bills will depend on whether fabric efficiency measures are adopted alongside a ZDEH system, the type of that system, and the relative price of fossil fuels versus electricity. In some cases the total bills may be higher, in other cases they may be lower. Based on Aether project experience, air source heat pumps (ASHPs) can potentially deliver bill savings of around 15-20% and ground source heat pumps (GSHPs) can deliver bill savings of around 35%-40%. For OIC, replacing its remaining fossil fuel boilers with heat pumps could therefore potentially equate to savings of £200K-250K per year.

[115] See Appendix 5 of the 'Carbon Management Programme Update Report' (2024)
[116] Indicative value representative of packages of fabric efficiency improvements and heat pump installations for different non-residential building types https://www.curriebrown.com/media/pq0fuerr/ipf-costing-energy-efficiency-improvements-april-2024-full-report.pdf
[117] https://www.orkney.gov.uk/media/irdenxac/item-10__pamp.pdf

OIC has estimated that the cost of installing GSHPs in its remaining properties is approximately £18m more than would be needed to replace boilers like-for-like, i.e. that is the extra-over cost.

It is understood that OIC is considering fabric improvements plus GSHPs for its remaining properties. As noted in the main body report, from a GHG emissions standpoint fabric improvements are not strictly necessary, even though they reduce energy bills. It is likely that cheaper packages of measures exist, for example, using ASHPs with roof-mounted PV. OIC should explore this opportunity.

For context, **Table 17** below compares typical capital and operational costs of different heating systems for non-domestic buildings, based on Aether project experience. It shows that, GSHPs may be around 4 times more than the cost of boilers, whereas ASHPs may be around 2-3 times the cost.

Table 17. Indicative costs of different heating system types

System	Capex (£/m²)	Capex (£ for an illustrative 5,000m² building)	Annual Opex (£/m² per year)	Comment
Boiler	~ £12–15/m²	~ £60,000 – £75,000	~ £8/m²yr	Baseline
ASHP	~ £21–36/m²	~ £105,000 – £180,000	~ £6–7/m²yr	High upfront cost, moderate saving
GSHP	~ £42–60/m²	~ £210,000 – £300,000	~ £5/m²yr	Highest capex, best run cost

A summary of the estimated costs is shown in **Table 18** below.

Table 18. Indicative costs and GHG savings for OIC buildings

Description	Indicative capital cost (£)	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Lighting & appliance efficiency, and fabric upgrades	£25-£54m	Up to £250K per year	-625	OIC
Replacing fossil fuel heating systems			*	OIC
Total	**£25-£54m**	Unknown	**-6,250**	**OIC**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

G.2 Tenanted properties

The cost of upgrading buildings, and the potential impact on energy consumption and bills, depends on various factors including the size and type of building and the package of measures selected.

For non-domestic buildings, assuming a typical cost[118] of £150/m² and based on GIA as per the 2024 Property Asset Management Plan[119] would suggest a capital investment requirement of around £2.5-3m for non-domestic tenanted properties. The actual figure may be lower if not all buildings require upgrades. Additionally, because these properties are already 100% electrically heated, and therefore have zero direct emissions, from a purely GHG emissions standpoint upgrades are not critical for

118 Indicative value representative of fabric efficiency improvements for different non-residential building types https://www.curriebrown.com/media/pq0fuerr/ipf-costing-energy-efficiency-improvements-april-2024-full-report.pdf
119 https://www.orkney.gov.uk/media/irdenxac/item-10__pamp.pdf

achieving net zero because it is likely that the electricity supply will decarbonise over time. However, it is important for reducing energy demand and tenants' bills.

Based on OIC's GHG inventory, tenanted properties used around 130 MWh of electricity in 2023/24. Assuming energy savings of 5-15% from packages of energy efficiency measures this would result in 7-20 MWh of electricity saved per year, representing savings in the low thousands of pounds annually. Note that, unlike buildings operated by OIC, any difference in energy bills would be borne by the tenants rather than the council.

Table 19. Indicative costs and GHG savings for tenanted properties (excl. social housing)

Category	Indicative capital cost (£)	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Lighting & appliance efficiency, and fabric upgrades	£2.5-3m	£2,000-£5,000 saving	*	Capital costs: OIC Energy bills: Tenants
Total	**£2.5-3m**	**£2,000-£5,000 saving**	**-30**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

G.3 Social housing

For social housing that is already 100% electrically heated, and therefore has zero direct emissions, from a purely GHG emissions standpoint upgrades are not critical for achieving net zero because it is likely that the electricity supply will decarbonise over time. However, it is important for reducing energy demand and bills and improving occupant comfort. For that reason, it has been assumed that the focus will be on fabric upgrades not heating system replacement.

OIC's Local Housing Strategy indicates that an investment of approximately £25.2m would be required for the stock to meet a minimum EPC rating of 'B', suggesting an average of around £26K per property.[120] On average, this could reasonably be expected to reduce space heating demand by around 10%, equating to a 5-7.5% reduction in energy bills per household per year, depending on the proportion that is currently spent on space heating.[121]

Table 20. Indicative costs and GHG savings for social housing

Category	Indicative capital cost (£)	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Fabric upgrades	£25.2m	£10-£300 saving per household	*	Capital costs: OIC Energy bills: Tenants
Total	**£25.2m**	**£10-£300 saving per household**	**-2,050**	**As above**

[120] https://www.orkney.gov.uk/media/q3jhi1yf/item-07__local-housing-strategy.pdf

[121121] Evidence from the Scottish Climate Change Plan Update indicates an average 13% reduction across the Scottish building stock as a whole; 10% is a realistic conservative assumption https://www.gov.scot/publications/greenhouse-gas-emissions-projections-scotland-results-phase-1-phase-2-modelling/

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

G.4 Vehicle fleet

Operational measures to reduce fuel consumption from OIC's vehicle fleet have not been assessed in detail. It has been assumed that a 5% reduction in fuel consumption would be achievable. Based on OIC's GHG inventory, which reported a total of around 341,000 L of diesel usage, this would be a saving of around £18K per year.

The total capital costs have been estimated based on a list of fleet vehicles owned by OIC[122] and market research on the typical upfront costs of purchasing electric or hybrid versions of those vehicles, as set out below. **Prices are solely intended as rough estimates and will vary depending on the specific make, model, supplier, etc.** Note that the total is highly sensitive to assumptions about the cost of heavy goods vehicles (HGVs), which are much more expensive. In some cases there are few or no hybrid or electric alternatives available on the market, so these numbers should be interpreted with caution.

For smaller vehicles, such as cars, vans, minibuses and pickup trucks, hybrid and EV alternatives are already available. Based on the costs set out below, those would cost around £5-7m to replace.

- Car: Around £25-£60K
- Van: Around £25K; OIC procured 3x electric vans in 2023 for £71,157.[123]
- Minibus: Around £45-65K
- Pickup: Around £50-75K

It is understood that replacing cars and vans with EVs is already part of OIC's business as usual (BAU) fleet replacement plan, so this does not represent an additional cost compared to what the council is already expecting to spend. At present, EV cars and vans currently cost around 25% more than internal combustion engine (ICE) alternatives, although that difference has decreased rapidly in recent years and this trend is expected to continue.[124]

It is estimated that the total capital costs for replacing other vehicles such as bin lorries, fire tenders, and other HGVs would range from £15m-£25m. Again this represents the total cost, rather than the extra-over cost, although the latter is higher than for smaller EVs since the technology is at an earlier stage of adoption. Research by Cenex Insight[125] indicates that battery electric HGVs currently cost 2.5 times more than diesel vehicles to purchase, and hydrogen fuel cell HGVs cost 3.5 times as much as diesel ones.

- Bin lorry: Experience from other councils suggests figures in the range of £320-560K.[126] OIC has commissioned a trial of an electric bin lorry which utilised grant funding.
- Fire tender: £860K based on experience from Cheshire Council[127]
- Other HGVs: £150-300K or more

[122] Provided to Aether by OIC via email on 24/09/24
[123] https://www.orkney.gov.uk/media/oqgabczd/procurement-annual-report-2022-2023.pdf
[124] https://evpowered.co.uk/news/price-gap-between-evs-and-ice-plummets/
[125] https://www.cenex.co.uk/app/uploads/2025/02/RCV-Insight-Guide-Cenex.pdf
[126] Cambridge council: £400K. Wiltshire: £323K. Nottingham: £560K.
[127] https://crewe.nub.news/news/local-news/revealed-cheshire-fire-service-own-zero-electric-vehicles-but-rent-and-cost-are-considerable-factors-176209

A 2024 study by EST[128] which examined fleet decarbonisation in more detail noted that 20 of OIC's HGVs drove less than 5,000 miles in a year and according to the EST study authors could therefore potentially be rationalised from the fleet. This indicates that, potentially, not all vehicles in the current fleet would need to be replaced and therefore the total cost might be lower than estimated.

The overall change in fuel bills will depend on whether efficiency measures are adopted along with zero-emission vehicles, the type of vehicle selected, and the relative price of fossil fuels versus electricity or other alternatives. In some cases the total bills may be higher, in other cases they may be lower. Research from Cenex Insight (see above) indicates that battery electric vehicles may have 20-60% lower running costs than diesel HGVs, whereas the running cost for hydrogen fuel cell vehicles may be twice as high as diesel. Hence, total operational costs/savings are unknown. For context however, this would be a saving of potentially more than £160K per year if all vehicles switched to battery electric, or a cost *increase* of more than £350K per year for hydrogen.

Table 21. Indicative costs and GHG savings for OIC's vehicle fleet

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Operational measures	N/a	£18K	-54	OIC
Replace fossil fuel vehicles	£20-£30m	Unknown	*	OIC
Total	**£20-£30m**	**Unknown**	**-1,075**	**OIC**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented <u>and</u> once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

The above figures do not include the cost of EV charging and associated infrastructure upgrades.

G.5 Construction

Operational measures to reduce fuel consumption from OIC's construction services have not been assessed in detail. It has been assumed that a 5% reduction in fuel consumption would be achievable. Based on OIC's GHG inventory, which reported a total of around 70,000 L of diesel usage and 95,000 L of kerosene, this measure alone would represent a saving of around £20,000 per year.

The overall change in fuel bills will depend on whether efficiency measures are adopted along with zero-emission vehicles, the type of vehicle selected, and the relative price of fossil fuels versus electricity or other alternatives. In some cases the total bills may be higher, in other cases they may be lower. Hence, total operational costs/savings are unknown.

The total capital costs have been estimated based on a list of construction plant/vehicles owned by OIC[129] and market research on the typical upfront costs of purchasing electric or hybrid versions of those vehicles/plant. **<u>Prices are solely intended as rough estimates and will vary depending on the specific make, model, supplier, etc. In some cases there are few or no fully electric models currently available.</u>** Note that the list from OIC was missing information for around 40% of entries, so the figures were estimated based on available information and prorated accordingly.

- Compact tractor: £20K-£50K
- Excavator: £70K-250K or more, noting there are few fully electric models available
- Forklift: £8K-£60K

[128] EST, Fleet Decarbonisation Study for Orkney Islands Council (2024)
[129] Provided to Aether by OIC via email on 24/09/24

- Loadall: £40K-£120K
- Loading shovel: £30K-£140K or more
- Mini digger: £15K-£45K
- Quad bike: £13K-£25K
- Roller: £1K-£60K or more
- Skidsteer: £5K-£60K
- Tractor: £100K-£200K

The indicative capital costs shown below represent the total cost and do not account for the amount that OIC would normally pay as part of its fleet replacement plans.

Table 22. Indicative costs and GHG savings for construction

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Operational measures	N/a	£20K	-27	OIC
Replace fossil fuel vehicles	£6m	Unknown	*	OIC
Total	**£6m**	**Unknown**	**-539**	**OIC**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

The above figures do not include the cost of providing charging stations or any associated infrastructure upgrades.

G.6 Public transport – Bus services

Since the bus service is contracted out, the cost of decarbonising the fleet would not be a direct capital cost to OIC, but instead would be reflected in the cost of procuring this service.

The cost of procuring electric buses varies widely depending on the specification and level of subsidy available. Stagecoach is the current bus service operator and a new fleet of low emission Euro 6 buses was provided in 2021.[130] Information provided by OIC suggests a typical diesel bus costs around £150k, with a new fleet costing around £8.5m in total. For comparison, it also suggests that a fully electric bus would be £350k, suggesting a considerable price uplift for EVs compared with internal combustion engine (ICE) models.[131] Those figures would suggest that replacing the fleet with EVs would cost up to £20m, or an extra £11.5m compared to diesel.

This broadly aligns with experience from other councils which suggests anything from £188K-£473K per electric bus.[132] However, note that this is a wide range, and that the costs of EVs may continue to reduce over time, a trend seen with other EVs. There are also subsidies available; the Scottish government's Scot ZEB scheme offers funding to help cover some of the additional costs so OIC might not have to bear the full brunt of the uplift.[133]

[130] https://www.orkneyharbours.com/about/case-studies/new-bus-fleet
[131] 'School and Public Bus Service Procurement', OIC 2020
[132] Dumfries and Galloway: £2.6m for 12 buses suggests around £220k per bus. https://www.dumfriesandgalloway.gov.uk/news/2025/dumfries-galloway-council-makes-ps266-million-investment-new-low-emission-buses-keep-communities-connected SULEB: £40.5m for 215 buses, around £188k per bus. https://www.bbc.co.uk/news/uk-scotland-scotland-business-56459350 First Bus: £35m for 74 buses, around £473k per bus. https://news-scot.firstbus.co.uk/news/first-bus-scotland-commits-gbp-35-million-to-electric-bus-investment
[133] https://www.transport.gov.scot/public-transport/buses/scottish-zero-emission-bus-challenge-fund

Although there are no definitive plans to phase out use of ICE buses in Scotland, there is a proposed rule to prohibit new buses that are *not* zero emission on local/franchised services from 2030.[134] It is therefore possible that OIC might be required to procure zero emission buses in future.[135]

Regarding operational costs or cost savings, given that OIC has an ambition to increase the proportion of journeys made by public transport, it may be the case that cost savings are partially or fully offset by an increase in fuel consumption due to the shift to sustainable travel modes. That has not been accounted for in the below figures which assume no increase in bus usage. Overall, operational costs could be around 50% lower if switching to EVs, which equates to a roughly £250K saving.

Table 23. Indicative costs and GHG savings for buses

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Operational measures	N/a	£250K *(assumes no increase in public transport usage)*	-1,582	Capital costs: OIC, Scottish Gov't Operational costs: Direct benefit to operator; long-term indirect benefit to OIC
Replace fossil fuel vehicles	£20m			
Total	**£20m**	£250K	**-1,582**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

G.7 Public transport – Inter-Isles Air Service

The Inter-Isles Air Service is currently operated by Loganair[136] and utilises two Britten-Norman Islander BN-2 planes. As of August 2025 OIC has secured funding from the Scottish Government for a third plane of the same type at a cost of approximately £2m.[137] As set out in the main body report, these are not compatible with sustainable aviation fuel (SAF) due to the engine type, and therefore it is assumed that all three planes would need to be replaced in order to decarbonise the air services.

For the capital cost of replacing the fleet, there is very little information available because zero emission aircraft are still an emerging technology. As a rough estimate it has been assumed that the cost uplift would be approximately 50%-100%, or around £3-£4m per plane. Replacing 2-3 planes would therefore require a total of £6m-£12m capital expenditure.

The operational costs or cost savings depend heavily on the technology that is adopted and is therefore not estimated; however, some factors to consider are:

[134] https://www.highwaysmagazine.co.uk/Scotland-looks-to-ban-non-zero-emission-buses-from-2030
[135] https://www.parliament.scot/chamber-and-committees/official-report/search-what-was-said-in-parliament/meeting-of-parliament-10-09-2025?iob=141393&meeting=16563
[136] https://www.orkney.gov.uk/latest-news/loganair-ltd-to-continue-operation-of-lifeline-inter-island-air-service/
[137] https://www.orkney.gov.uk/latest-news/historic-moment-as-orkney-islands-council-invests-in-third-aircraft-to-support-isles-connectivity/ This is roughly in line with costs seen elsewhere; an order of 4x planes of the same type for the Falkland Islands was $9.75m (£7.3m), representing an average of around £1.82m per plane. https://britten-norman.com/falkland-islands-government-to-order-four-new-britten-norman-islander-aircraft/

- The cost of SAF is significantly (4-5 times) higher than conventional jet fuel.[138] If blended in a mix of up to 50%, this would increase fuel costs by a factor of 2-2.5.
- Electricity costs more per kWh than aviation gasoline, but because electric engines are more efficient, the operational costs could be lower for battery electric planes.
- Hydrogen fuel cell planes may be more expensive to run because producing hydrogen and converting it back to useable energy is inefficient.

Table 24. Indicative costs and GHG savings for Inter-Isles Air Service

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Replace fossil fuel aircraft	£6-£12m	Unknown	*	Capital costs: OIC, potential funding from Scottish Gov't Operational costs: Direct benefit to operator; long-term indirect benefit to OIC
Total	**£6-£12m**	**Unknown**	**-412**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid, green hydrogen, or an alternative zero-emission fuel.*

G.8 Ferries

Operational measures to reduce fuel consumption from OIC's marine services have not been assessed in detail. It has been assumed that a 5% reduction in fuel consumption would be achievable. This would equate to a reduction in fuel costs of up to £75K per year.

For the capital cost of replacing the ferry fleet, estimates vary and will depend on the technologies selected. Some OIC reports suggest the cost to replace the ferry fleet with hybrid alternatives would be between £270-£400m[139] but others suggest the figure may be significantly higher.[140] Note that OIC would not bear all of the capital costs of ferry fleet replacement; this is shared with the Scottish Government.

The operational costs, or cost savings, associated with switching to a zero emission ferry fleet have not been included in the table below as this depends on the preferred technological option. Indicatively, a 20% reduction in fuel use, which could be achieved through modern efficient fossil fuel or hybrid propulsion systems, may equate to a saving of up to £300K per year. As in the case of vehicles, fully electric options would be expected to offer greater savings, whereas hydrogen options are typically more expensive.

[138] https://www.spglobal.com/commodity-insights/en/news-research/latest-news/agriculture/060225-airlines-see-relief-with-86-jet-fuel-saf-costs-hinder-sustainability-iata-chief
[139] https://www.transport.gov.scot/publication/local-authority-ferries-orkney-ferry-replacement-task-force-meeting-14-may-2025/
[140] https://www.bbc.co.uk/news/uk-scotland-north-east-orkney-shetland-66540270

Table 25. Indicative costs and GHG savings for ferries

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Operational measures	N/a	£75K	-500	Orkney Ferries
Replace fossil fuel vessels	£270-400m+	Unknown	*	OIC, Scottish Gov't
Total	**£270-400m+**	**Unknown**	**-10,000**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

G.9 Harbour craft and tugs

Operational measures to reduce fuel consumption from OIC's marine services have not been assessed in detail. It has been assumed that a 5% reduction in fuel consumption would be achievable. This would equate to a reduction in fuel costs of around £15K per year based on current prices.

For the capital cost of replacing the fleet, there is very little information available because zero emission vessels are still an emerging technology. The first hybrid pilot boat in the UK was built in 2019 and cost approximately £1m, compared to around £850,000 for an equivalent diesel pilot boat, suggesting an uplift of around 17%. It is unknown what the price of a battery powered or zero emission alternative would be, but as a rough estimate it has been assumed that the cost uplift would be approximately 50%, or around £1.3m per pilot boat. For tugs, OIC has advised that hybrid options may cost around £15m each, citing a case study from California, with an additional £3m of investment required for charging infrastructure.[141] Assuming OIC operates 5x pilots[142] and 4x tugs[143] this would put the total capital cost of fleet replacement at around £38-47m.

As with ferries (see previous section), the operational costs, or cost savings, associated with switching to a zero emission fleet have not been included in the table below as itwill depend on the preferred technological option. Indicatively, a 20% reduction in fuel use, which could be achieved through modern efficient fossil fuel or hybrid propulsion systems, would equate to a £60K-£65K saving per year. As in the case of vehicles, fully electric options would be expected to offer greater savings, whereas hydrogen options are typically more expensive.

Table 26. Indicative costs and GHG savings for harbour craft and tugs

Category	Indicative capital cost	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Operational measures	N/a	£15K	-105	OIC
Replace fossil fuel vessels	£38-47m	Unknown	*	OIC, Scottish Gov't
Total	**£38-47m**	**Unknown**	**-2,100**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

[141] https://www.marinelink.com/news/curtin-maritime-build-eight-hybrid-529839
[142] https://www.orkneyharbours.com/services/pilotage#:~:text=Orkney%20Harbour%20Authority%20operates%20a,Escort%20Areas%20Within%20Scapa%20Flow
[143] https://www.orkneyharbours.com/services/towage

G.10 Renewable energy

Large-scale wind: Based on examples from the Quanterness wind farm, large-scale onshore wind in Orkney is estimated to cost around £1.6m per MW to install, although this depends on the location. The Quanterness wind farm will export energy to the grid and is expected to generate a profit of around £100K per MW per year.[144] For context, OIC's electricity usage in its operational buildings as reported in its 2023-24 inventory was 13,664 MWh, so the equivalent amount of electricity could be generated annually using around 3.5-4 MW, or 2-4 large turbines.[145]

Roof-mounted solar PV: According to solar PV cost data published by DESNZ, median costs for roof-mounted PV are around £1,260-£1,880 per kW (£1.2-£1.8m per MW) depending on the size of the array.[146] The payback period depends on factors such as the system size, location, energy usage, cost of electricity and incentives/subsidies, but is typically around 5-10 years.

Wind versus solar: Although the price per MW appear similar, large-scale onshore wind generates much more electricity per unit of installed capacity than solar PV and is therefore generally cheaper from a generation-cost standpoint. However, solar PV may be more practical for reasons such as ease of deployment, fewer planning constraints, etc. Therefore, both play a complementary role in a diversified and sustainable energy mix.

Who claims the carbon credits?: In some circumstances, OIC may be able to claim the GHG savings from renewable electricity that it generates. This will depend on factors such as whether or not the renewable energy system is directly connected to OIC properties, electricity is exported to the grid, or OIC decides to sell renewable energy certificates (RECs). The potential financial benefits of selling electricity or RECs will need to be weighed up against reducing OIC's electricity bills on a project-by-project basis.

G.11 Potential future changes

The costs above are based on the current cost of technologies, and they assume that in most cases the default option is a traditional, fossil fuel combustion system for heating, propulsion and power generation. There are a variety of potential future changes that could affect either the overall cost, or the extra-over cost of installing a low emission technology compared to business as usual (BAU). These are briefly summarised below.

Buildings: Under the Bute House Agreement, the Scottish Government would require public bodies to use zero direct emission heating (ZDEH) systems by 2038. This is reflected in the draft Statutory Guidance for Public Bodies: Putting the Climate Change Duties into Practice.[147] In principle therefore, any ZDEH installed after 2038 would represent a BAU cost for OIC. The cost of the heating systems themselves is not expected to fall significantly, as heat pumps are a mature technology that is already widely in use globally.

Vehicles: The cost of EVs is expected to continue to fall, largely driven by lower battery costs. Increasingly, due to legislation, the default option will be for new cars, vans and buses to have zero tailpipe emissions, so the extra-over costs would also decrease. The UK Government aims to

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144 The Quanterness development is consented up to 30MW and is estimated to cost £50m but generate a profit of £3.3m per year. It is noted that a similar development at Hoy was estimated to cost up to £77m due to the additional electricity grid upgrades required, do the actual amount will depend on the location. https://www.orkney.gov.uk/latest-news/unanimous-decision-to-back-quanterness-wind-farm-project/

145 Assuming a capacity factor of around 40%, the annual output would be approximately 3,500 MWh/MW. https://marine.gov.scot/sites/default/files/00009361_00009362_-_eiar_volume_1_redacted.pdf

146 https://www.gov.uk/government/statistics/solar-pv-cost-data

147 https://www.gov.scot/publications/climate-change-duties-draft-statutory-guidance-public-bodies-consultation/

accelerate the transition to zero-emission road transport by ending the sale of new petrol and diesel cars and vans from 2030, and hybrids from 2035.[148] For buses, the Scottish Parliament has introduced a legislative provision (through an amendment to the Bus Services Bill) giving Ministers the power to ban the registration of new non-zero-emission buses from a date no earlier than 2030, subject to parliamentary approval and with scope for exemptions.

Renewable energy and battery technologies: The International Energy Agency (IEA) anticipates that the cost of renewables and batteries could come down, making it more affordable to utilise locally-generated renewable electricity, which in turn would reduce energy bills. Since 2010, globally the cost of solar energy has decreased by 90%, the cost of wind by 70%, and the cost of batteries by 90%, and according to the IEA these could decrease by a further 10-40% by 2035.[149]

Waste: The UK Government has indicated its intention to expand the scope of the Emissions Trading Scheme (ETS) to include waste incineration and energy from waste from 2028.[150] This would have major implications for authorities that operate or contract with energy from waste plants, including OIC, which sends waste to the Energy Recovery Plant (ERP) in Shetland. The ETS would make operators pay for the "fossil" portion of emissions from waste incineration, i.e. material made from petroleum-based plastics or synthetic fibres. Although the ERP operator is liable for the costs, some or all of it would potentially be passed on to OIC. This would make waste incineration more expensive and therefore strengthen the economic case for recycling and circular economy measures.

Maritime sector: The UK Government has also announced that the marine sector will be brought into the ETS. This would put a carbon price on emissions from domestic vessels. If and when this occurs, hybrid and low-emission ferries, tugs and harbour craft would face lower carbon-cost risk compared to fossil fuel vessels, making them comparatively more economically attractive.

Other technologies: Some of the technologies described in this report are still considered emergent or are not yet widely available, as in the case of electric HGVs and ferries and zero-emission planes. In some cases, further research and development could identify lower-cost options, and as technologies mature and economies of scale grow, production costs typically fall. Early deployment helps manufacturers refine designs, streamline manufacturing processes and build specialised supply chains, all of which reduce unit costs over time. Increased competition among suppliers can also drive prices down, while learning-by-doing and standardisation tend to improve efficiency and reduce the need for bespoke components. Together, these factors mean that technologies that are currently expensive can become significantly more affordable as markets expand and manufacturing experience accumulates.

[148] https://www.gov.uk/government/speeches/phasing-out-the-sale-of-new-petrol-and-diesel-cars-from-2030-and-support-for-zero-emission-vehicle-zev-transition#:~:text=No%20new%20petrol%20or%20diesel,100%25%20zero%20emission%20by%202035.
[149] https://www.iea.org/reports/world-energy-outlook-2025
[150] https://assets.publishing.service.gov.uk/media/687de90da8ee0c6e06f452d6/uk-ets-energy-from-waste-interim-authority-response.pdf

G.12 Additional notes

The following categories of mitigation measures are not presented separately within the cost estimates above:

- **Water & wastewater** – These are implicitly included within the range of cost estimates for upgrading buildings as it is assumed that the work would be undertaken at the same time as major retrofits and/or as part of routine maintenance.
  - Efficient taps and fittings are not necessarily more expensive than normal ones.
  - The cost of rainwater collection systems and greywater recycling systems depends on the building in question and the system selected. Rainwater collection can range from a few hundred pounds for water butts to several thousand pounds for larger, below-ground storage. Small greywater recycling systems (e.g. for domestic use) can be c. £2-3k for supply and installation, but larger systems can be higher, from c. £15-25k.[151]
- **F-gas leak detection and specifying low-GWP refrigerants**
  - For an individual engineer to conduct leak detection, site visits might range from £150-400 for a small to medium site or £500-800 for a larger site. The cost of permanently installed sensors might range from £1-2K for a small site to £5-20K for a building like a supermarket with large cold storage. For a medium office building therefore, a reasonable indicative cost would be somewhere within this range.
  - The cost of specifying low-GWP refrigerants varies widely depending on the appliance in question. In future, if higher-GWP refrigerants are phased out (Kigali Amendment), appliances with lower-GWP refrigerants would become more commonly available so would not represent an additional cost compared with normal system replacement.
- **Measures to reduce emissions from business travel and commuting** – No capital costs for OIC; will require some officer time to e.g. review business travel policy, survey staff commuting, develop incentive schemes for sustainable travel modes.
- **Measures to reduce emissions from waste** – Behavioural changes are assumed to incur no capital costs to OIC although would require some officer time/resources to promote changes. Measures to decarbonise the wider waste treatment system, including upgrading or providing new waste management facilities, would form part of a wider initiative to decarbonise waste for these areas rather than just OIC's operational emissions so are not included here. Wider measures such as installing carbon capture technologies at the Shetland ERP are not the responsibility of OIC, and in addition, cost information is not provided because the technology is not commercially available for that purpose.

[151] https://www.susdrain.org/files/resources/evidence/Ricardo_Independent-review-of-costs-and-benefits-of-RWH-and-GWR-Final-Report.pdf

G.13 Summary

The table below summarises the cost estimates for each category listed above. **This must be read in conjunction with the explanatory notes and caveats provided elsewhere in this document.**

Indicative capital costs refer to the total costs, not the additional costs compared to a baseline situation or like-for-like replacement.

The GHG impacts depend on the specific technology that is chosen and the relative GHG intensity of the fuel or electricity that is used. For each category, the 'Total' represents the maximum GHG reduction in this category once the measures are implemented *and* once there is a fully decarbonised energy supply, e.g. via the electricity grid, green hydrogen, or other alternatives.

Table 27. Summary of estimated costs and GHG impacts of different categories of mitigation measures

Description	Indicative capital cost (£)	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
OIC buildings				
Lighting & appliance efficiency, and fabric upgrades	£25-54m	Up to £250K per year	-625	OIC
Replacing fossil fuel heating systems		Unknown	*	OIC
Total	**£25-54m**	Unknown	**-6,250**	**OIC**
Tenanted properties				
Lighting & appliance efficiency, and fabric upgrades	£2.5-3m	£2,000-£5,000 saving	*	Capital costs: OIC Energy bills: Tenants
Total	**£2.5-3m**	**£2,000-£5,000 saving**	**-30**	**As above**
Social housing				
Fabric upgrades	£25.2m	£10-£300 saving per household	*	Capital costs: OIC Energy bills: Tenants
Total	**£25.2m**	**£10-£300 saving per household**	**-2,050**	**As above**
Vehicle fleet				
Operational measures	N/a	£18K	-54	OIC
Replace fossil fuel vehicles	£20-£30m	Unknown	*	OIC
Total	**£20-£30m**	**Unknown**	**-1,075**	**OIC**
Construction				
Operational measures	N/a	£20K	-27	OIC
Replace fossil fuel vehicles	£6m	Unknown	*	OIC
Total	**£6m**	**Unknown**	**-539**	**OIC**
Bus Services				
Operational measures	N/a	£250K *(assumes no increase in*	*-1,582*	Operational costs: Direct benefit to operator; long-term indirect benefit to OIC

Description	Indicative capital cost (£)	Operational costs or savings per year	GHG impact* (tCO_2e)	Who incurs the costs or benefits from savings?
Replace fossil fuel vehicles	£20m	*public transport usage)*		Capital costs: OIC, Scottish Gov't Operational costs: Direct benefit to operator; long-term indirect benefit to OIC
Total	**£20m**	**£250K**	**-1,582**	**As above**
Inter-Isles Air Service				
Replace fossil fuel aircraft	£6-£12m	Unknown	*	Capital costs: OIC, potential funding from Scottish Gov't Operational costs: Direct benefit to operator; long-term indirect benefit to OIC
Total	**£6-£12m**	**Unknown**	**-412**	**As above**
Ferries				
Operational measures	N/a	£75K	-500	Orkney Ferries
Replace fossil fuel vessels	£270-400m+	Unknown	*	OIC, Scottish Gov't
Total	**£270-400m+**	**Unknown**	**-10,000**	**As above**
Harbour Craft				
Operational measures	N/a	£15K	-105	OIC
Replace fossil fuel vessels	£38-47m	Unknown	*	OIC, Scottish Gov't
Total	**£38-47m**	**Unknown**	**-2,100**	**As above**

** The GHG savings will change depending on the carbon intensity of the electricity grid or any alternative fuels that are used. The 'Total' represents the maximum GHG reduction in this category once the measures are implemented and once there is a fully decarbonised energy supply, e.g. via the electricity grid.*

The above costs do not include the cost of additional infrastructure e.g. charging for electric vehicles, electricity grid upgrades, bunkering for alternative fuels, etc.

Appendix H Putting the costs into context

This section provides further information to support **Figure 9**, presented in **Section 4.4**.

H.1.1 Net zero compared to Gross Domestic Product (GDP)

The annual average cost of reaching net zero for the UK is around 0.2% of GDP

The costs of GHG mitigation measures should be considered in the context of wider economic activity. The CCC estimates that, "*the net costs of Net Zero will be around 0.2% of UK GDP per year on average in our pathway, with investment upfront leading to net savings during the Seventh Carbon Budget period [2038-2042]*."

In the context of the whole UK economy, 0.2% of GDP per year is small – roughly equivalent to £2 out of every £1,000 the economy produces annually, and comparable to the scale of normal year-to-year fluctuations in government spending or economic growth. These costs are modest relative to the size and volatility of the economy, spread over decades, and partly (or fully) offset by benefits such as lower fuel costs, reduced climate damage, improved air quality, and increased energy security.

H.1.2 The risk of inaction

Aside from the fiscal costs incurred to transition from a fossil fuel-based to a net zero emissions economy, there are costs associated with:

- **Damage**: the costs to government from the damage to the economy and public finances caused by a hotter climate with more extreme weather
- **Adaption**: the costs to government of measures taken to reduce the impact on, and increase the resilience of, the economy to higher temperatures and increasingly volatile and extreme weather

The OBR report on fiscal risks and sustainability (2025) highlights that, "***climate change poses significant risks to economic and fiscal outcomes in the UK.***" If the world warms by 3°C – which is plausible based on current trajectories – the OBR estimates that the cost of climate damage could equate to 8% of GDP by the 2070s. If, on the other hand, global temperature rises are kept below 2°C (as stipulated by the Paris Agreement), the UK's GDP would be around 3% lower in the 2070s compared to a no climate change scenario. In other words: **even if there is no further action taken to limit climate change, people, businesses and governments will still have to pay the price of inaction**; but collective action to reduce emissions can reduce the cost.

H.1.3 The wider co-benefits of decarbonisation

Policies in the Scottish Climate Change Plan could deliver £6.3 billion in value to Scotland from 2026-2040

The transition to net zero is expected to provide offer significant co-benefits for communities in Orkney. Research undertaken by the University of Edinburgh has modelled 11 types of co-benefits associated with net zero policy measures. The analysis, which was referenced in Scotland's Climate Change Plan, found that, in combination, these "*could deliver over £6.3 billion worth of value to Scotland between 2025 to 2040, which is a **per capita benefit of***

£1,150 over the 15-year period."[152] The co-benefits for Scotland, anticipated over the 15-year period, included:

- £1.5 billion associated with better air quality
- £180 million from *"addressing dangers associated with excessively cold homes"*; and
- £4 billion due to increases in active travel, with the physical activity leading to improvements in human health

Downscaling these results to Orkney, the research indicates **local area benefits of £67 million**.[153]

H.1.4 Job creation opportunities

The net zero transition could provide hundreds of new jobs in Orkney

The net zero transition offers opportunities for new sources of employment, with some estimates being "*between 135,000 to 725,000 net new jobs"*.[154] Within Scotland, it is estimated that the majority of these jobs would be in the buildings and energy sector, but also in transport and waste/circular economy.[155] There are also opportunities in the environment sector, on projects such as peatland restoration. NatureScot estimates that the workforce required to implement peatland restoration in future ranges between 380 to 1,340 jobs nationally, depending on the scale of projects being carried out.[156]

Scaling these figures by population, that could result in approximately **200-300 net new jobs across Orkney**. Analysis by X-Academy, which was used to underpin the OIC Offshore Development Strategy, suggested that the number of new jobs in Orkney associated with renewable energy alone could be several times higher than this figure.[157]

H.1.5 The value of investing in climate adaptation measures

Evidence suggests that investment in adaptation measures can result in lower costs overall due to the avoided costs of damage and avoided impacts on human health and wellbeing. The **ratio of benefits to costs typically range from 2:1 to 10:1**, according to evidence used in the Third UK Climate Change Risk Assessment (CCRA3).[158] The ratio depends on the specific context and project in question, but this highlights the benefits of early action to improve the climate resilience of communities and infrastructure.[159]

Climate adaptation measures can deliver £2-10 in benefits (including avoided damages) for every £1 invested

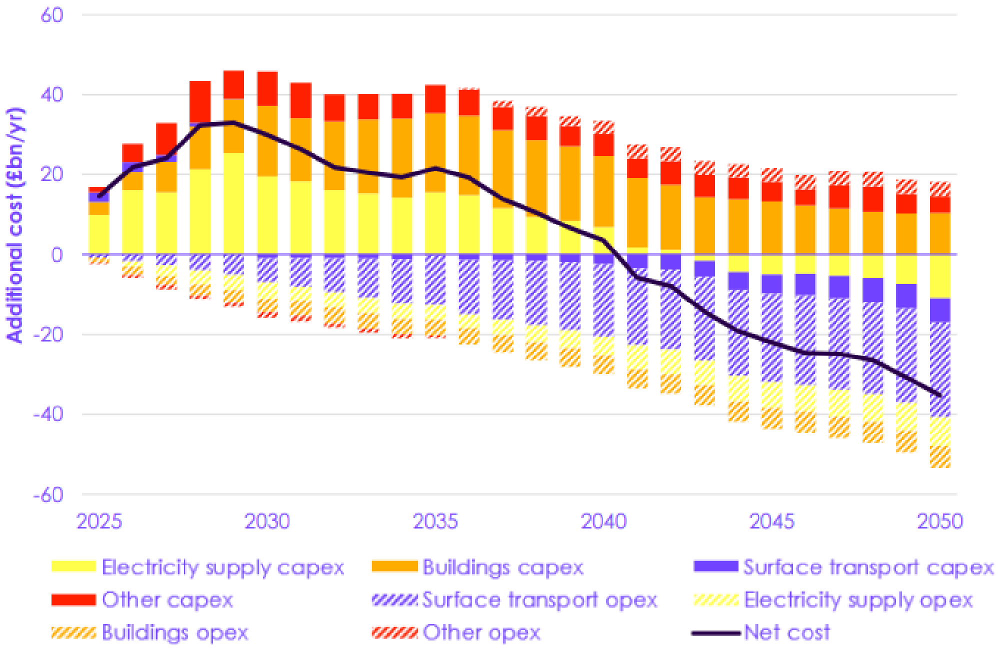
H.1.6 The cost of net zero compared to business as usual

The CCC has calculated that, **compared to a business as usual future with a high-carbon economy, a net zero future would be lower cost from the 2040s onwards**.[160] This is primarily because the initial

[152] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2025/11/scotlands-climate-change-plan-2026-2040/documents/scotlands-draft-climate-change-plan-20262040/scotlands-draft-climate-change-plan-20262040/govscot%3Adocument/scotlands-draft-climate-change-plan-20262040.pdf
[153] https://ukcobenefitsatlas.net/location?location=S12000023
[154] https://www.theccc.org.uk/wp-content/uploads/2023/05/CCC-A-Net-Zero-Workforce-Web.pdf
[155] https://www.stuc.org.uk/resources/stuc-green-jobs.pdf
[156] https://www.nature.scot/doc/peatland-action-mapping-current-and-future-workforce-and-skills-requirements-peatland-restoration
[157] https://www.orkney.gov.uk/media/t3sdvpp5/item-07-oic-offshore-energy-development-strategy.pdf
[158] https://www.ukclimaterisk.org/wp-content/uploads/2021/06/Monetary-Valuation-of-Risks-and-Opportunities-in-CCRA3.pdf
[159] https://www.theccc.org.uk/wp-content/uploads/2023/01/Investment-for-a-well-adapted-UK-CCC.pdf
[160] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf

capital expenditure in some sectors, such as building retrofits, heating system replacements and renewable energy, would be compensated by operational cost savings, particularly in the transport sector. This is illustrated in the graph below, which is reproduced from the CCC's 7th Carbon Budget report.

Figure 13 Additional capital expenditure and operating costs in the CCC Balanced Pathway, compared to the baseline. Source: CCC, 7th Carbon Budget, Figure 4



Analysis produced as part of the Scottish Climate Change Strategy 2026-2040 suggests that, *"most of the direct benefits are anticipated to go to households and businesses."* [161] It anticipates significant financial benefits associated with changes such as:

- Switching from petrol and diesel to electric vehicles, potentially reducing fuel bills by over £500 per year
- Funding schemes for sustainable farming practices, benefitting agricultural businesses
- Carbon markets/credits, and the increased use of timber to build low carbon homes, which would support forestry businesses

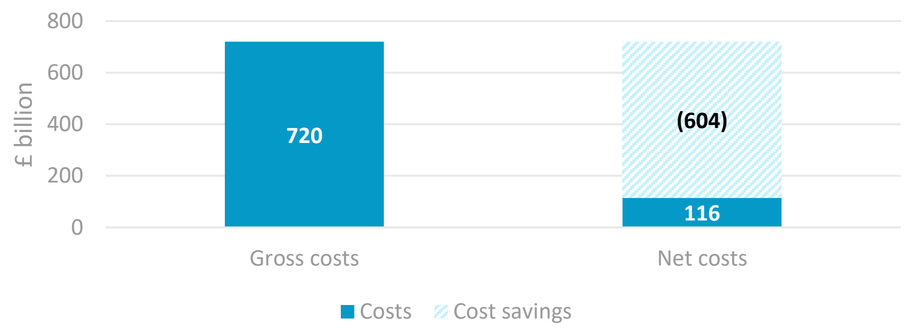
H.1.7 Net vs gross costs

The cost information presented in this study (see **Section 4** and **Appendix G**) focuses on gross costs, meaning the total upfront investment needed to reduce emissions. This study has not calculated net costs, which would adjust these upfront investments to account for savings and avoided 'business as usual' expenses. Those would include, for example, fuel bills, vehicle fleet turnover, and routine building maintenance or boiler replacements. For OIC, as is the case for the UK and Scotland more broadly, the total **net costs of GHG mitigation measures would usually be lower than the gross costs**. This is important to bear in mind when interpreting the figures in Section 4 and Appendix G.

[161] https://www.gov.scot/publications/scotlands-climate-change-plan-2026-2040/pages/5/

The graph below illustrates the difference in gross versus net costs for the UK as a whole, as set out in the Office for Budget Responsibility (OBR)'s recent report on fiscal risks and sustainability (2025).[162] **According to the OBR, "the net cost to the economy of reaching net zero", based on the measures in the CCC's 7th Carbon Budget, are expected to be £116bn, which is around 84% lower than the gross costs of £720bn**, as shown in the graph below.

Figure 14. Gross cost vs. net cost to the economy of reaching net zero, over the 26 years from 2025 to 2050. Source: OBR



H.1.8 Conclusion

Although the costs associated with GHG mitigation are significant, there is strong evidence that the net zero policies can provide a range of economic and social benefits. These include potentially significant bill savings for households, as well as job opportunities for the community.

The costs should also be understood in context as part of the wider economic health of the country, and compared to the consequences for GDP and other risks associated with a collective failure to reduce global GHG emissions.

[162] https://obr.uk/docs/dlm_uploads/Fiscal-risks-and-sustainability-report-July-2025.pdf

Appendix I Summary of responses from OIC officer workshop

As part of this study, a virtual workshop was held with OIC officers in June 2025. It was attended by a total of 12 representatives from multiple OIC departments, with individuals holding responsibility for a variety of service areas, including but not limited to:

- Climate change and energy
- Council housing
- Public transport
- Planning
- Strategic projects
- Economic development
- Waste
- Construction and quarries

During the workshop, attendees were asked to respond to some virtual polling questions, the results of which are described below.

Q: How clear are you on what your service area can do to reduce GHG emissions?

Attendees were given four options: (1) Very clear (2) Somewhat clear (3) Unclear and (4) Not relevant to me. Six attendees responded that they were 'very clear' and six were 'somewhat clear'. No attendees selected options 3 or 4, indicating a good level of level of awareness of GHG reduction. This was affirmed through the virtual and in-person workshops and separate one-on-one meetings with individuals from different departments.

Q: How does climate change fit into your team's current priorities or ways of working?

Attendees were given the opportunity to submit anonymous, free text responses to this question. The most prominent theme among the replies was that they are aware that climate change is a strategic priority, but this does not necessarily translate to specific action. Many of the attendees highlighted that it is only one of many conflicting priorities that they are expected to address. Some example quotes are provided below.

> *"There is good awareness and broad understanding of concepts and need to 'act' but I wouldn't say there is specific prioritisation or 'urgency' at the moment over any[thing] else [we] have to work with."*
>
> *"We are aware but it's not a priority."*
>
> *"Part of our considerations but only one of many and not the most important."*
>
> *"There is a clear appetite for doing the right thing within the team, but it's not a core consideration /not clear how best to pursue."*

One or two attendees did say that climate change is a more significant focus or priority:

> *"It is a significant part of it."*
>
> *"At the top of the list when considering all work, rather than the fall back position."*

Some attendees also highlighted that there is ongoing monitoring and that climate change is present in existing strategies for their service area:

> *"We have on-going monitoring for climate change."*

"Built into procurement to encourage contractors and consultants to think about their services and wider impact."

Q3: What would make it easier to take action on climate within your team or area?

Responses to this question addressed several themes, with the majority of responses relating to funding/budgeting processes, staff resources and practical support, and the need for clear leadership on climate issues. All responses are listed below; these are grouped by general theme.

1. Availability of funding; timescales and procedures for obtaining funding; budgeting processes

"Multi year funding"

"Give us the money rather than having to spend lots of time bidding"

"More funding, more time/capacity, longer term funding, less funding options, direct funding to local authorities and less administration around this."

"Feasibility funding to allow pipeline projects"

"Multi grant projects complicate things even further, so single stream would assist"

"OIC processes to enable getting through funding quicker. The negative to this for example is then having two procurement processes, one for general and another for grant funding"

"Funding bodies to have a realistic picture of public sector process."

"Funding that is about delivery not just innovation"

2. Practical support, including more time and officer resource to plan and implement projects, and clarified requirements:

"Staff time"

"Access to communication support and stakeholder engagement, champions"

"Time is next limiting factor"

"Clear standards and requirements."

"Ability to take forward projects - accommodation/skills"

"Capacity + get away from the constraint of a financial year (or part year)"

"Less standards and requirements"

"Clear targets for each team / service areas"

"Specific targets (policy or specific deliverables) to achieve (after have money)"

"Recognition of need for 'people resource' to plan, and deliver projects - not just run on end of desks"

3. Leadership, whether from within OIC or externally from the government

"Government actually prioritising climate change"

"Accountability - most councils have had an Environmental Team for decades"

"More detailed and specific corporate policies, compelling action"

"Legislation (to push the more expensive, lower emission option) and accompanying longer term funding to cover the difference"

"Priority and support"

4. Availability and reliability of solutions that can meet service requirements, specific to Orkney

"Availability of proven alternative fuels / vehicles / technology at reasonable prices and that are deliverable."

"Access to technology at mainland prices"

"National regulation hindering development in the islands where it doesn't apply"

5. Other issues raised:

"Need to partner with external organisations"

"Contractor availability"

"Space to innovate"

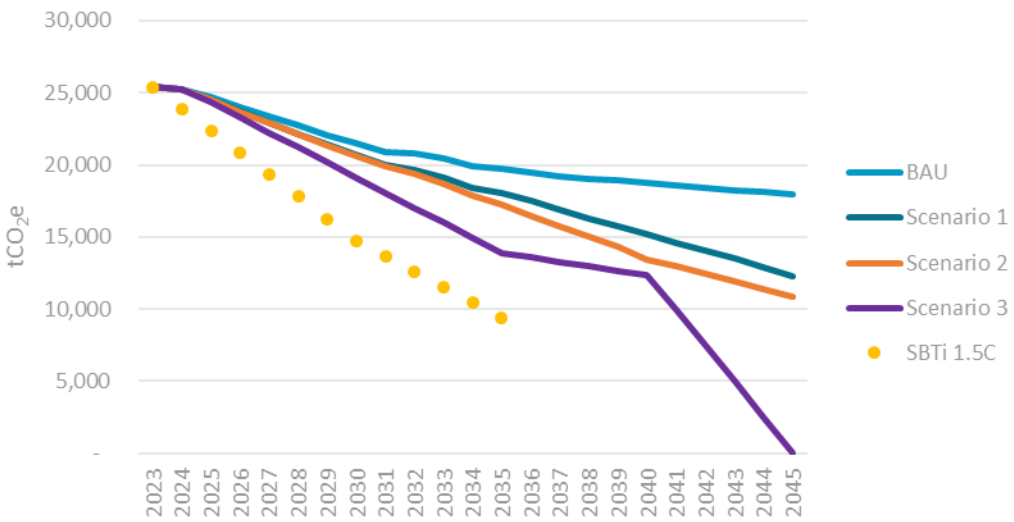
"Educating building users to save by turning down thermostats, turning things off."

Appendix J Comparing OIC's decarbonisation pathways against a 1.5°C scenario

In the Invitation to Tender (ITT), OIC requested that one of the decarbonisation pathways modelled in this study 'must be aligned to a 1.5 degrees Science-Based Targets approach.' In plain terms, this means following a pathway where greenhouse gas emissions fall rapidly in the near term, in line with global pathways that give a reasonable chance of limiting global warming to 1.5°C. These pathways are based on scientific estimates of the remaining global carbon budget and the rates of decarbonisation required across different sectors.

The Science-Based Targets Initiative (SBTi) target-setting tool is a free resource which has been used to assess the near-term GHG reductions that OIC would need to achieve in order to claim that it was aligned with this approach.[163] From a 2023/24 baseline, the targets would be (1) a 42% reduction in emissions by 2030 or (2) a 63% reduction in emissions by 2035.

The chart below shows the SBTi-aligned pathway as a dotted orange line, compared to the BAU pathway and the low, medium and high ambition scenarios described in Section 3 above. None of the modelled pathways meet the required pace of GHG reduction.



Aether's Carbon Scenario Model (CSM) was then used to test out different packages of mitigation measures enabling OIC to get closer to the science-aligned trajectory. The analysis indicated that meeting the 2030 target would involve replacing all fossil fuel heating systems and all buses with EVs *and* supplying 100% renewable electricity to meet the additional demand by 2030. Assuming the national grid is not net zero by that year, the latter would potentially have to be achieved with additional local renewables. For context, if OIC wanted to supply that amount of electricity via private wire, this would require around 10-15 MW of wind capacity, plus battery storage. Since, at the time of writing, it is late 2025, this would need to be accomplished within the next 4 years.

Meeting the SBTi 2035 target would involve all of the above, in addition to replacing almost all vehicles (including HGVs) and construction plant with zero-emission

[163] https://sciencebasedtargets.org/resources

alternatives. OIC would also need to achieve a 30-35% reduction in emissions from marine services through some combination of operational measures, engine repowering/retrofits, electrification, hybridisation or other zero emission technologies. All of those changes would need to take place by 2035.

This analysis suggests that OIC would not be able to achieve the scale of GHG reductions needed to comply with such an approach. This is primarily due to the challenge of decarbonising the ferry fleet which has a large impact on the calculations. However, near-term reductions are possible for other sources of emissions. OIC can still demonstrate a high level of ambition by bringing forward those mitigation measures.

Appendix K Definitions of offsetting, and the future outlook for offsetting approaches

A range of guidance advises organisations on how to treat residual emissions, advising on the use of offsets and insets, though many are tailored to large corporates rather than local authorities. This section presents further discussion of the main guidance applicable to public bodies in Scotland, set out in support of Section 44 of the Climate Change (Scotland) Act 2009, alongside key corporate standards and principles that influence offsetting/insetting practice elsewhere.

Draft statutory guidance for public bodies

Section 44 of the Climate Change (Scotland) Act 2009 requires public bodies, in exercising their functions, to act '*in the way best calculated to contribute to the delivery of the [national climate change] targets*'.[164] Guidance to support public bodies in their climate change duties was published in 2011, though this guidance was principally focused on emission reductions and adaptation, and was written prior to the adoption of Scotland's 2045 net zero target in 2019. The 2011 guidance, therefore, does not cover the need to compensate for residual emissions. In February 2023 the Scottish Government produced updated guidance for public bodies on offsetting and insetting.[165] In February 2025, Scottish Ministers consulted upon newly updated guidance, the draft of which includes guidance on the treatment of residual emissions, in Section 5.4.6 (hereafter 'the draft guidance').[166] This draft guidance, though still being consulted upon, remains the most relevant and applicable to OIC.

This draft guidance delineates between insetting and offsetting and encourages any projects or procurement of carbon credits to be local to Scotland, in order to contribute towards the delivery of Scotland's net zero target. Insetting, in accordance with the draft guidance, refers to activities that avoid, reduce or remove emissions within the organisation's operational boundary.[167]

The draft guidance does, however, define insets as occurring on an organisation's 'own landholdings or, by agreement, on the wider public estate'. This would differ to how insetting is understood in key corporate standards. For example, the Science Based Targets Initiative's (SBTi) define insetting as 'climate mitigation projects or programs wholly contained within the scope 3 value chain boundary of a company or projects partially within its scope 3 supply chain boundary (spanning their supply chain and other companies' supply chains)', whilst noting there is no widely accepted definition of the term. Insetting, therefore, need not be limited to organisation's own landholdings or that of the wider public estate, and can extend across Scope 3 supply chains.

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[164] Climate Change (Scotland) Act 2009, available at: https://www.legislation.gov.uk/asp/2009/12/section/44

[165] https://sustainablescotlandnetwork.org/news/offsetting-guidance-published-for-public-bodies

[166] Energy and Climate Change Directorate (2025), Climate change duties - draft statutory guidance for public bodies, available at: https://www.gov.scot/publications/climate-change-duties-draft-statutory-guidance-public-bodies-consultation/pages/0/

[167] In the draft guidance, the operational boundary refers to the boundary as practiced in the GHG Protocol Corporate Accounting and Reporting Standard, referring to scopes 1,2 and 3, across emissions sources owned or controlled by the organisation and those arising indirectly from the activities of the organisation owned and controlled by another organisation. See Chapter 4 of the GHG Protocol Corporate Accounting and Reporting Standard, available at: https://ghgprotocol.org/corporate-standard In Scotland the guidance extends this to the wider public estate.

Offsets, within the draft guidance, refer to projects taking place elsewhere, without a direct connection to the organisation, that similarly avoid, reduce or remove emissions. Offsets can be certified against a set standard (for example, in the UK, the Woodland Carbon Code and Peatland Code) and transacted on the voluntary carbon market (VCM) as carbon credits.

The outlook for carbon offsetting/insetting

The wider landscape of corporate standards, along with the guidance towards carbon offsetting/insetting, is currently undergoing major revisions following criticism. The SBTi Corporate Net Zero Standard, for example, one of the largest corporate standards covering nearly 3,000 companies, is currently being revised following criticisms that the standard's targets lack transparency[168] and are largely based on arbitrary benchmarks[169]. Similarly, a new 'Net Zero Standard' is currently being developed by the International Standards Organization (ISO), following the publication of guidelines in 2022[170]. Initiatives such as the Voluntary Carbon Markets Integrity Initiative (VCMI) and the Integrity Council for the Voluntary Carbon Market (ICVCM) were both launched in 2021 to improve the use of offsets by corporates and their design by project developers[171].

These efforts have coincided with several scandals that have reduced confidence in the VCM and the demand for offsets. For example, research published in 2024, found that a vast majority, 84%, of carbon credit projects spanning avoided deforestation, fuel-efficient cookstoves and fluorinated gas destruction, are unlikely to constitute real and additional emissions reductions[172]. This research followed articles published in 2020, 2022 and 2023 that found that a majority of avoided deforestation projects certified by the world's largest certifier of carbon offset projects, Verra, did not significantly reduce deforestation.[173]

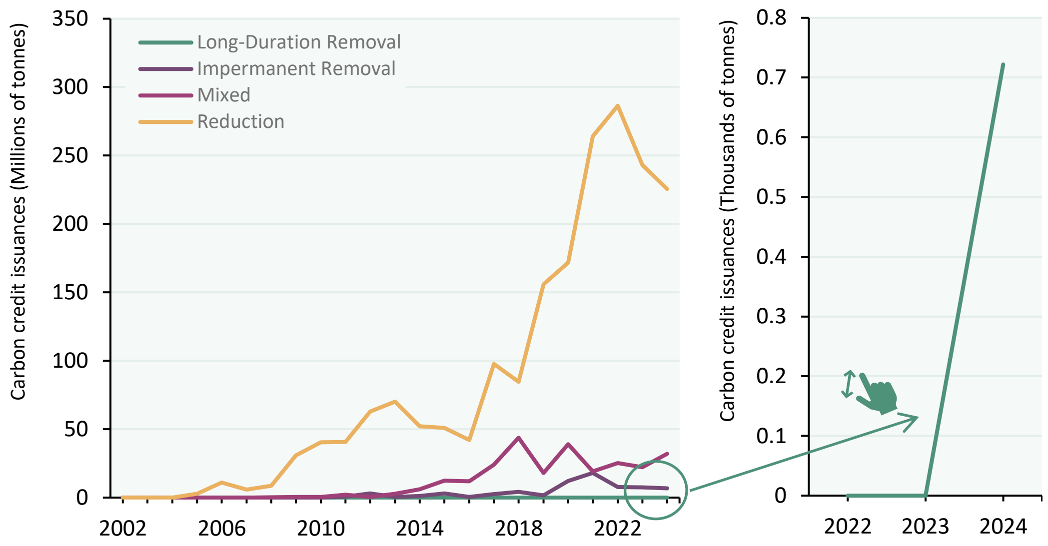
Whilst these projects take place outside of Scotland and the UK, many in developing country contexts, they can impact upon the direction of corporate standards and offsetting practice. For example, the draft guidance for public bodies prioritises standards such as the Woodland Carbon Code and the Peatland Code, in part owing to their stricter requirements towards additionality and permanence when compared to the standards common to international projects.[174]

Elsewhere, some corporate standards and guidance are responding by prioritising credits representing removals over emission reduction credits. For example, the ISO 2022 Net Zero Guidelines advises that organisations should '*counterbalance residual emissions only through investment in high-quality removals which can be in the value chain or through removal-based offsets*'[175]. This is advocated on the basis that a net zero claim is only sufficient if residual emissions are compensated by the physical removal of

[168] Bjørn et al., 2023, Increased transparency is needed for corporate science-based targets to be effective, Nature Climate Change, available at: https://www.nature.com/articles/s41558-023-01727-z
[169] Reisinger et al., 2024, Science-based targets miss the mark, Communications Earth & Environment, available at: https://www.nature.com/articles/s43247-024-01535-z
[170] ISO (2024), Creation of international standard on net zero gets underway, available at: https://www.iso.org/contents/news/2024/06/netzero-standard-underway.html
[171] DESNZ (2025), Voluntary carbon and nature markets: raising integrity, available at: https://www.gov.uk/government/consultations/voluntary-carbon-and-nature-markets-raising-integrity
[172] Probst et al., (2024), Systematic assessment of the achieved emission reductions of carbon crediting projects, Nature Communications, available at: https://www.nature.com/articles/s41467-024-53645-z
[173] West et al., 2020, Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon, PNAS, available at: https://www.pnas.org/doi/abs/10.1073/pnas.2004334117 , Guizar-Coutiño et al., 2022, A global evaluation of the effectiveness of voluntary REDD+ projects at reducing deforestation and degradation in the moist tropics, Conservation Biology, available at: https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/cobi.13970 , and ,West et al., 2023, Action needed to make carbon offsets from forest conservation work for climate change mitigation, Science, available at: https://www.science.org/doi/abs/10.1126/science.ade3535
[174] Page 128 of the draft guidance.
[175] ISO (2022), IWA 42:2022(en) Net zero guidelines, available at: https://www.iso.org/obp/ui/#iso:std:iso:iwa:42:ed-1:v1:en

an equivalent amount of CO_2 directly or indirectly from the atmosphere[176]. This is a large shift compared to prior practice in the VCM, where all but 3% of carbon credits issued in 2024 represent removals[177]. As shown below in Figure 15, Long-Duration Removal projects are historically limited shown and hence are too small to appear in the graph on the left; the graph on the right therefore zooms in to focus on these numbers for 2022-2024. Whilst this is a requirement at the global scale to attain net zero, it is contested as to whether this also applies to sub-national entities, such as local authorities[178]. The draft guidance currently aligns with the prioritisation of removals[179], however, it is key to note that this remains contested and may be subject to change.

Figure 15. Carbon credit issuances by type on the VCM. Source: Berkely Carbon Trading Project (2025), Voluntary Registry Offsets Database v2025-08



More recent standards have proposed a transition to not only removals but more permanent methods of CDR. For example, the draft revised SBTi Corporate Net Zero Standard recommends a *'like for like approach, based on the atmospheric lifetime of the GHG residual emissions being addressed'*, meaning fossil CO_2 emissions, owing to their longer residence time in the atmosphere, must be compensated by CDR methods that store CO_2 on geological timescales[180]. Similarly, the Oxford Offsetting Principles, guidance published by leading academics at the University of Oxford, advocates that organisations, in their offsetting, '*shift to removals with durable storage (low risk of*

[176] Allen et al., 2022, Net Zero: Science, Origins, and Implications, available at: https://doi.org/10.1146/annurev-environ-112320-105050
[177] Berkely Carbon Trading Project (2025), Voluntary Registry Offsets Database v2025-08, available at: https://gspp.berkeley.edu/berkeley-carbon-trading-project/offsets-database
[178] Möllersten et al., 2024, Demystifying carbon removals in the context of offsetting for sub-global net-zero targets, available at: https://doi.org/10.1080/17583004.2024.2390840
[179] With the exception of the Peatland Code, which largely certifies emission reductions from degraded peatlands.
[180] SBTi (2025), SBTi Corporate Net Zero Standard Version 2.0 - Initial Consultation Draft, available at: https://sciencebasedtargets.org/developing-the-net-zero-standard

reversal) to compensate residual emissions by the net zero target date'[181]. In practice this means the prioritisation of CDR methods that store CO_2 geologically, rather than in the ecosystem as in the case of nature-based solutions (NbS). Whilst this guidance does not impact directly on Scottish climate policy, the UK government is considering acknowledging the need for '*geological net zero*', whereby '*residual fossil fuel emissions are balanced with geologically permanent removals*' in policy design and national targets[182]. The draft guidance, therefore, does not fully reflect the direction of corporate standards and UK climate policy (although noting that it is aimed at a different audience). On the other hand, the prioritisation of more permanent methods of CDR is also contested, both on the basis that (within transitions) near term emission reductions are still required at scale and also the fact that the availability of more permanent methods of CDR is currently limited in the UK and globally[183]. Their higher cost when compared to NbS, similarly may dissuade participation in the VCM and the overall willingness of organisations to engage in climate action[184].

To maximise participation in the VCM and corporate climate action, some advocate for a need to dispense with offsetting, instead adopting a 'contribution approach', whereby emissions are instead priced according to a carbon price and the funds generated used to finance climate action beyond an organisation's supply chain (or organisational boundary)[185]. This could extend to the procurement of carbon credits without their retirement against the emissions presented in the organisation's greenhouse gas inventory[185]. The advocacy of a contribution approach coincides with attempts to recognise an organisation's wider contribution to climate action, beyond their direct and indirect emissions, such as recognising their efforts in political advocacy or the climate benefits of the products and services they provide[186]. This aligns with the notion presented in the draft guidance, that the efforts of public bodies should contribute to the delivery of Scotland's climate targets. With this in mind, it may be advisable to explore approaches that contribute towards delivery beyond the reduction of emissions.

In conclusion, the draft guidance remains the most relevant and applicable to OIC. However, it is important to recognise that corporate standards and offsetting practices are continually changing, presenting a need to regularly revise OIC's approach to offsetting.

[181] Axelsson et al., 2024, Oxford Principles for Net Zero Aligned Carbon Offsetting (revised 2024), Smith School of Enterprise and the Environment, University of Oxford, available at: https://www.smithschool.ox.ac.uk/research/oxford-offsetting-principles
[182] DESNZ (2025), Independent Review of Greenhouse Gas Removals, available at: https://www.gov.uk/government/publications/greenhouse-gas-removals-ggrs-independent-review
[183] CO2RE (2025), The UK State of Carbon Dioxide Removal, available at: https://co2re.org/wp-content/uploads/2025/07/UK-State-of-CDR-Report.pdf
[184] Letter 'Do Not Rule Out Nature from Climate Action: the Scientific Imperative for Incentivizing Natural Climate Solutions on the Path to Net Zero', signed by 160+ scientists and carbon market actors, available at: https://docs.google.com/document/d/17Thti_gG-rqiuoybj1EUpzR59ZjRCsWDRuni3aHmN4o/edit?ref=csofutures.com&tab=t.0#heading=h.ytwmlzsgf59a
[185] Wuppertal Institut (2024), A guide to implementing the contribution claim model, available at: https://allianz-entwicklung-klima.de/wp-content/uploads/2024/09/2409_Guide_Contribution-Claim-Model.pdf
[186] Axelsson et al., (2024), Is impact out of scope? A call for innovation in climate standards to inspire action across companies' Spheres of Influence, Carbon Management, available at: https://www.tandfonline.com/doi/full/10.1080/17583004.2024.2382995

Appendix L NbS assessment methodology

L.1 Introduction

This section describes the approach and data sources used to estimate the CO_2 sequestration or avoidance rates[187] for different project types, and the technical land availability to carry out NbS projects.

It is important to note that there are differences between how GHG reductions are accounted for in:

- National Government reporting, especially relating to land use change,
- the wider range of national decarbonisation-related plans, policies and strategies and
- how the voluntary carbon offset market operates.

So, for example, although closely aligned, the methodology that underpins the Woodland Carbon Calculator tool will have some differences to those used by the IPCC in developing national GHG inventories, and the Local Authority GHG dataset published annually by DESNZ. The NbS estimates presented in this report are intended to help inform OIC's decision-making and potential future stakeholder engagement, not to produce an IPCC-compliant carbon flux analysis. For context, the area-wide land use emissions in Orkney, as reported in the DESNZ statistics, are presented in **Appendix Q**.

L.2 CO_2 sequestration or avoidance rates

Typical CO_2 sequestration or avoidance rates for different methods have been obtained from the literature. These are based on a combination of IPCC emission factors as used in the UK GHG Inventory, along with evidence from NatureScot, ClimateXChange, Defra, the Centre for Ecology and Hydrology (CEH), the Woodland Carbon Code and Natural England. Interviews with technical experts, including experts with specific local knowledge, have been used to provide additional context where relevant.

Table 28. Rates of CO_2 sequestration or avoidance in different NbS project types

Description	GHG impact (tCO_2e/ha per year)	Reference
Woodland creation	-2 to -13	Natural England, *'Carbon Storage and Sequestration by Habitat: Research Report NERR094'* (2022), Appendix 2[188] gives a range of -2 to -13. NatureScot[189] gives a range from -2 to -5, so this has been represented this range as -2 to -13. This range encompasses information from Forest Research and Scottish Forestry.
Peatland restoration	-1.5 to -30	-15 is indicative mid-range value; actual value may range from c. 3-37 tCO_2e/ha according to Defra, *'Aligning the Peatland Code with the UK*

[187] Some NbS projects, such as tree planting or woodland creation, result in carbon being removed from the atmosphere and stored or 'sequestered' in vegetation or soil. On a given piece of land, therefore, there may be net negative GHG emissions. Other projects reduce or avoid GHG emissions that would otherwise occur if there were no intervention, as in the case of peatland restoration. In those cases, the land may still be a net emitter of GHGs, but at a lower rate than before.
[188] https://publications.naturalengland.org.uk/publication/5419124441481216
[189] https://www.nature.scot/doc/guidance-evidence-carbon-and-nature

		Peatland Inventory: Research Report SP0822' (2022).[190] According to interviews carried out with external experts (see **Appendix S**), values specific to Orkney can range from -1.5 to -30, with restored peatland sequestering 0.3 to 0.4.
Grassland restoration/creation	Arable to grassland 0.3 to -2.5	Rees, R.M. et al., '*Soil carbon and land use in Scotland: Final report'* (2018); ClimateXChange, Edinburgh.[191] Aether analysis based on LULUCF emissions data within the 2024 UK GHG Inventory gives a value of -2.23 for cropland.
	Conservation of existing grassland: -2.2	See Footnote 191
Sustainable agricultural practices	Hedgerows: -8 to -22	See Footnote 189
	Increase forage in rotation: 0 to -0.5	See Footnote 191
	Increase yields and residue return: 0 to -0.3	See Footnote 191
	Use organic materials more effectively: -0.1 to -0.8	See Footnote 191
	Improve grazing practices: 0 to -0.1	See Footnote 191
	Increase grassland productivity: 0 to -2	See Footnote 191
	Catch crops: -0.1 to -0.3	See Footnote 191
	Grassland extensification: -0.5 to -0.9	See Footnote 191
	Reduced/no tillage: 0 to -0.7	See Footnote 191
Agroforestry	Alley cropping: -3 to -5	See Footnote 189
	Silvo-pastoral: -5	See Footnote 189
	Shelterbelts[192]: -6	See Footnote 189
	Orchards: -0.5 to -5	See Footnote 189

190 https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectID=21088
191 https://www.climatexchange.org.uk/wp-content/uploads/2023/09/soil-carbon-and-land-use-in-scotland.pdf
192 Note that this value assumes that the species is beech as a default; the OIC Woodland Guide indicates that this may only be suitable in sheltered locations. https://www.orkney.gov.uk/media/p5jfazi4/woodland-design-guide.pdf

	-0.5 to -6	Based on which option is chosen.
Marine	Seagrass: -2.5	See Footnote 189
	Kelp: 0 to -1.4	See Footnote 189. There is likely a temporary carbon store through biomass production and a small proportion of this can be permanently sequestered, however exact values are unknown due to current research gaps. No value is given for what constitutes a 'small proportion', so this is indicatively taken to be between 0-1% of -13.9 (the estimated temporary carbon store). Roughly 30% of dry matter of kelp is assumed to be carbon, as identified in the Task 5 Extension work (see Appendix S), emphasising the existence of this temporary carbon store
	Native oysters	An effective habitat restoration option in terms of environmental benefits, however there are uncertainties as to whether these provide net carbon sequestration, and whether there is net sequestration can also be location specific.[193] Therefore no sequestration values have been estimated due to the research gaps generally in blue carbon potential.
Coastal	Saltmarsh: -4.2 to -5.19	NatureScot (see Footnote 189) gives a value of -4.2 and UK Centre for Ecology & Hydrology, *'Saltmarsh Blue Carbon in UK and NW Europe - evidence synthesis for a UK Saltmarsh Carbon Code'* (2022) gives a value of -5.19.[194]
	Sand dunes: -2.1	See Footnote 189 There is low certainty in this value due to limited research available.
Wetlands	1.6-10.6	See Footnote 189

For all NbS categories, the actual rates of GHG sequestration of avoidance will depend on factors such as the current land use, project design, and management regime.

L.3 Assessing technical land availability for NbS

To determine the technical land available and types of NbS possible on Orkney, the habitats and geography have been assessed from publicly available mapping on terrestrial geography and habitats, soil composition and marine habitats.

Note, OIC has also requested advice on the potential use of LiDAR (Light Detection and Ranging) data to support NbS assessments. This is provided in **Appendix O**.

[193] https://noraeurope.eu/real-time-carbon-budgets-and-the-native-oyster-carbon-sink-or-source-2/
[194] https://www.ceh.ac.uk/sites/default/files/2022-05/Saltmarsh%20Blue%20Carbon%20in%20UK%20and%20NW%20Europe_1.pdf

L.3.1 Terrestrial Geography and Habitats

In this assessment, terrestrial geographies and habitats have been assessed using the 2016 soils and carbon map for Scotland.[195] The map contains seven categories, and for each category shows the proportion of land that is classified as 'existing peatland' (class 1), 'potential peatland' (classes 2, 3, 5), 'soils that may be suitable for peatland restoration' (class 4), and mineral (class 0) or other soil types (-2). For ease of interpretation within the context of this study, categories within the 2016 Peat Map have been aggregated based on broad land use classification types as per the CEH Land Cover Map.[196]

Note that there are numerous publicly available maps which show land cover, land use, habitat types and soil geology across Orkney. For the purpose of assessing carbon sequestration potential, these have different advantages and limitations due to using different data collection methods, classification systems, levels of spatial disaggregation, update frequency, etc. A brief comparison of alternative datasets is presented in **Appendix R**. The land areas these datasets report are not always like-for-like comparable, which means that **the figures below have moderate to high uncertainty**.

Table 29. Terrestrial habitat types across Orkney and associated land area estimates

Habitat type	Land area estimate (km^2)	Peat soils estimate (km^2)
Coastal	37.8	Class 4: 1
Freshwater and wetlands	33	Class 4: 1 Class 5: 1
Bogs and fens	83	Class 1: 47
Grassland	608	Class 3: 7 Class 4: 104 Class 5: 14
Heather	213	Class 3: 7 Class 4: 94 Class 5: 37
Forests and trees	5	N/A
Arable land	12	N/A
Built areas	24	Class 4: 1

L.3.2 Marine geography and habitats

The marine area of Orkney[197] covers approximately 9,258 square kilometres.[198] The National Marine Plan Interactive (NMPi) mapping tool,[61] developed by Marine Scotland, visually identifies habitat types, alongside presenting a range of other data regarding the marine environment in Scotland for use for marine development projects. Data presented in this mapping tool identifies the presence of seagrass beds, kelp beds, and Maerl Beds within the marine environment surrounding Orkney Islands. Additional to this there is the NatureScot dataset which presents the predicted kelp habitats, identifying the potential for Kelp forests across specific locations in the marine

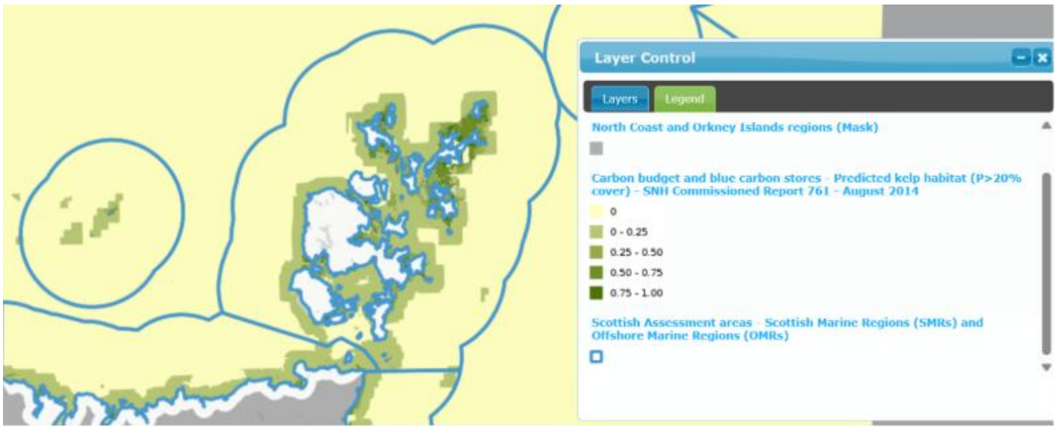
[195] https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/
[196] https://www.ceh.ac.uk/data/ukceh-land-cover-maps
[197] This is defined as the region within a 12 nautical mile buffer zone around the landmass.
[198] https://www.orkney.gov.uk/media/hvipwofn/orkney-islands-regional-marine-plan-consultation-draft-final-2.pdf

environment surrounding Orkney Islands, especially in more sheltered locations and in close proximity to the coastline.

Although data were not available to download, visually it has been estimated based on this mapping that roughly 1-6% of the Orkney marine area consists of kelp habitat. Correspondence with the OIC Marine Planning team indicated that 1-5% of the marine area in Orkney may potentially support kelp habitat; this is an indicative estimate intended to represent a conservative assumption. This is shown in **Map 1** below.

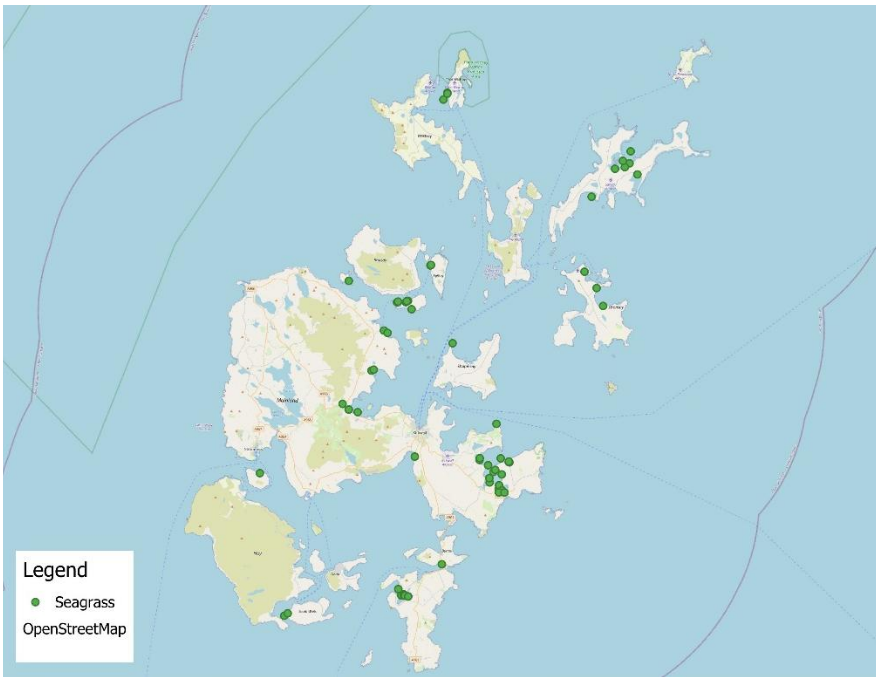
Kelp habitat area was also cross checked with the Blue Carbon audit of Orkney waters[199], which estimates a habitat coverage of 487km², which is within the range estimated from the NMPi mapping tool. Records of seagrass beds were also identified from downloaded data from NatureScot, however only data on occurrence of seagrass beds were available, with no data on area covered. There were 64 seagrass bed records in the Orkney Island area, which are represented in **Map 2**, which have been estimated to comprise ~1% of the marine area. The habitat area of Seagrass noted in the Blue Carbon audit of Orkney waters was 14.23km² based on predictive modelling and ground truthing. Maerl beds are also visually represented in **Map 3**, which have been estimated to comprise ~1% of the Orkney marine area from mapping, with 36km² estimated as part of the Blue Carbon audit.

Map 1: Predicted kelp habitats within the Orkney Islands marine area. Source: NMPI mapping tool



199 https://data.marine.gov.scot/dataset/blue-carbon-audit-orkney-waters

Map 2: Seagrass records within the Orkney Islands marine area. Source: NatureScot gems habitat point dataset.



Map 3: Maerl bed records within the Orkney Islands marine area. Source: NMPi mapping tool.

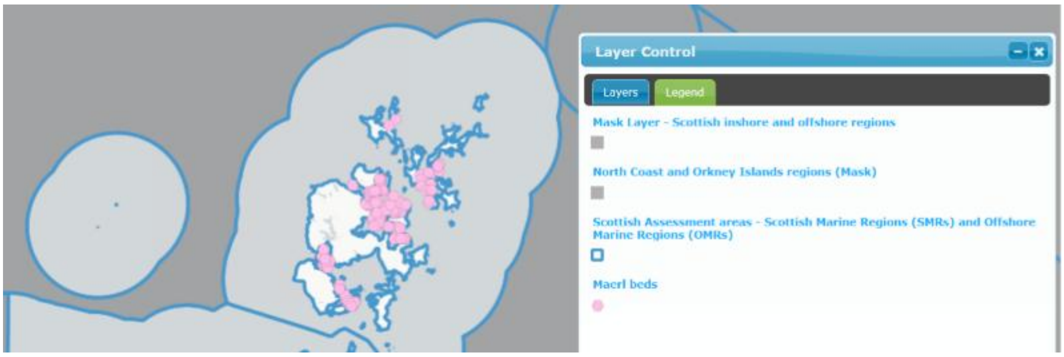


Table 30. Estimated marine habitat cover. Source: National Marine Plan Interactive (NMPi) mapping tool and NatureScot gems habitat point dataset.

Habitat type	Estimated cover (km^2)	Source
Kelp	93 – 487	See footnote 35 and NatureScot gems habitat point dataset
Seagrass	14-93	Footnote 35 and NMPi tool
Maerl beds	36-93	Footnote 35 and NMPi tool

L.3.3 Habitat quality

As evidenced, Orkney contains blanket bog and peat soils, however many of these are degraded due to drainage, grazing, and historic peat cutting.[200,201] Peatland surveys

200 https://www.orkney.gov.uk/media/cyvf52u1/i11_app7_orkney_local_biodiversity_action_plan.pdf
201 https://ruralexchange.scot/island-agriculture/environmental-profile/

across two areas have been conducted by Peatland Action. Based on these data records, there is no current record from the two survey areas on Orkney of any good quality peatland habitat present.[202] Peatland recorded from this survey is all degraded or drained. Therefore, it has been assumed that most peatland present on Orkney could be restored to some extent. Note that a previous report by SRUC assumed that the potential for peatland was restricted to areas of bare peat, and therefore produced a much lower estimate. The realistic figure is likely to be between these two estimates. Please see **Appendix S** for more information.

In comparison, Orkney's marine environment is typically identified as being of high quality and protected, such as by the North-West Orkney Nature Conservation MPA, which involves fisheries management measures.[203] Additionally, at a broader level, the Orkney Islands Regional Marine Plan integrates MPA protections into local marine management. This means that development proposals (e.g., aquaculture sites, harbours, or renewable energy projects) must undergo Habitats Regulations Appraisal to ensure they do not negatively affect designated site.[204] However, the *Orkney Marine Natural Capital Assessment* and *State of the Environment Assessment* highlight pressures from fishing, aquaculture, and climate change on these habitats[205] which pose a risk to maintaining future habitat quality in this region.

L.3.4 Additional information from OIC

OIC has provided Aether with a map of its landholdings, as well as those of the Royal Society for the Protection of Birds (RSPB), overlaid with the Peatland 2016 Map. The map indicates that OIC holds a relatively limited proportion of land containing carbon-rich soils and peatland, suggesting that the main opportunities for NbS projects on Council-owned land may involve tree planting, with some peatland restoration potential. Across Orkney as a whole, and RSBP's landholdings, there are a significant proportion of areas of confirmed or likely carbon-rich soils. However, the current mapping does not provide detailed landownership information for this area beyond OIC and RSPB ownership, presenting a gap in understanding that will require further investigation. Clarifying ownership boundaries and assessing the condition of these habitats will be important for identifying potential project sites and helping to prioritise future NbS across Orkney. OIC officers have advised that some low-risk project opportunities may be identified relatively easily from existing knowledge / information already held by local stakeholders and relevant OIC departments. With further project resourcing these could be investigated and where suitable pursued in the near term.

L.3.5 Technical land areas available for NbS

In **Table** 31 below, the technical land available for each NbS type is estimated, using the data discussed in the previous sections. If land was found to be potentially suitable for multiple NbS project types, prioritisation was given in order of peatland projects, woodland projects, sustainable agricultural projects and then grassland projects. This is

[202] https://snh.maps.arcgis.com/apps/webappviewer/index.html?id=31eaa69a03014972b7888bc927714bbc
[203] https://www.gov.scot/publications/fisheries-assessment-north-west-orkney-ncmpa-fisheries-management-measures-within-scottish-offshore-marine-protected-areas-mpas/
[204] https://www.orkney.gov.uk/media/3iebag12/oirmp-habitats-regulations-appraisal-2024.pdf
[205] https://www.orkney.gov.uk/our-services/planning-and-building/development-and-marine-planning-policy/marine-planning/state-of-the-environment-assessment/

based on the scale of carbon reduction (per hectare) for each project type, assuming that the aim is to maximise GHG reductions.

Note that technical land available simply means the area where the NbS could be geographically implemented, not accounting for any other relevant constraints on land use such as economically available land. It is also important to consider that these options could not all occur simultaneously, and therefore technical land available should only be interpreted independently for each project type.

Table 31. Technical land available for NbS projects

Project type	NbS type	Estimate of technical land or seabed (km^2)	Justification
Peatland	Condition improvements on existing peatland habitats	95	Assuming all peatland is in a degraded condition, as discussed in the section on habitat quality.
	Peatland restoration on peat soil without current peatland habitat.	45 – 66 (not including class 4 soils) 96 - 200 (just class 4 soils)	Assuming peatland restoration, including full-rewetting, is possible on all peat soil across Orkney. The lower range value given represents where grassland is not restored to maintain grazing use or cropland use or on built areas, and the upper range value represents restoration across all appropriate soils not including built areas. Class 4 soils have been separated out as although they are not confirmed as peat soil they may still be suitable for some peatland restoration.[206]
Coastal	Coastal habitat restoration and creation	Not quantified	Lack of data availability on suitable coastal land in Orkney to provide an estimate for restoration.
Marine	Kelp bed creation	93 - 460	Indicatively, it has been assumed that 1-5% of the marine area would potentially be suitable for kelp bed restoration and this forms the basis for the calculations presented in this report. This has been chosen as a conservative estimate following discussions with the OIC Marine Planning Team; more detailed assessments would be needed to produce a refined estimate of technical potential.
	Seagrass bed creation	278 - 370	Limited area, estimated at ~5% here, of the marine area of Orkney contains suitable shallow (<10 m), sheltered, sandy or muddy substrates with good

[206] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf

			light penetration and low wave energy.[207]
	Maerl bed creation	Not quantified	Lack of data available on suitable habitat areas to provide estimates for creation initiatives. Additionally, Maerl beds are known to grow at a slow rate, reducing their suitability as a NbS option from a GHG reduction standpoint.
	Native oysters	Not quantified	Please see Table 28 for explanation.
Woodland	Woodland creation	9 – 96	For the lower range value, 9km² is assumed to be available under the situation where all class 7 land (that of low agricultural value) is converted to forest for sequestration purposes. To represent the upper range value the land area identified for forestry across Orkney[208] as presented by the National scale land capability for forestry map has been used. The current wooded area has then been subtracted from this to represent the upper range value of potential forest creation. Although this map is specific to forestry, it provides a potential estimate of the areas where soil types and climate conditions could support trees in Orkney.
Grassland	Grassland creation	0.2	Assuming 18% of arable land is focused towards grassland restoration.[209]
	Grassland conservation	0 – 51	The upper range value assumes grassland restoration to some extent is possible across all available grassland habitat. This also assumes that peatland restoration on pre-existing peat soil that overlaps with grassland habitat is prioritised due to the greater sequestration benefits. The lower range value represents if all existing grassland is of good quality. This assumption has been made due to the lack of data available on grassland habitat quality across Orkney.
Agroforestry	All categories	30 – 90	Assuming 5 - 15% of agricultural land (including arable land and grassland used for grazing) is used for agroforestry as is the aim under the Climate Change Committee 7th carbon budget. It is acknowledged that yields, species selection, etc. would be different in

207 https://www.nature.scot/doc/naturescot-research-report-1286-seagrass-restoration-scotland-handbook-and-guidance
208 https://zenodo.org/records/6322608
209 https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Agriculture-land-use-land-use-change-forestry.pdf

			Orkney than elsewhere; this is reflected in the carbon sequestration values cited in Table 9.
Sustainable agricultural practices	Hedgerows	3	Assuming 5% of agricultural land as a field margin or Ecological Focus Area.[210]
	Other	520	Assuming implementation on all other agricultural land outside of that used for agroforestry and hedgerows.

L.4 Cross-checking information against other data sources

Several previous studies have considered the future potential for NbS projects in the locale of Orkney, including but not limited to:

- Rural and Agricultural Development: Maximising the potential in the islands of Orkney, Shetland and Outer Hebrides (SRUC, 2024)
- Baseline Inventory for Greenhouse Gas Emissions in the Highlands and Islands (Highlands and Islands Enterprise, 2024)
- Blue Carbon Audit of Orkney Waters (Scottish Government, 2020).

Those studies have been reviewed and the information has been cross-checked against the sequestration estimates provided in this report. Key findings of relevance to this analysis are summarised below and further details are provided in **Appendix S**.

- In the SRUC report, remote sensing was used to estimate the area of bare peat in the context of a discussion about potential peatland restoration projects. The area of bare peat was found to be low, at 0.3ha, but the authors acknowledged that the actual area suitable for restoration would be much higher. The current study examines technical potential for restoration in a broader sense, and therefore this finding has not been directly used.
- The HIE report considered opportunities for carbon sequestration projects across Orkney. The authors assumed that, in order to be used for this purpose, the land in question would need to be suitable only for rough grazing. The authors estimated that 25,637ha of land met this description. They further assumed that this could deliver 350 tCO_2e/ha reduction over 30 years, or around 11-12 tCO_2e/ha/year on average, which is in line with WCC figures although higher than may be expected for a typical woodland in Orkney. Those estimates provide a useful sense-check; they do not represent the total technical potential across all of Orkney but likely represent a more feasible potential, accounting for economic and social factors and competing land uses.
- The Blue Carbon report noted that there are opportunities for such projects in the waters around Orkney, but estimates of carbon sequestration potential were not provided as these are highly uncertain.

L.5 Attribution of NbS carbon reductions

The GHG reductions from NbS projects occur over long periods of time – typically decades for woodland, centuries for peatland. However, organisations often report emissions on much shorter timescales, e.g. annually. Market mechanisms (e.g. voluntary carbon market crediting systems) have been developed to allow organisations to claim

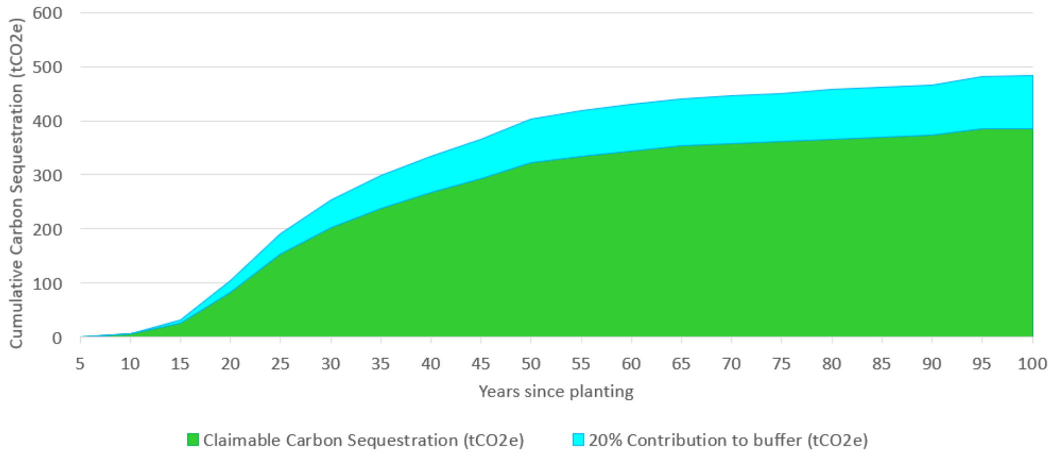
[210] https://www.nature.scot/landscapes-and-habitats/habitat-types/farmland-and-croftland/hedgerows-and-field-margins

credit for multiple years' worth of GHG reductions from an NbS project, and count that against their emissions generated in a single year, as a means of offsetting. The benefits of these market mechanisms that attribute future accumulated sequestered carbon to emissions is that they create financial liquidity into NbS projects. However, this means that NbS GHG impacts can be accounted for in two different ways: on an annual (year-by-year) basis or on a cumulative (multi-year) basis, with the correct method depending on the context.

Previous sections of this report have described the GHG impacts on an annual basis. In contrast to annual accounting, this section discusses the potential scale of impact from a project-based accounting standpoint, as is used by the Woodland Carbon Code and Peatland Code, and provides commentary on how this can form part of OIC's net zero transition strategy.

As explained previously, sequestration rates vary across different projects, but also vary on the same site over time. This is illustrated in **Figure 16** below. The graph is indicative only and shows the annual modelled carbon removals from a single example site, based on inputs carried out by OIC officers using the ESC tool and Woodland Carbon Code (WCC) calculator. The cumulative amount of carbon sequestered over time increases slowly in the first few years as the trees establish, then speeds up in the initial decades, before tapering off over time. The graph demonstrates, how early plantings can deliver useful contributions by mid-century, with additional (smaller) contributions continuing beyond that date.

Figure 16. Cumulative carbon sequestration from 1ha of woodland for a project site in Orkney. Source: OIC estimate using ESC tool and the WCC calculator



The results presented in **Section 5.2.2** reflect the average sequestration rates (tCO_2e/ha per year) across multiple decades. They have been used to derive an indicative order of magnitude estimate of the scale of potential across Orkney as a whole. That is a common approach used in organisational net zero strategy development and action planning, as it provides a like-for-like comparison against the organisation's emissions in a given year and is especially relevant if land use is included within the organisations GHG inventory.

The Woodland Carbon Code is based on the same underlying technical evidence, but allows organisations to instead accumulate and claim credit for multiple years' worth of carbon sequestration at points in time and attribute this, for example toward residual emissions in a target year such as 2045. Based on the results of the above single example , one hectare of woodland in Orkney could be predicted to sequester around 139 tCO_2e over a 20 year period (111 tonnes claimable as saleable credits). Therefore, if OIC wanted to offset 1 years' worth of residual emissions in 2045 (which could be approx. 10,000 tCO_2e) using NbS projects within Orkney, the council could do this either by (for example):

- Purchasing the carbon credits from a verified woodland project outside of Orkney of around 65 ha in size[211]; or
- Planting a woodland of around 90 ha on its own land in Orkney (referred to in the WCC as 'growing your own units'[212]), waiting for the project to establish, and then claiming the carbon units at a future date.

Note, this is a simplification and OIC should refer to WCC guidance in more detail prior to undertaking work. Actual crediting depends on WCC rules regarding verification and unit issuance.

The above credits would only be enough to offset 1 years' worth of residual emissions, so additional projects would be required in order for OIC to continue to claim to have reached net zero emissions for each subsequent year. It should therefore be noted that such an approach on its own would not sustain net zero beyond a decade or so, without requiring excessively large areas of land. If OIC wanted instead to plant a woodland that could continue to sequester 10,000 tCO_2e each year – and continue to do so over many decades – this could require an area of new woodland on the scale of a couple of thousand hectares. The example is a demonstration of how although land based NbS can contribute to emissions targets, they can only do so as a complement towards genuine decarbonisation and their emission calculations are in no way equivalent to the priority of eliminating fossil fuel use and emissions.

L.6 Limitations of this assessment

The estimates presented above are derived solely from a desk-based assessment. They are intended to give OIC a broad understanding of the potential scale of carbon removal possible and also which types of projects may be suitable in the Orkney context and the key characteristics of each option. These results should therefore be viewed as indicative only, and used to guide decisions about which project types merit more detailed investigation in future. Any project that OIC chooses to pursue may require a dedicated feasibility study – including technical assessment, cost-benefit analysis, and evaluation of risks and dependencies – before a decision to proceed could be taken. This is particularly true of large-scale projects. There are however, likely to be a number of smaller scale projects which may be possible to investigate and progress in the near term and to gain experience in project implementation.

For NbS, refining the estimates of available land area and the likely carbon sequestration or avoidance rates across Orkney as a whole would require more granular feasibility work. This would include site-specific assessments such as field surveys, soil sampling, and evaluation of existing land uses and constraints.

[211] Desk use of WCC / ESC tools by OIC officers and reviewed by Aether indicates that the sequestration potential from projects in Orkney could typically be lower (approx. 20-30% lower) than projects on the Scottish mainland, due to differences in species selection, yield, site conditions, etc. Therefore, the same number of carbon credits could be achieved using less land if located in a different site in Scotland.

[212] https://www.woodlandcarboncode.org.uk/grow-your-own-carbon-units

Appendix M Engineered removals assessment methodology

M.1 Introduction

This section describes the approach used to estimate the scale of potential to undertake engineered CDR projects in the locale of Orkney, along with data sources and references.

M.2 Methodology

Engineered removal methods are nascent in the UK, with few limited commercial projects. Their current price and limited supply, limits the prospect that OIC can directly procure engineered removal credits to compensate for ongoing residual emissions. Engineered methods, however, require inputs in terms of energy and materials in order to deliver a net negative emission, which can then be procured as a removal credit.[213] Similarly, to enable permanent storage, engineered methods are typically paired with geological storage – subsurface injection into either deep saline aquifers or depleted oil and gas fields.[214] This allows for an approach whereby the availability of inputs and storage can provide an initial assessment into nearby potential, beyond the availability of current projects. This could indicate an enabling role for OIC, in the support or provision of different parts of the supply chain.

This study has evaluated all main engineered removal methods considered by the UK Government or active in the voluntary carbon market within the UK. This includes BECCS, DACCS, ERW and biochar, but excludes methods such as ocean alkalinity enhancement and ocean fertilisation which are considered a distinct third category by DESNZ.[215] To assess nearby potential, Aether has evaluated each option across its supply chain, considering available inputs and CO_2 storage media, to provide an initial estimate of potential projects.

The main inputs[216] include the availability of biomass, for BECCS and biochar, low-carbon or renewable electricity and heat for DACCS, and silicate fines for ERW. For means of storage, BECCS and DACCS are dependent on the availability of geological storage, whilst ERW and biochar are typically spread on agricultural land. This is summarised in the table and further details are provided in the following sections.

Table 32. Engineered removal methods, including their inputs and means of storage

Resource required	Relevant project type(s)	Commentary	Potential in/near Orkney?
Inputs			
Biomass	BECCS Biochar	Limited supply; would need to be imported but this would undermine climate rationale	Low

[216] Note that ‘inputs’ here describes regular inputs needed for the operation of the scheme, and not the capital/embodied carbon of the materials required to construct the initial site, or the machinery required to deliver a net-negative emission. For example, DACCS requires both steel and concrete to build the base and air contactors through which ambient air is passed.

Resource required	Relevant project type(s)	Commentary	Potential in/near Orkney?
Renewable or low carbon energy	DACCS	High availability of renewable electricity; no source of industrial heat identified.	High
Silicate fines	ERW	Limited supply; would need to be imported but this would undermine climate rationale	Low
CO2 storage media			
Agricultural land	Biochar	Most commonly applied on cropland but could potentially be applied on grazing land which is more prevalent locally	Medium
Geological storage	BECCS DACCS	Significant offshore geological storage sites in North Sea but transport and licensing challenges present obstacles	Medium

M.3 Biomass

Orkney's potential to use bioenergy with carbon capture and storage (BECCS) or biochar as local carbon-removal solutions is limited by fundamental resource and infrastructure constraints. Both approaches require a reliable, continuous supply of biomass. Orkney has very few trees[217] and overall biomass availability across the islands is extremely low. This means the archipelago lacks the low-opportunity-cost biomass resources, such as forestry residues, thinnings, or dedicated energy crops, that BECCS or biochar systems depend on. Consequently, any realistic deployment of these technologies would likely require importing biomass, which would reduce the net climate benefit due to transport emissions and introduce significant logistical costs.

BECCS faces additional challenges. To operate viably, a BECCS facility needs a large, steady supply of biomass, continuous demand for the heat and/or electricity it generates, and sufficient scale to make carbon capture equipment economically feasible. Orkney does not meet these conditions. The islands' low population density limits the potential for district heating, and the electricity grid is already constrained, with competing demands from renewable generation. Meeting BECCS scale requirements would therefore necessitate substantial biomass imports and a reliable market for the energy produced. These are conditions that are unlikely to be achievable. Biochar offers the advantage of operating on smaller scales, such as at a farm or community level. However, the severe limitation on available biomass remains a critical barrier.

At a national and global level, biomass has multiple roles in decarbonisation, spanning inputs into engineered removals, low-carbon transport fuels or electricity generation. Therefore, there is competition for dedicated energy crops or waste biomass across multiple sectors, which may further limit availability. A 2011 study explored the potential to grow short-rotation coppice (SRC) willow for bioenergy in Orkney and estimated that yields of 6-8 oven-dry tonnes (ODT) per hectare per year might be achievable.[218] A small scale BECCS facility might require inputs of tens or hundreds of

[217] https://www.orkney.gov.uk/media/lnqbi4dx/orkney-trees-and-woodlands-strategy-consultation-draft.pdf
[218] https://pure.uhi.ac.uk/en/studentTheses/the-potential-of-short-rotation-coppice-src-willow-salix-l-as-a-b/

thousands of tonnes per year. As a rough indication of scale, if the facility utilised 50,000 ODT per year, this might require dedicating 6,300-8,300 ha of land to SRC production, representing 7-10% of all agricultural land in Orkney.[219] For these reasons, both BECCS and biochar are considered impractical options for carbon removal on the islands and are excluded from further consideration.

M.4 Low-carbon or renewable electricity

DACCS is an energy-intensive process, but unlike some other CDR methods is not constrained by available land area. The key inputs required are:

- Renewable electricity – to drive fans that pull in ambient air
- Renewable or low carbon heat – to regenerate the sorbent, a material that chemically binds with CO2 and captures it from the atmosphere. The temperature depends on the technology used. Liquid sorbents require high grade heat (upwards of 900°C) while solid sorbents require low grade heat (around 100°C).

Globally, the only operational DAC plant at the time of writing (November 2025) is Orca, operated by Climeworks in Iceland. Once the technology is adopted at scale, modelling for the CCC anticipates that DACCS may need around 2.9 MWh of electricity per tonne of CO_2 captured.[220] On that basis, as a rough estimate, if OIC was seeking to offset around 10 ktCO_2e residual emissions per year, in line with the carbon pathway analysis set out in **Section 3**, this would require around 29 GWh of renewable or low-carbon electricity.

In principle, DACCS could be powered using electricity from curtailed wind generation (i.e. (wind power that is intentionally reduced or shut off because it cannot be fully accommodated by the grid due to oversupply, transmission constraints, or operational limits). Significant wind curtailment occurs in Scotland, including at the Moray wind array near Orkney. For context, the wind farm at Quanterness is expected to produce 96 GWh per year, based on a capacity factor of 38.3%.[221] That capacity factor assumes some amount of curtailment, so there could be an additional 29 GWh available if curtailment is reduced. This suggests that, in theory, a DACCS plant, if operated in Orkney, could use the additional energy made available by curtailed electricity from a wind farm the size of Quanterness to remove emissions on the order of 10,000 tCO_2e per year. There are a wide variety of additional practical considerations that would need to be addressed, but this indicates that the locally available renewable energy supply would, in principle, be sufficient.

However, the economic viability of such an approach would be challenging, as it would require an uncertain schedule of operation for DACCS, which may complicate financing.[222] While the curtailed electricity would be inexpensive, no DACCS plant is currently planning variable operation; existing designs are intended to run continuously using grid electricity. As a result, government plans support DACCS facilities operating at high capacity factors (90%).[75] Similarly at current costs, and even with a reduction of costs foreseen in modelling carried out for the CCC, the costs will remain prohibitive, running into the multimillion.[22075]

[219] https://www.orkney.gov.uk/media/argiviw0/orkney-economic-review-2020.pdf
[220] https://www.theccc.org.uk/publication/assessing-the-feasibility-for-large-scale-daccs-deployment-in-the-uk/
[221] https://orkneywindfarms.co.uk/wp-content/uploads/2023/09/EIAR_Vol-1_Chapter-1_Introduction.pdf
[222] https://www.sciencedirect.com/science/article/pii/S2590332223003007

The provision of heat presents an additional challenge. Sorbent regeneration requires a reliable heat source, which could come from natural gas or some co-location of waste industrial heat. In Orkney, unless there is an available source of high-grade heat, the DACCS facility would likely need to be solid sorbent-based. The energy demands could therefore potentially be met with electricity, assuming sufficient grid capacity and the operation of an industrial heat pump.

M.5 Silicate fines

For silicate fines, extensive UK mapping has been carried out to support the research and development of ERW projects in the UK. This includes an inventory of UK mineral resources suitable for ERW published in 2023.[223] This surveys UK active and inactive quarries suitable for ERW. The study did not indicate any suitable rock extraction sites in Orkney, which suggests that material would need to be imported for this purpose if this was an option OIC wanted to pursue. It is also understood that OIC previously explored the use of material from Cursiter Quarry which was analysed and found not to have sufficient carbon capture potential.

A previous study estimated that the scale of GHG reduction from ERW could be anywhere between 3-40 tCO_2e per hectare per year.[224] However, transporting fines to Orkney could potentially undermine the climate benefit of a project, depending on the distance and mode of transport, and the scale of the resulting emissions. Similarly, the climate benefit also depends on factors such as the type of rock, the application rate, and the amount of rainfall. In other words, generally it would make more sense to apply ERW material close to the quarries that produce it, rather than transporting it to Orkney.

M.6 Geological storage

Offshore geological storage of carbon dioxide is not a limiting factor in the UK overall. The North Sea has large potential storage in both saline aquifers and depleted oil and gas fields. In Orkney, the major oil terminal is Flotta, which currently imports oil via a single pipeline from the Piper and Claymore oil fields.[225] Both fields are still in production and are therefore not available for carbon storage at present.

In theory, existing pipelines such as the one from Flotta to the Piper and Claymore fields could be adapted to transport captured CO_2 to offshore storage sites. However, such a conversion would require significant technical modifications, regulatory approval, and investment, so it is not expected in the near term. Existing storage licenses, such as those held by Shell and Storegga, are focused on the Acorn cluster at St Fergus in northeast Scotland, which is a larger and better-connected site with nearby industrial sources of CO_2.[226] In practice, political, economic, and logistical factors make it unlikely that Flotta would be used for CO_2 storage in the near term.

Based on these considerations, if geological storage was required by any DACCS plant on Orkney, there would be no practical way in the short to medium term to transport the captured CO_2. While offshore storage capacity exists elsewhere in the North Sea, the

[224] https://pubs.rsc.org/en/content/articlepdf/2016/em/c6em00386a
[225] https://experience.arcgis.com/experience/de29b515976048018c4b65ad2c1b026d
[226] https://www.nstauthority.co.uk/news-publications/carbon-capture-storage-licence-awarded/

lack of connecting pipelines or other transport infrastructure from Orkney makes access to geological storage infeasible until and unless the transport issue can be resolved.

M.7 Limitations of this assessment

The estimates presented above are derived solely from a desk-based assessment. They are intended to give OIC a broad understanding of the potential scale of carbon removal possible and also which types of projects may be suitable in the Orkney context and the key characteristics of each option. These results should therefore be viewed as indicative only, and used to guide decisions about which project types merit more detailed investigation in future. Any project that OIC chooses to pursue may require a dedicated feasibility study – including technical assessment, cost-benefit analysis, and evaluation of risks and dependencies – before a decision to proceed could be taken. This is particularly true of large-scale projects. There are however, likely to be a number of smaller scale projects which may be possible to investigate and progress in the near term and to gain experience in project implementation.

For engineered carbon removal options, the level of uncertainty is higher than for NbS. Several of these technologies are still emerging and are not widely deployed, meaning that information on achievable carbon removal rates, energy and material requirements, operational constraints, and local applicability remains limited. As a result, any future assessment would need to draw on updated evidence as the technologies mature and more real-world performance data becomes available.

Appendix N Developing the assessment schema for offsetting / insetting project options

The approach to developing the assessment schema is outlined below. It comprised a review of relevant assessment schemes and environmental/sustainability priorities as set out in the Orkney Local Development Plan and Strategic Environmental Assessment.

N.1 Reviews of potential assessment schemes

A wide literature exists on the assessment of CDR methods. Feasibility studies, which seek to assess the feasibility of a CDR method in a specific scenario or national circumstance, tend to use a schema of multiple dimensions to choose between methods. We survey three international examples from the academic literature [Holland-Cunz & Baatz (2025), Borchers et al (2024), and Förster et al., (2022), see footnote [227]] and one recent UK example from the UK Government' recent Independent Review of Greenhouse Gas Removal (the Independent GGR Review).

Each schema used has the following commonalities:

- **Consideration of marginal costs** – All schemas include a measure of cost, such as the marginal cost per tonne of CO_2 captured. The schema used in Holland-Cunz & Baatz (2025) is designed to inform policies to incentivise CDR methods and therefore frame cost according to policy cost or the 'cost-effectiveness', referring to the 'overall costs of a policy instrument to achieve a given outcome compared to other policies'. Whilst the Independent GGR Review uses only marginal cost, both Borchers et al (2024) and Förster et al., (2022) include other cost criteria, such as the opportunity cost of a CDR method when employed on land with other possible uses, and capital and investment costs, such as the cost of capital. For the preliminary nature of this assessment, marginal costs are used.

- **Environmental impacts** - All schemas include a measure of the impacts on the surrounding environment. Both Borchers et al (2024) and Förster et al., (2022) split environmental impact by the impact on air, land and water, including criteria spanning the impact on biodiversity, soils, water demand, air quality and ambient noise. Holland-Cunz & Baatz (2025) include a number of criteria under the heading 'Impacts on the non-human environment', whilst the Independent GGR Review includes simply 'environmental impacts'. For the purposes of this preliminary assessment, we assess environmental impacts according to the likely impact on biodiversity and land, considering the objectives presented in the Strategic Environmental Assessment (SEA) for Orkney. The assessment of environmental impacts also aligns with the principles of the draft guidance to avoid harm on nature.

[227] The three are: Holland-Cunz & Baatz (2025), How to govern carbon dioxide removal: an assessment framework for policy instruments, Climate Policy, available at: https://www.tandfonline.com/doi/full/10.1080/14693062.2025.2459315 ; Borchers et al (2024), A Comprehensive Assessment of Carbon Dioxide Removal Options for Germany, Earth's Future, available at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023EF003986 ; and Förster et al., (2022), Framework for Assessing the Feasibility of Carbon Dioxide Removal Options Within the National Context of Germany, Frontiers in Climate, available at: https://www.frontiersin.org/journals/climate/articles/10.3389/fclim.2022.758628

- **Permanence** – Many schemas explicitly recognise permanence as a key criterion. For example, both Borchers et al (2024) and Förster et al., (2022) include three measures of permanence, the natural persistence of storage, ranging from decades, to centuries to millennia, and the risk of natural and anthropogenic disturbances. Holland-Cunz & Baatz (2025) includes a measure of the 'Timeline of climate effectiveness' which assesses the potential risks for carbon storage through natural leakage or human-induced disturbances. The Independent GGR Review does not feature permanence explicitly in it's schema, but delineates between 'geologically permanent' methods and 'non-permanent' methods.

- **Social context** – Nearly all schemas include a social dimension. For example, Borchers et al (2024) and Förster et al., (2022), include a measure of public perception, ranged from low, ambivalent or high risk, and a measure of previous experience in past development projects. The social context, unlike measures such as permanence, which is largely inherent to the method, is best informed by considering the local context of the project, reflecting the concerns of the local community.

- **Policy support** – Schemas such as the Independent GGR Review include a measure of policy, describing whether incentives such as grants are available from government or elsewhere to encourage the uptake of projects.

Each of these criteria inform our schema used to assess the potential of CDR in Orkney.

N.2 Local considerations within the assessment schema

As detailed above, there is a need to adapt the schema to reflect the priorities local to Orkney. OIC's Local Development Plan (2017-2022)[228] was reviewed for policy criteria that are potentially relevant to offsetting/insetting projects. These include:

- Policy 1: Criteria for All Development
- Policy 2: Design
- Policy 8: Historic Environment & Cultural Heritage
- Policy 9: Natural Heritage and Landscape
- Policy 12: Coastal Development

These policies address several key themes, that support the assessment schema, as summarised in Table 33 below.

Note that a new local plan, aligned with the National Planning Framework 4 (NPF4)[229] is currently being developed.[230] Since this is not yet finalised, the table below refers to the most recent adopted plan. The policies within NPF4, and how these support the assessment schema, are discussed in **Table 34**.

228 Orkney Local Development Plan 2017 - 2022
229 https://www.gov.scot/publications/national-planning-framework-4/
230 https://www.orkney.gov.uk/our-services/planning-and-building/development-and-marine-planning-policy/development-planning-land/local-development-plan-newsletter/

Table 33: Analysis of OIC's Local Development Plan (2017-2022) and the connection to the assessment schema

Schema heading	Theme	Policies	Description
Environmental Impacts	Environmental Protection	1, 9	All projects should consider site designations and protections, including those for Site of Special Scientific Interest (SSSIs), Special Areas of Conservation, Local Nature Conservation sites, Marine Protected Areas, and other Protected Habitats. Projects should ensure that there are either no significant effects on the site's integrity or objectives, or that projects meet the requirements laid out for development at that specific site designation/protection as stated in the development plan. Projects will also aim to protect, improve and enhance the water environment, wetlands, peatland/carbon rich soils, woodlands, and coastal zones. In any case where protection of these ecosystems and their integrity is not possible, projects should ensure they adhere with the requirements for development on that ecosystem laid out in the development plan. Alongside this, projects should avoid any adverse effects on protected or priority species, alongside any damage or loss to biodiversity and geodiversity, with the aim of incorporating biodiversity benefits and habitat connectivity into project design.
Social context	Landscape and heritage conservation	1, 8, 9	Projects should conserve, preserve and be designed to prevent any negative impacts on the wider areas character (including townscapes, landscapes and coastlines), provisions from these characters, the National Scenic Area (NSA), Cultural Heritage assets, sites of historic significance, the Wild Area of Hoy, coastal zones, and landscape sensitivities identified in the Orkney Landscape Character Assessment. Projects which are likely to have adverse effects on the landscapes and sites listed should only go ahead if they meet the requirements stated in the development plan.
Social context	Social sustainability	1, 8, 9, 12	Projects should avoid any adverse impacts on nearby properties or users, both on land, along the coastline, and in the marine environment. There will be an aim to protect, enhance and promote access to natural heritage, including green infrastructure, landscape, coastlines and the wider environment. In addition to this, projects will aspire to avoid locations that have

Schema heading	Theme	Policies	Description
			a strategic value for marine related industries or community use.
Environmental impacts	Sustainable design and energy efficiency	1, 2	Where applicable, all projects should utilise sustainable design approaches, such as resource efficiency, applying sustainable construction approaches and materials. Projects will also aim to minimise the use of energy and materials through both the construction process and design of the project.

Table 34. Policies of relevance within NPF4 and their relation to the assessment schema

Schema heading	**Policy number**	**Policy summary**
Policy support	1	Development proposals will give weight to the global climate and nature crises.
Policy support	3	Support for protection of biodiversity and reversing biodiversity loss, as well as strengthening nature networks.
Policy support	4	There should be best use of nature-based solution and overarching protection, restoration and enhancement of the natural environment.
Policy support	5	Protection and restoration of peatland.
Policy support	6	Protection and expansion of forests, woodlands and trees.
Social context	7	The historic environment, assets and places should be protected.
Social context	10	Coastal communities, their assets and resilience to climate change should be supported.
Policy support	11	Emerging technologies such as carbon capture utilisation and storage should be encouraged, promoted and facilitated.
Policy support	20	Blue and green infrastructure should be protected and enhanced.
Social context	32	The aquaculture industry should be encouraged, promoted and facilitated, whilst minimising and adverse environmental impacts.

The policies within the Local Plan reflect the definition of 'sustainability' as set out in the Strategic Environmental Assessment (SEA) for Orkney.[231] These sustainability objectives have also been considered within the assessment schema. Those are shown in the table below.

Table 35. Objectives from SEA Environmental Report 2024

Schema heading	**SEA objective category**	**Objective**
Environmental Impacts	Climate factors	'Contribute to national targets to address the cause of climate change by reducing greenhouse gas emissions.'

[231] https://www.orkney.gov.uk/media/twpnbocp/oirmp-sea-draft-appx-included-2024.pdf

		'Support the transformational change to a low carbon economy, consistent with national objectives and targets.'
		'Address vulnerability in the Orkney to the likely effects of climate change.'
Environmental Impacts	Biodiversity	'Conserve protected sites and species.'
		'Safeguard valuable habitat from loss and fragmentation through development.'
		'Protect biodiversity.'
		'Maintain healthy ecosystems and work with the natural processes which provide important services to communities.'
Environmental Impacts	Water	'Promote the protection and improvement of the water environment, including burns, lochs, estuaries, wetlands, coastal waters and groundwater.'
		'Protect against developments which have potential to cause or exacerbate coastal erosion and flooding.'
Environmental Impacts	Coastal processes / Benthic sediments / Soils	'Reduce the threat of contamination and seek to protect soils from damage such as erosion or compaction.'
		'Recognise the environmental benefits provided by soils and protect their quality and quantity.'
Environmental Impacts	Geology	'Protect designated and undesignated sites which are recognised and valued for their geological or geomorphological importance.'
Social context	Landscape	'Maintaining and enhancing distinctive landscape character.'
Social context	Cultural heritage	'Promote the care and protection of the designated and non-designated historic environment.'
		'Enable positive change in the historic environment which is informed by a clear understanding of the importance of Orkney's heritage assets and ensures their future use.'
		'Safeguard cultural heritage features and their settings through responsible design and siting of development.'
Social context	Population and Human Health	'Improve community environments and quality of life.'
		'Protect and enhance human health and promote access to health, social and recreational facilities.'
Environmental impacts	Material assets	'Promote sustainable and efficient use of natural resources.'

Appendix O Evaluation of CDR projects against the assessment schema

This section describes the rationale for the rankings of CDR projects in **Section 5.2.2.**

Method: Peatland Restoration	
Potential	High potential across Orkney overall. The area of land that is technically suitable is much higher than the land that is practically feasible at present, due to social and economic considerations (see below).
Cost	Drain blocking is the most cost-effective and scalable technique. Actively eroding peatlands are more expensive and complex to restore. Restoration costs vary widely: £450 to £9,000 per hectare, depending on site type and location. Advice from a peatland expert consulted with for this report indicated costs of £1,000 per hectare, but these may be higher in Orkney.
Environmental Impacts	Positive benefits in terms of biodiversity, habitat creation, and potential benefits in terms of climate resilience and flood risk mitigation.[232] Assessments should be undertaken as needed to help ensure that peatland restoration does not damage the historic environment.
Permanence	There are risks that carbon removal potential may be limited, or reversed, due to effects of climate change and other environmental perturbations (such as disease). However, schemes do factor for risks and the Peatland Code will address losses via wider use of buffer credits.
Social feasibility	Large land areas would be required to deliver carbon removals on the scale that OIC would need to offset, with visual impacts on the landscape and repercussions on the local economy. Domestic level peat cutting rights also pose a potential obstacle which would need to be addressed sensitively.
Policy	Peatland Action funding is provided by the Scottish Government for peatland restoration projects, with the potential to cover all project costs upon successful application, but not annual management.[94] Peatland Carbon Code however can complement and support longer term.

Method: Woodland Creation	
Potential	This is possible in principle, although there has been low extent of implementation to date, both due to climatic/environmental factors and the fact that a high proportion of land is used for agriculture. Targets for expanding woodland have not been set within the Tree and Woodland Strategy.[233] High windspeeds in combination with shallower soils may limit tree growth. To a degree this can be mitigated by identifying native tree species better adapted towards high winds and use of silvicultural techniques.[234] As with peatland restoration, the area of land that is technically suitable is much higher than the land that is practically feasible at present, due to social and economic considerations (see below).
Cost	The cost of tree planting can vary significantly but are usually in the order of a few thousand pounds per hectare based on available grant funding.

[232] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[233] https://www.orkney.gov.uk/media/lnqbi4dx/orkney-trees-and-woodlands-strategy-consultation-draft.pdf
[234] https://pure.uhi.ac.uk/en/studentTheses/the-potential-of-short-rotation-coppice-src-willow-salix-l-as-a-b/

Environmental impacts	Positive benefits in terms of biodiversity, long-term habitat creation, and potential benefits in terms of climate resilience and flood risk mitigation.[235] At the same time and in the wrong place, trees can sometimes negatively impact and sensitivities locally can include archaeology, important wading bird populations and landscape. Location specific assessment is important.
Permanence	Carbon removal potential may be limited, or reversed, due to effects of climate change and other environmental perturbations (such as disease, drought, flooding or fire) and poor management.
Social feasibility	Large land areas would be required to deliver carbon removals on the scale that OIC would need to offset, with visual impacts on the landscape and repercussions on the local economy. However, smaller scale projects (planting individual trees or small clusters) may be more acceptable and can potentially add up. For instance, planting trees along riparian corridors could be a key consideration. Projects could be limited by existing levels of expertise and capacity[233] although this challenge is not insurmountable.
Policy	The Northern Isles of Scotland can receive an initial planting payment rate of £3,600/ha, and an annual maintenance payment rate of £624/ha for 5 years.[236]

Method: Marine habitat restoration and creation (kelp beds, seagrass meadows, Mearl beds, Brittlestar beds, native oysters)	
Potential	There is a high technical potential, but this is constrained by significant financial and social considerations (see below). Additionally, there are high levels of uncertainty as to the scale of carbon removal that can be achieved and knowledge gaps around the technical elements of successful project delivery.
Cost	Variable dependent on solution adopted, but case study evidence suggests it is much higher than land-based projects, potentially in the region of hundreds of thousands of pounds (£000s) per hectare over 10 years.[237]
Environmental impacts	Potential to deliver positive impacts in terms of marine biodiversity, habitat creation, water quality, climate resilience, and coast stabilisation.
Permanence	Carbon storage depends on marine conditions; only the fraction that reaches deep water or long-lived sediments comprises long-term storage. Carbon removal potential may also be limited, or reversed, due to effects of climate change and other environmental perturbations. There is also a lack of clarity on how restoration sites can be protected to safeguard the benefits in the long term.
Social feasibility	Trawling limitations and restrictions on activities of marine users could be required for marine projects with potential economic knock-on effects. Stakeholder engagement and participation is key to delivering carbon removal benefits. Additionally, there are constraints surrounding implementing marine habitat restoration and creation, generally across marine NbS and specifically for kelp beds, due to a lack of technical application/experience in the field.
Policy	Marine habitat restoration is supported in national and local marine planning policy. Funding for seabed restoration projects can be provided

[235] https://www.hie.co.uk/media/45yblemc/baselining-inventory-for-ghg-emissions-in-the-highlands-and-islands-report.pdf
[236] Scottish Forestry - Forestry Grant Scheme
[237] https://www.nature.scot/doc/naturescot-research-report-1286-seagrass-restoration-scotland-handbook-and-guidance

	through the Scottish Marine Environmental Enhancement Fund (SMEEF). Average of £55.3K per seabed project awarded between 2021-2023.[238]

Method: Grassland restoration	
Potential	The extent of implementation is dependent on identification of suitable degraded grassland for restoration.
Cost	Grant-supported costs may be up to around £750/ha.[239]
Environmental impacts	Benefits to biodiversity, soil health, hydrology and climate resilience. Large physical footprint due to quantity of land needed to address OIC's residual emissions.
Permanence	Carbon removal potential may be limited, or reversed, due to effects of climate change and other environmental perturbations (such as disease, drought, flooding or fire) and poor management.
Social feasibility	Landowner engagement and ecological assessment of appropriate establishment sites would be key.
Policy	Supported by the Scottish Agri-Environment Climate Scheme. Grants were previously available under the Scottish Government's Nature Restoration Fund but this is currently closed to new applications.[240]

Method: Agroforestry	
Potential	See notes on woodland creation. Agroforestry could potentially be adopted more widely across Orkney as it would not require land to be dedicated to woodland, but opportunities will be highly site specific. The total area – and carbon benefit – of interventions on individual sites would therefore be smaller than for woodland.
Cost	As for woodland, grant-supported costs are usually in the low thousands of pounds (£000s) per hectare.[241]
Environmental impacts	Broadly similar to woodland creation (see above) but on a smaller scale. Benefits relate more to the creation of mixed habitats and strengthen connectivity for generalist or edge-loving species rather than woodland specialist species. Provision of shade or soil improvements can benefit livestock or boost agricultural output in some circumstances.
Permanence	Carbon removal potential may be limited, or reversed, due to effects of climate change and other environmental perturbations (such as disease, drought, flooding or fire). The likelihood of disturbance on agricultural land could be higher than for dedicated woodland if not managed carefully.
Social feasibility	Integrating trees into existing cropland or pasture—through systems such as alley cropping or scattered planting, which requires careful spatial planning to avoid competition for light, water, and nutrients. Site selection must account for soil type, wind exposure, and topography to ensure tree survival and compatibility with farming operations. Stakeholder engagement and participation is key to delivering carbon removal benefits.

[238] https://smeef.scot/wp-content/uploads/2024/07/SMEEF-Impact-Report-2-FINAL-03-July-2024.pdf
[239] https://www.ruralpayments.org/topics/all-schemes/agri-environment-climate-scheme/management-options-and-capital-items/creation-of-species-rich-grassland/
[240] https://www.nature.scot/funding-and-projects/nature-restoration-fund/nature-restoration-fund-guidance
[241] https://www.ruralpayments.org/topics/all-schemes/forestry-grant-scheme/agroforestry/

Policy	Areas of agroforestry and trees on farms may be able to qualify as Ecological Focus Areas (EFAs) requirements towards Enhanced Greening payments.[242]

Method: Sustainable agricultural practices	
Potential	There is a high potential for implementation due to the quantities of agricultural land available on Orkney, although there are some uncertainties around the global net GHG benefits if there is a trade-off with yield.
Cost	Costs vary widely depending on the practice and scale.
Environmental impacts	Benefits to biodiversity, soil health, water quality and climate resilience. Can result in subtle changes to the use of existing agricultural spaces, however does not require large visually impactful changes to the existing landscape.
Permanence	Largely dependent on the long-term management of the site.
Social feasibility	Key issues relate to the impact on costs to farmers/crofters and agricultural outputs, therefore policy support (see below) is critical. Stakeholder engagement and participation is key to delivering carbon removal benefits.
Policy	A range of funding options are available, e.g. through the Agri-Environment Climate Scheme (AECS).[243]

Method: Direct Air Carbon Capture and Storage (DACCS)	
Potential	Theoretically high based on the availability of renewable energy (including wind curtailments) in and near Orkney and proximity to geological storage sites. However, the technology is at an early stage of development. Existing pipelines are not available for transporting captured CO_2 so additional investment or alternative means of transport would be required.
Cost	Projected costs in 2030 estimated as £150-700 per tCO_2e removed (see Figure 11). To decrease costs, the UK government has confirmed plans to introduce a Contracts for Differences (CfD) revenue model for engineered removal projects, integrating the resulting removal credits into the UK Emissions Trading Scheme (ETS) to provide demand.
Environmental impacts	High demands for energy could place pressure on grid capacity. Limited footprint compared to NbS although would require construction of specialist facilities, with accordant visual impact.
Permanence	Very long-lived (tens of thousands of years) under the right conditions (see Section 5.1.2). However, estimates are largely based on modelling and small-scale demonstrations, as the technology is still relatively new and long-term monitoring data are limited.
Social feasibility	Would require changes in licensing arrangements for existing geological storage sites.
Policy	Engineered removals are supported by the UK Government which has funded a range of R&D projects and produced a vision for carbon capture, usage and storage (CCUS).[244] The government has also funded small pilot

[242] https://www.ruralpayments.org/topics/all-schemes/basic-payment-scheme/basic-payment-scheme-full-guidance/greening---bps/greening-guidance-2026/greening---overview/
[243] https://www.gov.scot/news/supporting-sustainable-agriculture/
[244] https://www.gov.uk/government/collections/uk-carbon-capture-usage-and-storage-ccus#recent-milestones

	scale projects since 2020 and since published the 'GGR Business Model', a policy designed to jumpstart the first round of commercial projects.[245]

[245] https://www.gov.uk/government/publications/greenhouse-gas-removals-ggr-business-model

Appendix P Use of LiDAR data

LiDAR (Light Detection and Ranging) provides high-resolution, three-dimensional information on vegetation structure and terrain, offering a direct means of quantifying canopy height, density, and surface morphology. This structural detail makes LiDAR particularly valuable for estimating above-ground biomass and monitoring landscape change, both of which are relevant to assessing carbon sequestration and ecosystem restoration outcomes. In the context of calculating LULUCF emissions and removals, it is particularly helpful for: (a) Establishing a baseline assessment of above-ground biomass; and (b) Monitoring changes in above-ground biomass over time.

LiDAR could therefore be used to complement estimates of above-ground carbon sequestration impacts generated by tools such as the Woodland Carbon Code Calculator. In particular, it could help with monitoring the changes associated with dispersed tree planting, shrubs, shelter belts, hedges etc. which may otherwise not be reflected in land cover datasets that are less granular in scale.

However, LiDAR data alone are insufficient to generate robust estimates of carbon sequestration or future carbon reduction potential, particularly for ecosystems such as peatlands. While LiDAR effectively captures surface elevation, hydrological features, and vegetation structure, it does not measure peat depth, soil carbon content, water table dynamics, or greenhouse gas fluxes, which are factors that dominate carbon cycling in these systems. Accurate carbon accounting therefore requires integrating LiDAR with complementary datasets and direct, site-based measurements, including soil sampling, vegetation surveys, and hydrological monitoring, alongside established emission factors (e.g. those in the UK Peatland Code).

When compared with other geospatial datasets, LiDAR serves a complementary role. The UK Vegetation Object Model (VOM) provides modelled classifications of vegetation types and structures but is based on inferred relationships rather than direct physical measurements. NDVI (Normalised Difference Vegetation Index) captures vegetation greenness and productivity but lacks vertical structural information, limiting its utility for biomass estimation. Meanwhile, datasets such as Trees Outside Woodland (TOW) map tree cover across non-forested landscapes but offer limited detail on canopy height and volume. LiDAR enhances all these datasets by supplying empirically derived structural data that can improve the accuracy of biomass and carbon stock assessments.

Discussions with expert stakeholders undertaken as part of the Task 5 extension work suggested various potential applications for LiDAR data in Orkney. They advised that the dataset:

- can be served as a baseline dataset for future monitoring, reporting, and verification (MRV)
- can help to identify areas for afforestation and monitor hedgerows if farmers receive payments or demonstrate livestock shelter benefits
- complements existing datasets (peatland maps, soil maps) but still requires ground-truthing for site-level precision
- will provide high-resolution topographic and vegetation data, enabling accurate peat measurements and vegetation cover mapping
- will allow tracking of vegetation changes over time (e.g., willow expansion), supporting carbon accounting and restoration progress assessments
- could also support verification for Woodland Carbon Code projects, through current calculation tools (e.g., iTree)

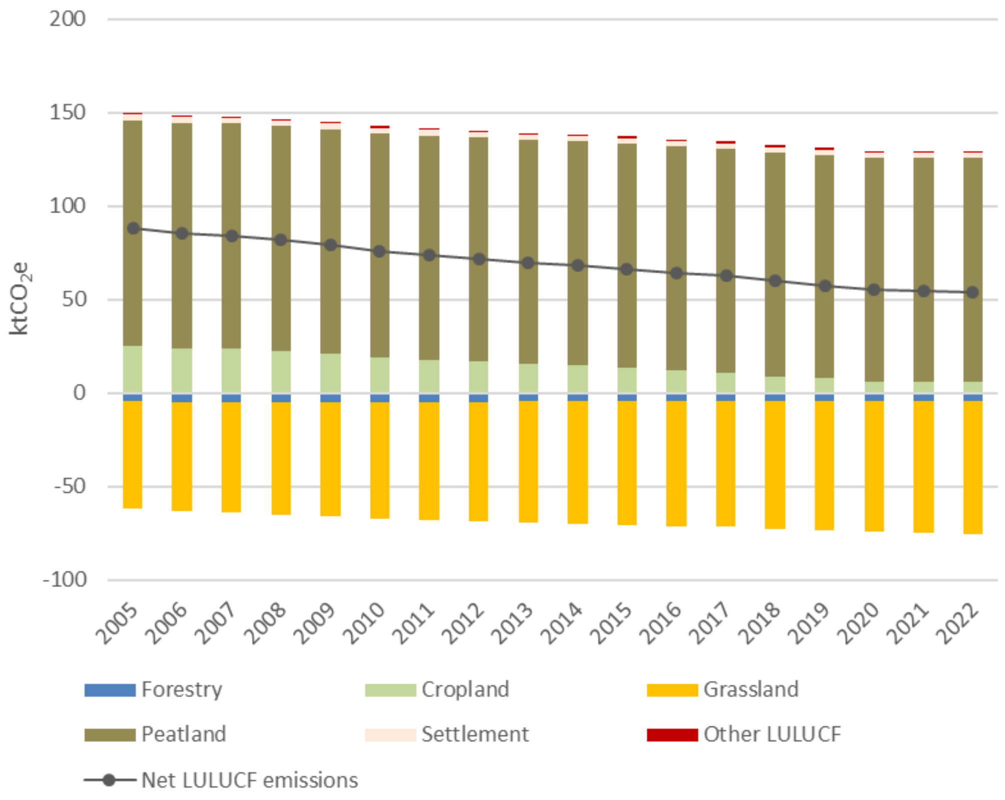
In summary, LiDAR provides the structural framework for understanding landscape and vegetation change, but ground-truthing and direct measurements are indispensable for translating these observations into credible, validated estimates of carbon sequestration / reduction potential.

Appendix Q Historical emissions from land use in Orkney

For context, Figure 17 below shows emissions from land use, land use change and forestry (LULUCF) in Orkney from 2005-2023, based on the DESNZ Local Authority GHG emissions statistics.[246] It shows that overall grassland on mineral soils acts as a stable / slightly increasing net 'carbon sink', absorbing more GHGs each year than it emits (in part reflecting a cycle of grasslands following cropping). Orkney's areas of forestry or woodland absorb carbon, though the overall effect is smaller simply because there is much less woodland across the islands. By contrast, peatlands emit more GHGs than they absorb. This is mainly due to the historical drainage of peatland, which exposes the peat to air and speeds up the breakdown of stored organic material. Croplands and settlements (built-up areas) also tend to emit more GHGs than they absorb.

On balance, this means that LULUCF emissions in Orkney as of 2023 were around 55 ktCO_2e per year. There has been a decreasing trend, largely due to grassland acting as an increasing carbon sink, combined with lower emissions from cropland. Emissions from peatland have remained relatively stable in that time. The graph clearly indicates the potential for GHG reduction via peatland restoration and also the current low level of woodland.

Figure 17. Historical Emissions in Orkney from Land Use, Land Use Change and Forestry (LULUCF). Source: DESNZ



[246] https://www.gov.uk/government/collections/uk-local-authority-and-regional-greenhouse-gas-emissions-statistics

Appendix R Comparison of datasets used to estimate technical land available for NbS projects

The following table briefly compares some of the data sources on land cover and soil geology that were considered as part of this study. It describes the relative advantages (pros) and limitations (cons) of each one, in the context of trying to provide an estimate the technical potential for NbS projects across the archipelago via desk-based research.

Data source	Advantages	Limitations
Spatial datasets/maps		
CEH land cover map	Highly detailed Updated each year Comprehensive coverage (no gaps) Aligns with dataset used to produce UK GHG inventory and LA GHG statistics	Considers land cover, i.e. what is occurring at the surface, and not necessarily underlying soil conditions, therefore cannot be used on its own to identify peatland restoration potential
Habitats Map of Scotland	Habitat descriptions relevant to a range of NbS projects and aligned with Biodiversity Action Plan (BAP) categories	Unexplained gaps in coverage across Orkney Considers land cover, i.e. what is occurring at the surface, and not necessarily underlying soil conditions, therefore cannot be used on its own to identify peatland restoration potential Appears to mistakenly categorise a large amount of grazing land as cropland
Peatland Map of Scotland 2016	Considers soil geology and can therefore be used to identify likely peat coverage Includes data on land use categories Comprehensive coverage across Orkney (no gaps)	Not updated recently (although underlying geology presumed not to change) Needs to be supported by site surveys; peatland mapping is predictive only Land use and habitat categories do not align with other datasets reviewed
ESRI Living Atlas Land Cover Map	Comprehensive coverage Updated regularly	Considers land cover, i.e. what is occurring at the surface, and not necessarily underlying soil conditions, therefore cannot be used on its own to identify peatland restoration potential Land use and habitat categories do not align with other datasets reviewed and some categories are not widely used in UK context (e.g. 'rangeland')
Other datasets reviewed		
DESNZ LULUCF statistics	Shows current estimated emissions and sequestration from different land use categories, aligned with the NAEI Widely used to inform other studies and datasets e.g. SCIS	Reports GHG emissions only, not land areas
Economic statistics as reported in the Orkney Economic Review 2020	Provides sense-check of woodland, cropland and grassland area statistics obtained from other sources	Land use categories relate to agricultural techniques, not reflecting underlying soil conditions or inventory categories

Appendix S Summary of findings from Task 5 extension work

S.1 Introduction

The context review undertaken as part of the Net Zero Transition Study highlighted a number of prior studies that explore land use and nature-based solutions within Orkney, which are therefore highly relevant to Task 5. Following on from the main work package, OIC requested that Aether review those studies in more detail to ensure that findings are integrated into Task 5 as appropriate, including (where relevant) an evaluation of the top-line quantified estimates of carbon sequestration potential outlined in those studies. OIC also requested that Aether conduct a series of interviews to clarify the data, identify additional information sources, and discuss data and knowledge gaps that may increase uncertainties in the overall assessment of emission reduction and carbon sequestration potential. This section presents a summary of the additional work, referred to as the 'Task 5 Extension'.

The Task 5 Extension aims to progress OIC's understanding of the potential scale/order of magnitude of GHG reductions that could be achieved through changes in land use and land management practices by critically evaluating key sources of evidence. This will provide greater clarity on the uses and limitations of the existing evidence base, help refine the assessment of opportunities, and inform discussions about next steps.

S.2 Approach and methodology

S.2.1 Overview of tasks

The extension activities to Task 5 consisted of two components (sub-tasks):

- Sub-task 1, a desk review of four reports/studies to assess what information they contain about carbon sequestration within Orkney. (see S.2.2).
- Sub-task 2, which involved conducting interviews with expert stakeholders who have deep knowledge of the underlying data requirements or of various activities aimed at implementing different NBSs in Orkney (see S.2.3).

S.2.2 Sub-task 1: Desk review of previous studies

A template was developed that allowed for a thorough examination of the above-mentioned studies from a single perspective. The focus was placed on the assessment of the availability and accuracy of the data used, the methodology, and the uncertainties associated with the estimates of carbon reduction or sequestration potential. A list of questions is presented below:

1. Aim of the study and drivers for the work completed
2. Types of land use or activities considered in the study: Agriculture, Peatlands, Forest, Reforestation and Afforestation, Marine Ecosystems (Blue carbon), Other (please specify)
3. Gases considered: CO_2, CH_4, N_2O
4. Assessed carbon sequestration potential:
    a. Estimated potential for carbon sequestration: include quantitative values (scale of reduction) and brief explanatory notes
    b. Timeframe when this can be achieved
5. Assessment methods:
    a. Models and methodologies used (e.g., IPCC Guidelines, carbon budget models)

   b. Data accuracy: if there was any mention of accuracy, provide a brief explanation. Describe main data gaps and limitations
   c. Consideration of uncertainty and sensitivity of assumptions: if mentioned, provide a brief explanation
6. Impact on local community and economy, were there any mentions of how sequestration projects will affect:
   a. Employment and food security
   b. The balance between economic benefits and environmental effects
   c. Other (please specify)
7. Political and regulatory aspects, were there any mentions of factors that will facilitate achieving the potential sequestration goals?
   a. Please list them, if any mention in a study
   b. Development of carbon markets for farmers and landowners

The following studies were reviewed using the template described:

- Carbon Audit for the Inhabited Scottish Islands (Aether, 2023)
- Rural and Agricultural Development: Maximising the potential in the islands of Orkney, Shetland and Outer Hebrides (SRUC, 2024) / Rural & Agricultural Development: Maximising the potential in the islands of Orkney, Shetland and Outer Hebrides
- Baseline Inventory for Greenhouse Gas Emissions in the Highlands and Islands (Highlands and Islands Enterprise, 2024) / Baselining Inventory for Greenhouse Gas Emissions | HIE
- Blue Carbon Audit of Orkney Waters (Scottish Government, 2020) / Blue Carbon Audit of Orkney Waters.pdf

S.2.3 Sub-task 2: Stakeholder and expert (online and email-based) interviews

To assess the feasibility of implementation of various NBSs, alongside the availability and accuracy of the underlying data in the context of Orkney, online interviews and email-based questions with experts in various fields were conducted. This helped to obtain expert feedback on various topics. A generic set of questions that was sent to the interviewer in advance is presented below, although it should be noted that these questions were adjusted to take into account each person's expertise.

Effectiveness of NbS in the context of Orkney:

- Which NbS related to land use-based activities (e.g., peatland restoration, agroforestry, grassland management, cover crops) are most effective in the conditions of Orkney? Which of these is likely to have the greatest impact in terms of GHG emissions mitigation and which ones are less effective?

Data accuracy and availability:

- In your view, is the current availability and accuracy of data sufficient to reliably estimate the carbon sequestration potential of different NbS in the Orkney context?
- Where do you see the largest gaps?
- What resolution or level of data quality is required to achieve reliable carbon sequestration estimates for a small region such as Orkney? Could widely used datasets - such as IPCC default factors or data from the UK national inventory - be applied to estimate the potential impacts of NbS implementation, or would more locally specific data be necessary?

- Can datasets from other Scottish regions with similar ecological conditions be used or calibrated for Orkney, or would the results still have a high degree of uncertainty? How might local factors such as wind or soil characteristics influence their effectiveness?

Modelling tools:

- Which modelling tools do you consider most suitable for estimating carbon sequestration potential (mitigation potential) in Orkney's conditions?
- What are the key input variables that should be considered as priority?

Research and data sources:

- Are there research gaps specific to the Orkney context that need attention?
- Could you recommend key studies or datasets that provide insights into the carbon sequestration potential (mitigation potential) of NbS relevant for Orkney?

Economic aspects:

- Do you have any information or references regarding cost estimates for implementing different NbS in Orkney?
- From your perspective, what types of financial and institutional frameworks could make NbS implementation more efficient and widespread in Orkney?

Social and Institutional aspects:

- In your opinion, which factors - finance, policy coherence, technical capacity, or stakeholder engagement - will have the greatest influence on the successful implementation of NBSs in Orkney over the next decade?

S.3 Desk review of previous studies

This section summarises the outcome of the desk review. Information is presented in the order of the questions as they appeared within the template (see Section S.2.2).

Headline findings:

- Three of the studies (Aether 2023, SRUC 2024 and HIE 2024) draw on LULUCF emissions information from the National Atmospheric Inventory (NAEI) or underlying datasets to present quantified estimates of emissions and removals across Orkney as a whole. Those provide an indication of the current levels, although they do not unto themselves provide the basis for estimating future GHG reductions from land use that can be achieved through NbS projects.
- One of the studies (HIE, 2024) does present an estimate of the potential future scale of carbon sequestration that could be achieved through increases in tree planting and peatland restoration.
- A fourth study (Scottish Government, 2020) examined opportunities for blue carbon within Orkney waters. It noted multiple environmental benefits of such projects but did not contain quantified estimates of the GHG reduction potential, citing lack of available data.

S.3.1 Carbon Audit for the Inhabited Scottish Islands (Aether, 2023)

The main objective of this study was to provide an initial overview of GHG emissions across the 86 inhabited islands in Scotland, including emissions estimates from detailed audits produced for the six Carbon Neutral Islands. The study serves as a baseline for understanding current emissions levels within Orkney. The study does not provide sufficient basis for estimating future GHG reductions from land use that can be achieved through NbS projects, however, as that was not the focus of the work.

The assessment focused on several key land use categories, including agriculture, peatlands, and forests (covering reforestation and afforestation activities). Marine ecosystems, such as blue carbon habitats, and other land use types were not considered within the scope of this study.

Three major GHG were analysed: CO_2, CH_4, and N_2O.

With respect to carbon sequestration, the study primarily examined historic emissions and removals.

The 2006 IPCC Guidelines were utilised to conducts the estimates. Emission estimates for the Land Use, Land Use Change and Forestry (LULUCF) sector were derived mainly from UK Centre for Ecology & Hydrology (UKCEH) land cover maps for the years 2000 and 2019, at a 25-metre raster resolution. These data were supplemented by additional sources, including the Soils World Reference Base (WRB) Map, information on peatland areas from 1990, and expert judgement regarding peatland conditions inferred from land use changes. Emission factors were taken from the UK National Inventory and 2006 IPCC Guidelines, with additional literature sources used for eroded and modified bogs, reflecting active eroding conditions. Detailed emission factor values are presented in the original report (Table 4, p.30; Table 5, p.33).

Peatlands were identified as a major source of emissions, underscoring the importance of further work to refine peatland categorisation and to assess condition more precisely.

The estimates relied on several key assumptions: linear land use change between 2000 and 2019; the use of maps with differing resolutions to construct the time series, which may affect the consistency and accuracy of the data; and no alteration in peatland condition where no land use change was detected, which may in turn influence the appropriateness of the emission factors applied. In addition, changes to grassland or forest land on organic soils were assumed to represent re-wetted peatlands, and only peatland areas identified in the peatland area map were treated as organic soils.

Several data gaps and limitations were noted: the study lacks information on management practices occurred on different land use categories, data on harvest rates, biomass burning and fertiliser application on forest land were not presented.

The categorisation of peatland areas was highlighted as a critical source of uncertainty. Although the report acknowledged that the uncertainty in the emission estimates is high, there was limited formal analysis of uncertainty or sensitivity to underlying assumptions.

The study did not consider potential impacts on local communities or economies.

Likewise, political and regulatory aspects were not discussed.

S.3.2 Rural and Agricultural Development: Maximising the potential in the islands of Orkney, Shetland and Outer Hebrides (SRUC, 2024)[247]

The study reports findings on the potential impacts of forthcoming agricultural and related policy changes on farms, associated upstream and downstream sectors, local communities, cultural heritage, land use, and the natural environment within the jurisdictions of Orkney Islands Council,

[247] https://sruc.figshare.com/articles/report/_b_Rural_Agricultural_Development_Maximising_the_potential_in_the_islands_of_Orkney_Shetland_and_Outer_Hebrides_b_/26125552

Shetland Islands Council, and Comhairle nan Eilean Siar (the Outer Hebrides). As with the Carbon Audit for the Inhabited Scottish Islands (see previous section), it reports area-wide LULUCF emissions. The study serves as a baseline for understanding current emissions levels within Orkney. The study does not provide sufficient basis for estimating future GHG reductions from land use that can be achieved through NbS projects, however, as that was not the focus of the work.

The assessment included agricultural land, peatlands, and forested areas (including reforestation and afforestation). Marine ecosystems (blue carbon habitats) and other land use types were not within the study's scope.

Three principal GHG were covered: CO_2, CH_4, and N_2O.

The study did not directly assess the projected potential for carbon sequestration or provide quantitative estimates of future emission reductions. Instead, it focused on historical emissions, removals, and socio-economic parameters as of 2021–2022, with limited projections. However, the study pointed out that the current use of these lands was identified as a limiting factor for peatland restoration. A couple of examples were provided on ongoing restoration projects, highlighting both progresses achieved, and barriers encountered. The main challenges described were:

- A lack of skilled labour to carry out restoration work
- Certain financial and legal uncertainties regarding Peatland Code accreditation could create risk for some land managers and owners.
- Structural issues within crofting regulations, which complicate decision-making and ownership of potential carbon credits, particularly in common grazings and tenanted hill areas.

The study used data from the national GHG inventory, compiled according to the 2006 IPCC Guidelines and supported by country-specific information. The analysis did not present explicit information regarding data accuracy, uncertainty, or sensitivity of assumptions.

The SRUC study also presented data on bare peat estimated based on 2018 satellite imagery produced by NatureScot Geographic Information Group Earth Observation team for the Peatland Action project. This estimated a total of 0.3 ha of bare peat in Orkney and was used as an indication of the potential for peatland restoration. The study noted that, while bare peat may benefit from restoration, it does not indicate the total area of peatland in need of restoration as the data does not include the extent of peatland affected by artificial drainage. Furthermore, the use of earth observations to identify bare peat would result in only large areas of actively eroding peat being identified. This means that the areas for potential peatland restoration in the SRUC study are underestimated for Orkney. An assessment of how carbon sequestration projects might influence employment patterns or food security across the island communities was not conducted. However, the study included detailed examinations of supply chains (Section 9) and the importance of agriculture to island economies (Section 9.3). Land capability for both agriculture (Section 3.1) and forestry (Section 3.2) was also analysed.

Nature/farming conflicts were discussed in Section 8.6, covering issues such as goose management, sea eagle interactions, and deer density and management. The report clarified that, *'Future tiered support should take consideration of the existing positive biodiversity and environmental outcomes being achieved in these island groupings – as well as where management needs improving. Positive actions should inform the types of conditional measures and targeted scheme design of future agricultural support – with training needs.'*

Regarding peatland restoration, the study concluded, *'There are opportunities for peatland restoration and improved peatland management in across the island groupings, but there needs to be legislative clarity over peatland restoration and peatland carbon rights on common grazing, and future policy design must include measures to support managed grazing regimes post restoration across all Tiers (as discussed by Thomson et al 2023).'*

The study did not assess political or regulatory drivers that could facilitate the achievement of carbon sequestration objectives.

S.3.3 Baseline Inventory for Greenhouse Gas Emissions in the Highlands and Islands (Highlands and Islands Enterprise, 2024)[248]

The study provides baseline GHG emissions for the Highlands and Islands region and its local authority areas. It evaluates regional emissions by sector to identify the main contributors. The study also highlights gaps and limitations in national datasets and suggests where more localised data collection could be improved. In addition, it assesses the region's current and potential contribution to national renewable energy generation and considers its terrestrial carbon sequestration potential. The study provides a high-level estimate of the potential future GHG reductions from land use that could be achieved through NbS projects across the islands.

The study considered different land use types, with a particular focus on agricultural, peatland, and forested areas:

- Agricultural land was assessed using the Land Capability for Agriculture in Scotland rating system, with Classes 6.1–6.3 and 7 identified as being within the scope of potential carbon sequestration activities.[249]
- Peatlands were included, with data on areas classified by soil type presented.
- Forests, including reforestation and afforestation activities, were also considered.
- Marine ecosystems (blue carbon) and other land uses were not included in the analysis.

The analysis focused on three main GHGs: CO_2, CH_4, N_2O.

Agricultural land: areas capable of supporting only rough grazing were identified as having potential for carbon sequestration activities. If the land were to be transformed into woodland, then the number of carbon units per hectare could theoretically be calculated. Carbon sequestration potential for peatlands was also estimated based on restoration data from Shetland and Nah-Eileanan Siar, allowing for an assessment of potential future restoration and carbon sequestration.

The HIE report considered opportunities for carbon sequestration projects across Orkney. The authors assumed that, in order to be used for afforestation, the land in question would need to be suitable only for rough grazing. The authors estimated that 25,639 ha of land met this description. They further assumed that this could deliver 350 tCO_2e reduction per hectare over 30 years, or around 11-12 tCO_2e/ha/year on average during that time period, which is in line with WCC figures although higher than may be expected for a typical woodland in Orkney. The authors then calculated the scale of carbon removal potential if 2.5%, 5% and 7.5% of that land was converted to carbon sequestration projects. (Note the report does not state whether there was a technical reason for applying this constraint; that this may have been used to represent social and economic factors and

[248] https://www.hie.co.uk/research-and-reports/our-reports/2024/july/15/ghgresearch/

[249] https://soils.environment.gov.scot/maps/capability-maps/national-scale-land-capability-for-agriculture/
Class 6.1 - Land capable of use as rough grazings with a high proportion of palatable plants
Class 6.2 - Land capable of use as rough grazings with moderate quality plants
Class 6.3 - Land capable of use as rough grazings with low quality plants
Class 7 - Land of very limited agricultural value

competing land uses.) Total estimate of 224,300 (2.5% or 640 ha), 448,600 (5% or 1,282 ha) and 673,000 (7.5% or 1923 ha) tCO_2e units in total on this basis. This is shown in the table below. The report states that there may be a reluctance amongst landowners to give up quality agricultural land to sequestration activity. Therefore, an estimate is provided for the sequestration potential of Class 7 land only that has limited agricultural value.

For peatland restoration, the authors assumed a potential sequestration rate of around 200 tCO_2e per hectare[250]. It is stated that the carbon sequestration potential of degraded peatland depends on the nature of the peatland, and the sequestration rate of 200 tCO_2e is used for theoretical purposes. Due to the lack of completed Peatland ACTION restoration projects in Orkney, the median restoration rate per annum was estimated based on restoration rates for Shetland and Na h-Eileanan Siar. An estimate of sequestration potential is provided for 10% and 25% uplift of peatland restoration above the median rate.

Table 36. Estimated carbon sequestration potential over 30 years (as presented in Table 7.3, Table 7.4 and Table 7.7 of the HIE report)

	Assuming 350 tons CO_2e per ha over 30 years		
Percentage of land converted to carbon sequestration projects	2.5%	5%	7.5%
Forestation of land suitable for rough grazing (Classes 6.1–3 and 7)	224,300	448,600	673,000
Forestation of land suitable for rough grazing (Class 7 only)	8,100	16,300	24,500
	Assuming 200 tons CO_2e per ha		
Assumed restoration rate per annum	Medium restoration rate per annum	+10% above median rate	+25% above median rate
Peatland	5,205	5,725	6,506

Marine resources have capacity to capture and store carbon, but unlike land- based environment, there are no well-established systems for managing this ecosystem. This gap is because the marine biotechnology and marine environmental services sectors are still at the early stages of development. However, this may develop as sequestration approaches mature.

The Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)[251] methodology was used.

Discussion on data accuracy and uncertainty rates associated with the sequestration potential estimates was not provided in the study. However, the study clarified that it relied on a portfolio of data. The UK local authority and regional GHG emissions national statistics timeseries data set released each year by the Department for Energy Security and Net Zero (DESNZ) were used as it provides a consistent source of data on territorial GHG emissions, which facilitates comparison with Scotland and other parts of the UK.

The study did not explicitly assess the impact of potential sequestration projects on employment or food security, nor on the balance between economic benefits and environmental effects. However, wider benefits associated with peatland restoration and woodland creation were identified, including:

[250] Note that the HIE report does not state over how many years the sequestration of 200 tCO_2e per hectare are assumed to occur. Based on the referenced data source (http://www.gov.scot/publications/national-development-plan-crofting/pages/11/), this may be referring to sequestration over 100 years.

[251] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

- Improved biodiversity and habitat creation, including enhanced availability of deadwood in habitats.
- Flood risk mitigation and improved water management through increased water interception, infiltration, and retention.
- Reduced soil erosion and improved soil nutrient management, limiting damage from wind and rain.
- Creation of skilled jobs, particularly in managing woodlands, and peatland restoration projects.
    - Positive impacts on community engagement, environmental education, and volunteering opportunities.
    - In the case of woodland creation, contributions to community wealth building through multiple forms of capital: financial, social, individual, natural, and built capital, such as recreational facilities or trails.

The study identified several potential challenges to implementing various sequestration projects:

- Information gaps and misunderstanding of sequestration potential among landowners and communities that creates resistance toward sequestration schemes.
- Cultural factors and traditional factors such as established farming practices, emotional ties to the land, and 'moral duty' to maintain current management practices, as well as financial pressure.
- Limited local capacity to deliver, especially in remote areas where not enough skilled people to implement restoration and other sequestration projects.
- Geographical constraints in the Highlands and Islands constrain the extent to which sequestration can be implemented, as it may displace existing land uses: e.g., agriculture land use. For example, ideal woodland sequestration conditions are found on flatter land, and thus in direct competition with grazing.

S.3.4 Blue Carbon Audit of Orkney Waters (Scottish Government, 2020)[252]

The study aimed to assess blue carbon stocks associated with key habitat types at a regional scale using Orkney coastal waters as a case example. The study focused exclusively on marine ecosystems as the source of blue carbon. Other land use types such as agriculture, peatlands, and forests, including reforestation and afforestation, were not considered. Within the marine ecosystem category, the audit included both sedimentary carbon stores, covering organic and inorganic carbon, and living biological habitats.

The audit considered CO_2 as the primary GHG.

It should be noted that carbon sequestration rates were not assessed as part of this audit. Insufficient data exists for many of the key habitats in Orkney to reliably estimate rates of sequestration. Therefore, the audit focuses on carbon stocks present in surface sediments surrounding Orkney, rather than long-term burial or sequestration potential. Consequently, quantitative values for carbon sequestration were not included. However, the study does highlight the substantial existing carbon stores already held within Orkney's marine environment, emphasising their importance as natural assets. This shows the value in protecting these habitats to maintain their current carbon stores and support their potential future contribution to carbon sequestration as more data becomes available.

A variety of models and methodologies were employed to estimate carbon stocks across different habitat types. The study contained a discussion of data accuracy, and concluded that it is

[252] https://data.marine.gov.scot/dataset/blue-carbon-audit-orkney-waters

constrained by methodological limitations, insufficient empirical data (including sediment thickness, elemental ratios, and species growth and sequestration rates), as well as by reliance on predictive habitat models and the limited representativeness of the available samples.

Uncertainties were discussed: the greatest sources of uncertainty were associated with estimates of habitat area, followed by biomass density and blue carbon biomass. Seagrass meadows (Zostera) show considerable variability in organic carbon values across different geographical regions, leading to high uncertainty when extrapolating from one bed to another. The highest overall levels of uncertainty were identified for kelp forest and horse mussel habitats.

The audit did not assess the potential impacts of blue carbon sequestration projects on employment, food security, or the balance between economic benefits and environmental effects.

The audit did not specifically address policy mechanisms for achieving sequestration goals. However, it highlighted several protected marine areas in Orkney based on biodiversity value. These include the Wyre and Rousay Sounds MPA, which protects maerl beds, kelp, and seaweed communities; Papa Westray MPA, which protects cliffs and near-shore waters used by black guillemots; Sanday SAC, which protects rocky reefs, Laminaria, bryozoan and hydroid turfs, horse mussel beds, and brittlestars; and Faray and Holm of Faray SAC, which protects Grey seal colonies and kelp forests. The audit also highlighted pressures on carbon stocks. Saltmarsh habitats and other blue carbon resources were classified as vulnerable without effective coastal management. Ocean acidification impacts horse mussel beds, flame shell beds, maerl, brittlestars, and bryozoan thickets, while seagrass and kelp may be more resilient. Maerl and kelp beds are also susceptible to warming sea temperatures. Activities increasing turbidity, such as dredging, sediment resuspension, or land erosion, could reduce the carbon capture capacity of photosynthesising blue carbon habitats.

S.4 Stakeholder interviews

This section presents the results of interviews conducted with key expert stakeholders involved in the development and implementation of NbS. The aim of the interviews was to assess the availability and accuracy of relevant data and to evaluate the potential effectiveness of carbon sequestration and emission reduction potential of proposed NbS and where possible, in the context of Orkney. The feedback collected during the interviews was summarised and anonymised for inclusion in this report. The following NbS were discussed with stakeholders at varying levels of detail:

- Peatland restoration
- Woodland creation (including smaller clusters or individual tree planting)
- Grassland restoration
- Agroforestry
- Sustainable agricultural practices
- Marine restoration (blue carbon)

IMPORTANT: The information presented in this section is based solely on the data obtained during the interviews and represents a consolidated summary of views from the experts / stakeholders. This is intended as informative towards understanding of this sometimes complex and developing field. Aether accepts no responsibility for the accuracy of the advice provided.

S.4.1 Effectiveness of NbS in the context of Orkney

This section summarises the advice provided to Aether during the course of the expert (online and email-based) interviews that were carried out.

Peatland restoration

Restoring peatlands can offer a significant climate opportunity for Orkney. Peatland restoration delivers a GHG mitigation benefit because it reduces the quantity of GHG emissions that would otherwise occur, not by providing immediate carbon sequestration. Near-natural peatlands can be net carbon sinks but most restoration sites initially reduce emissions by restoring hydrology and halting oxidation. Local conditions present unique challenges: peatlands can be shallow or mixed with mineral soils, so restoration potential and costs vary. Hence, the feasibility of restoration depends on a wide variety of factors, including but not limited to site conditions such as slope and hydrology.

Although restoration methods such as drain blocking and rewetting are relatively costly, they remain more cost-effective than engineered carbon dioxide removal (CDR) techniques and deliver additional benefits – enhanced biodiversity, improved water regulation, and reduced wildfire risk. Degraded peatlands are highly vulnerable to drought and fire, which can cause catastrophic carbon releases. Rewetting mitigates these risks, making peatlands less likely to burn and quicker to recover if fires occur. In particular, hydrological interventions slow peak flows, extend baseflow, maintain wet conditions for bog vegetation, and reduce nutrient and carbon export to streams and the sea. While drains on slopes do not store water, blocking them reduces conveyance and attenuates floods, producing smoother hydrographs and better drought resilience. Actively eroding complexes on slopes or cliffs require tailored earthworks and contractor training, highlighting the need for site-specific designs.

Finally, restoration significantly lowers wildfire risk. Rewetted peatlands are less likely to ignite and recover faster post-burn, providing a nonlinear risk benefit under Orkney's changing climate.

For Orkney, stakeholders advised that drain blocking offers the fastest practical gains. In contrast, actively eroding sites on slopes with peat banks and gullies require complex earthworks, which carry higher risk and cost. Accurate site diagnosis is critical: aerial processing followed by ground checks improves decision-making and reduces mis-targeting.

To conclude, in addition to biodiversity enhancement, peatland restoration in Orkney delivers climate benefits mainly through:

- Rapid reduction of GHGs that would otherwise be emitted from degraded peat.
- Systemic risk reduction - lower vulnerability to wildfire and drought and benefits to slow surface run-off and flood attenuation.

Woodland / Agroforestry

High winds and salt, low tree survival rates, and some challenging soils make large-scale woodland creation in Orkney difficult. More sheltered valleys, such as Happy Valley, or Berriedale on Hoy, offer better conditions for tree growth, but overall potential remains limited compared to some other regions.

An opinion put forward by several experts during the course of the technical interviews was that, for Orkney, the most realistic option for tree planting is not large-scale woodland creation, but small-scale, farm-integrated planting, including willow belts and silvopastoral systems. Typical plantings are small (below 1-2 hectares) and dispersed across the landscape. Shelter belts and mixed planting can improve resilience, with native species like willow and birch, and other species like sycamore performing well in sheltered sites. Alley cropping – rows of trees with space for machinery – has been successfully trialled in France and could possibly be considered / attempted in parts of

Orkney's more sheltered arable land. More commonly, planting in margins of grassland areas was also suggested by stakeholders.

Carbon sequestration from trees will likely be smaller in scale than carbon mitigation from peatland restoration. Tools such as Ecological Site Classification (ESC) can help identify suitable species, and the Woodland Carbon Code (WCC) can estimate carbon potential, though it assumes soil carbon remains largely static apart from initial disturbance losses.

Tree planting in the right place offers important co-benefits: willow can support nesting birds and bioremediation (RSPB), while shelter belts protect livestock and enhance biodiversity. One stakeholder advised that such areas may also qualify as Ecological Focus Areas under new farm payment schemes, providing financial incentives (although this may not reflect current funding schemes).

Tree- and scrub-based NbS should complement peatland restoration rather than replace it. Interventions must account for hydrology, site exposure, and logistics. ESC outputs can guide species selection, but in exposed coastal areas, wind and salt stress may be underestimated; temporary shelterbelts or nurse stands (e.g., larch or Sitka) can aid establishment before transitioning to native communities. Willow is supported by the Royal Society for the Protection of Birds (RSPB) due to its value for nesting birds and bioremediation. In addition, shelter belts can provide protection for livestock and enhance biodiversity. It should also be noted that such areas could qualify as Ecological Focus Areas (EFAs) under new farm payment schemes, offering financial incentives.

Cover cropping and grassland and livestock management

Cover cropping is considered effective for soil protection and nutrient retention, although it has only modest carbon benefits compared to peatland restoration or woodland creation. The activity can be understood as a potential "quick win" for soil health and resilience rather than a major carbon sink. During the interviews, the Aether team was advised that its feasibility is good within Orkney, and farmer interest exists due to existing policy incentives. At present, a project involving 13 farmers in Orkney is implementing cover crops to fill the 5-6-month gap between spring barley crops. The main objective of the project is to reduce soil erosion, retain nutrients, and maintain soil structure during fallow periods. Therefore, avoided erosion can also be considered a relevant benefit or solution.

With regard to grassland management, biodiversity and soil health benefits are significant, but the carbon sequestration potential is understood to be low in the context of Orkney, as grasslands are near saturation (i.e. they are close to equilibrium with minimal additional sequestration potential). In particular, shifting from monoculture ryegrass to diverse swards (e.g., white clover) improves soil health, rooting structures, and nitrogen fixation.

Given Orkney's high livestock densities (around 70,000 cattle and 140,000 sheep) and spring barley-based systems, the most effective agroecological strategies focus on grassland and nutrient cycles rather than large-scale woodland conversion. Enteric methane mitigation through feed supplements offers further potential, with reductions of 30–40% possible if cost and adoption challenges are addressed. Practices such as mob grazing and the use of diverse swards can improve system resilience with benefits for soil and biodiversity).[253] it is understood that scientific studies in the early

[253] https://www.soilassociation.org/our-work-in-scotland/scotland-farming-programmes/mob-grazing/why-start-mob-grazing/

stages of research are starting to establish whether there are carbon sequestration benefits associated with mob grazing and the scale of any benefits.[254]

Blue carbon projects

This option was not discussed during the online interviews. As a result, information on its effectiveness and data availability for projects in Orkney was limited. One expert provided a response to questions sent via email and their input is summarised below.

The respondent was aware of the Blue Carbon Audit for Orkney (see Section S.3.4) and noted the uncertainty in estimating blue carbon stocks. They advised that:

- To reduce uncertainty in estimates of blue carbon stocks in Orkney it would be valuable to enhance model validation. This would require more detailed coastal mapping and additional carbon measurements to support and refine the mapping outputs.
- Carbon fluxes at the seabed interface and within deeper sediment layers remain poorly understood for Orkney's blue carbon habitats. These processes could be better quantified through core measurements.
- The contribution of algal biomass to carbon sequestration also represents a notable data gap, as this habitat type was not included in the Orkney Blue Carbon Audit.

The respondent also noted that it is also important to avoid considering blue carbon solely at the coastal scale. Land-based activities in adjacent catchments can significantly influence the condition of blue carbon habitats and their capacity to sequester carbon. In the future, adopting a catchment-scale approach will be essential, as nutrient-rich runoff from land can affect the health of seagrass meadows. In some areas of Scotland, extensive seagrass dieback has already occurred due to such pressures. The respondent advised that preventing similar impacts in Orkney will be crucial to safeguarding the long-term carbon sequestration potential of Orkney's seagrass meadows.

The respondent further advised that it is also worth considering the role of blue-carbon habitats, such as seagrass meadows, in providing coastal protection. They noted that preliminary work on this was done in a CREW report.[255] The report focused on Scotland nationally, with regional case studies e.g. Sanday in Orkney, which faces regular flood risk.

S.4.2 Data accuracy and availability

The following datasets were discussed with stakeholders and the following section summarises their views on the potential applications of each dataset:

UK GHG inventory data can be used as a starting point for scoping peatland restoration and other NbS projects. However, the data should be further validated to make the estimates more accurate in the context of Orkney.

Carbon and Peatland Map (2016) is widely used by statutory agencies and restoration projects and remains the best large-scale resource, yet it is insufficient for site-level planning, as it is:

- high-level and lacks sufficient detail regarding erosion and degradation.
- not suitable for identifying marginal peat areas, such as shallow peat mixed with mineral soils.
- Its broad classification categories may lead to potential over- or underestimation of peat extent and carbon content.

[254] https://doi.org/10.1016/j.nbsj.2023.100054
[255] https://www.crew.ac.uk/publications/effect-shellfish-kelp-and-sea-grass-beds-flood-risk-and-coastal-erosion-scotland

Peatland Action dataset includes hundreds of thousands of peat depth points across Scotland as it maintains a large peat-depth database from restoration programmes, improving national coverage over time. However, the coverage for Orkney may be incomplete. Critical parameters such as soil carbon depth, peat bulk density, emission factors for Orkney-specific conditions are missing. These gaps highlight the need for site-specific to ensure reliable estimates. Combined with soil maps and aerial imagery, this dataset is essential for accurate carbon stock assessments and determining site suitability for Peatland Code projects.

Soil maps (James Hutton Institute) are available but basic, showing soil series (type of soil) without depth or detailed carbon stock information. Farmers increasingly conduct soil assessments, but data is fragmented and uncentralised.

- The maps are useful for general classification but are not sufficient for carbon accounting or restoration planning.
- Ground-truthing is essential, as maps alone are not accurate enough for site-level decision-making.
- Soil maps should be considered as part of the data package used for peatland restoration planning, but they require to be integrated with the Peatland Action dataset and field surveys to ensure accuracy.
- Hence, extensive soil surveys and deep soil core sampling are required to help understand carbon stock potential.

The **ESC tools** use James Hutton Institute's Soils dataset, which applies dominant soil types per polygon, but up to nine soil types can occur within a unit, introducing uncertainty. For sites over 100 hectares or highly variable terrain, local soil surveys and targeted coring should supplement national data, along with terrain and exposure layers. ESC allows integration of user-supplied data, enabling bespoke workflows for site-specific outputs.

Several stakeholders confirmed that maps must be supported by measurements of peat depth, condition, dry bulk density, and soil organic carbon content in line with the Peatland code and depending on peatland type. Engaging experts such as the James Hutton Institute is essential for robust accounting. Spatially disaggregated, Orkney-specific data is valuable. Current soil maps provide broad texture and series information but lack depth and carbon stock profiles. Orkney's diverse soils require locally captured data, including farm nutrient plans, soil assessments, and ideally deep cores for baseline carbon stocks.

The **LiDAR survey (2024–2026)** provides high-resolution topography and vegetation cover for monitoring peat height and afforestation potential. Full LiDAR coverage of Scotland is expected to be available by 2026 which will significantly improve carbon accounting accuracy. For more information on the uses of LiDAR in Orkney, please see **Appendix O**.

S.4.3 Modelling tools

The Peatland Carbon Code provides a standardised framework for calculating emission reductions and the only recognised tool in the UK to generate tradable carbon units from peatland restoration. The use of the tool offers landowners and farmers a financial incentives and policy support, which is particularly relevant for Orkney where peatland restoration can replace emissions from degraded organic soils.

The Code is designed to align with IPCC guidelines, incorporating emission factors and uncertainty ranges the UK national GHG inventory, using UK-wide averages that may not fully reflect local conditions (e.g., Orkney; slower peat accumulation, different bulk density). Experts agreed that these factors may not be fully accurate for Orkney, i.e. as literature values they may reflect the available evidence based from existing studies but will not necessarily be predictive of the real-world conditions on a specific Orkney project site. However, they are validated and widely accepted for carbon trading and experts agreed that the Peatland Code is a credible approach and suitable for progressing peatland projects in Orkney

In general, the Code is appropriate for peatlands, but less so at field-level resolution (e.g., vegetation, erosion, land use history); it works best for larger restoration areas. The application of the Code requires accurate on-site baseline data, including peat depth and condition, as well as soil organic carbon content and fine dry bulk density for some areas of drained peatland where peat soils are heterogeneous. The code should be supplemented with soil maps and local datasets to improve accuracy. LiDAR surveys, which are planned to be finalized for Scotland will further enhance monitoring and verification. Moreover, the Peatland Code and Peatland ACTION already maintain an established partnership and work closely together, aiming to align their processes as effectively as possible on an ongoing basis. Peatland ACTION encourages all applicants interested in the Peatland Code to initiate this process before beginning the restoration design plan for Peatland ACTION.

Woodland Tools

To inform decisions regarding potential sites and conditions for implementation of tree planting, the **Ecological Site Classification** (ESC)[256] can/should be utilised. The tool was created to assist in selecting tree species according to the conditions of the site of interest and provides a mechanism for including such site characteristics as soil fertility, soil moisture, wind conditions, and climate. ESC is designed to support the decision-making process by providing a quick assessment of the site's potential characteristics and allowing exploration of the effects of projected climatic changes on the site and species interactions over time. In addition, it was stressed that the ESC tool defines the site potential and subsequent productivity; however, appropriate management practices can help overcome certain constraints. For example, in exposed coastal areas, planting non-target species can serve as an effective windbreak to shelter the main planting mix..

The Woodland Carbon Code (WCC) is recognised as a key framework for estimating carbon sequestration from tree planting projects in the UK. It provides carbon look-up tables for different species and planting mixes, which when combined with site based yield class information (e.g. from ESC tool) can inform project-level carbon accounting.

Experts noted that WCC can be applied in Orkney but with limitations due to local conditions, including high wind exposure and salt spray reduce tree growth rates. Moreover, small, fragmented planting areas (1–2 ha) are common, making large-scale woodland projects less feasible. Hence, this NbS (the WCC application) will likely be less used in comparison to peatland restoration. However, despite these constraints, the WCC is still useful for calculating carbon potential for native woodland creation and Shelterbelts and small-scale plantings. Although soil carbon will increase under new woodlands, the tool does not account for soil carbon changes in its standard calculations (initially assumed static), focusing primarily on biomass carbon.

The WCC is often combined with site classification tools (e.g., ESC) to determine species suitability and yield class before applying the WCC tables. However, the use of the underlying yield-class data embedded in the ESC tool can be challenging under Orkney conditions due to lack of local growth trials and the area's high exposure. Further combining the WCC with LiDAR data and local monitoring activities can improve accuracy of the estimates.

[256] Ecological Site Classification (ESC) - Forest Research

Farm-level tools

AgriCalc (SAC) tool and **SmartCarbonToolkit** for GHG baselines were also mentioned as an option to be complementary used by farmers. However, the experts noted the limited resolution for specific parameters/practices and the fact that the tools are more suited for farm-level GHG accounting.

S.4.4 Research and data sources

Stakeholders highlighted several additional sources of data which OIC could refer to in future. The resources provide detailed data, which can be used to assess carbon sequestration and emission reduction potential:

- James Hutton Institute (The James Hutton Institute, crops, soil and environmental research): Soil maps, peatland condition data.
- Maps | Scotland's environment web: A couple of Land Information Search applications including LIS AGRI-environment and forestry and LIS COMAH environmental risk assessment.
- The James Hutton Institute, crops, soil and environmental research leads the peatland project and modelling, including About the project | UKRI NERC funded Peat Mothership project and JULES - Joint UK Land Environment Simulator | JULES JCHMR
- Scotland's Rural College Environment | SRUC has a leading role in developing new approaches to measurement and mitigation of GHG emissions from agriculture.

S.4.5 Economic aspects

The peatland restoration costs in Scotland vary widely, ranging from approximately £450 per hectare for simple drain blocking to £9,000 per hectare for complex erosion control or afforested bog restoration. These differences are driven by technique complexity, site accessibility, contractor expertise, and island-specific logistics. Drain-blocking projects typically are less costly, while highly eroded sites and tree removal on afforested bogs are more costly. Island conditions significantly influence costs. Limited availability of low-ground-pressure excavators and the need to import specialised machinery can increase rates compared to mainland projects. Early engagement with contractors is essential to assess equipment requirements and maintenance capacity.

Some experts noted that a widely used figure is approximately £1,000 per hectare. This benchmark is applied by the Scottish Government for large-scale restorations. However, in the context of Orkney, there are several factors that could influence the final cost level: on islands like Orkney, costs rise due to remote locations, leading to additional expenses for equipment maintenance and logistics, especially when helicopter transport for materials may be required. Costs are also affected by the limited availability of specialised equipment (e.g., low-ground-pressure diggers) and the need to bring contractors and machinery from the mainland.

Organic-soil grassland rewetting may involve opportunity costs for farmers, while tree planting and alley-cropping provide shelter and multifunctional benefits. Linking ESC yield outputs to Woodland Carbon Code tables enables indicative carbon revenue modelling, and LiDAR baselines can reduce future monitoring costs by supporting remote verification of dispersed plantings.

S.4.6 Social and Institutional aspects

Building local capacity for peatland restoration in Orkney requires close collaboration with landowners, noting also that some productive farmland lies over peat soils. Orkney examples will be important in building interest and progress can only occur with landowner involvement. Clear communication of carbon benefits, biodiversity gains, and practical restoration designs that integrate with farm operations is essential to encourage uptake along with well evidenced information about costs, benefits and returns. At present, engagement and awareness are the main priorities. To date, one peatland agent and a well-known nature conservation charity have already delivered restoration projects on Orkney, and these can serve as examples to inform farmers, and landowners about the opportunities and benefits of restoration.

All island groups will have specific land use and competing demands in varying degrees (e.g. peat cutting rights) that will need to be considered in project developments.   Engagement with communities and locals will be important.

S.5 Recommendations and future work

Taking data availability and limitations into account and the information shared during the (online and email-based) interviews, the following actions were summarised by the Aether team. The actions can be identified as priorities for establishing a ground base for assessing carbon sequestration and emission reduction potential resulting from the implementation of various NbS.

To obtain validated and Orkney-specific data:

- Conduct systematic peat-depth surveys.
- Integrate new measurements with Peatland Action datasets to reduce uncertainty in peat classification.
- Calibrate ESC yield classes using local growth data and link to Woodland Carbon Code tables for biomass carbon estimates.
- Integrate the obtained data (together with existing datasets) through a unified GIS model combining Carbon and Peatland Map, JHI soils, Peatland Action depth points, and LiDAR database.
- Build an MRV system to track baseline, intervention, and verification stages, integrating Peatland Code/WCC documentation and uncertainty buffers.
- Build partnerships with various scientific stakeholders to obtain scientifically validated data, which can be used for informed decision-making and achieving more accurate results.

OIC could further discuss these options with key stakeholders such as RSPB, Nature Scot, Local Universities and the Islands Centre for Net Zero, to explore funding potential and to prioritise accordingly:

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