Ricardo
Energy & Environment



Shetland Islands Net Zero Routemap (NZSR)

Final report on baseline, business as usual and net zero pathways

Report for Shetland Islands Council

Shetland Islands Council

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Table of contents

Executive Summary

Shetland Islands Council

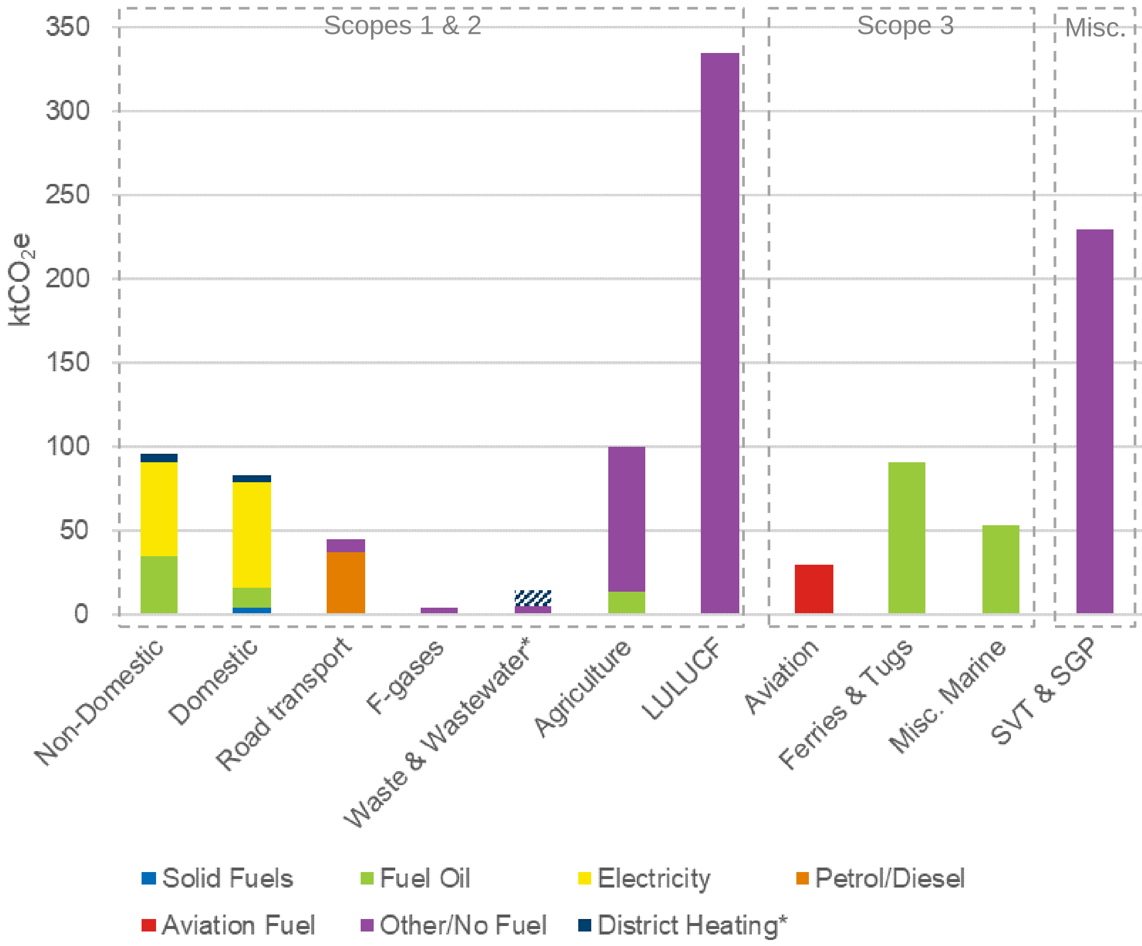
Introduction

The need for urgent action to reduce harmful greenhouse gas (GHG) emissions has never been clearer. The Glasgow Climate Pact, agreed at the COP26 climate conference in Scotland in November 2021, resolved to pursue efforts to limit the temperature increase to 1.5ºC above pre-industrial levels. At a national level, the target set by Scottish Government is to achieve net zero greenhouse gas (GHG) emissions by 2045. At a local level, on 2nd January 2020, Councillors at the Shetland Islands Council (SIC) voted to acknowledge a climate emergency, thus recognising the need for an immediate response to mitigate human-induced climate change.

This report provides a strategic routemap for how Shetland as a whole can work towards achieving net zero emissions. (A separate report has been prepared for the Council's own emissions.) The aim is to take a high-level view of all known sources of emissions in order to identify suitable mitigation measures and start to develop a more detailed implementation plan. This is important because it helps to ensure that all relevant decision makers, including the Council, the local community, local businesses, Government, and others, can start to make informed decisions that are aligned with the urgent need to decarbonise our economy and lifestyles.

Current sources of emissions in Shetland

The graph below presents an estimate of different sources of GHG emissions in Shetland as of 2019.



** Emissions from the energy recovery plant (ERP) are shown in the 'Waste & Wastewater' category as 'District Heating' purely for scale. They are in fact allocated to end users in domestic and non-domestic buildings.*

Note: LULUCF stands for 'Land use, land use change and forestry', SVT stands for Sullom Voe Terminal and SGP stands for Shetland Gas Plant. All estimates are provided in CO_2e except for LULUCF, which is CO_2 only.

The GHG emissions profile for Shetland is highly unusual. Whereas for most Local Authorities, emissions are dominated by energy use in buildings and road transport, in Shetland some of the largest sources of emissions are from land use, energy industries, and agriculture.

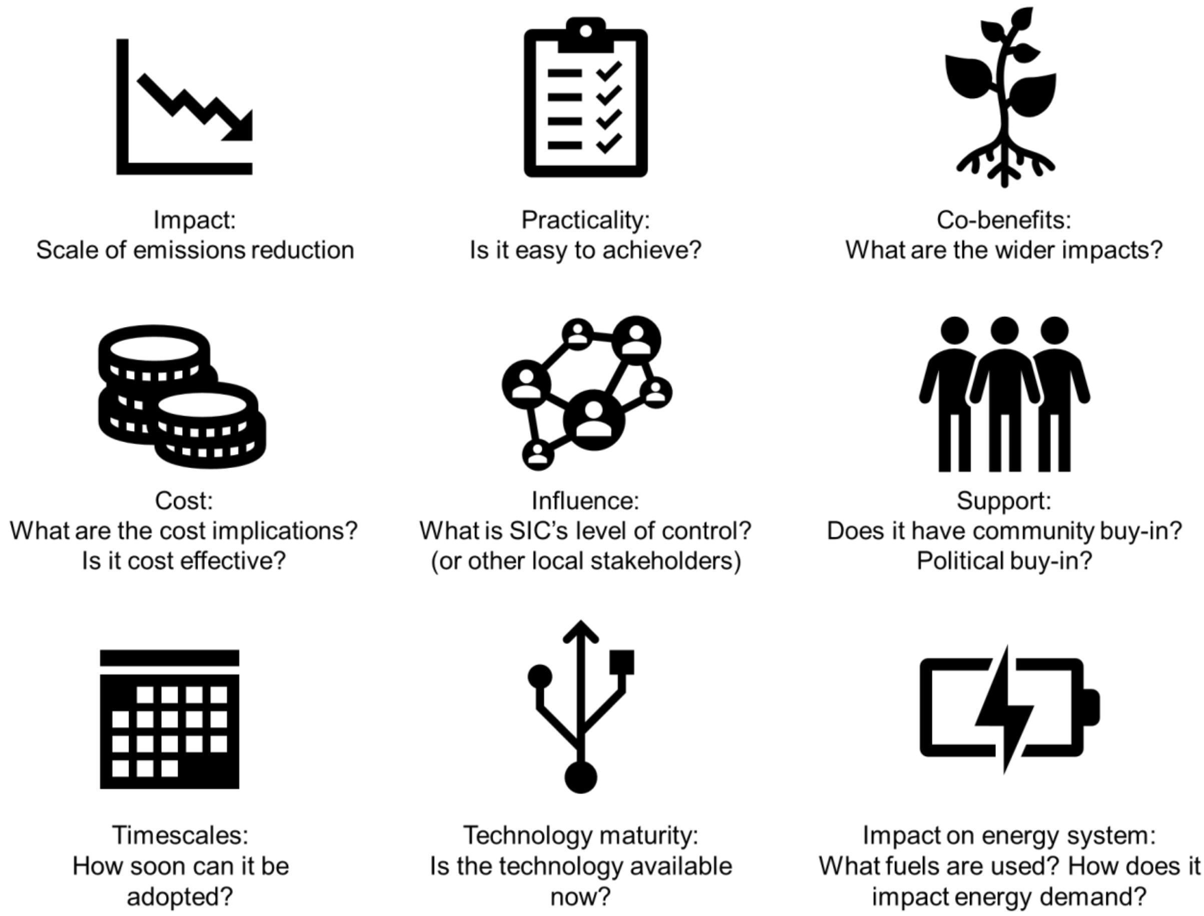
The GHG emissions baseline is intended to highlight the scale of impact from different sectors and sources of emissions. It is important to understand that the relative scale of emissions does not necessarily mean that a sector is less efficient or inherently more polluting than any of the others. There are various complex factors at play, most notably:

- The rural setting and geography – emissions from buildings and road transport would be comparatively higher if the area was more densely populated, whereas emissions from marine vessels would be lower if it was in a landlocked setting
- The nature of Shetland's economy – with oil and gas and agriculture being some of the key sectors
- The underlying geology and soil conditions – available data suggests that the single largest source of emissions is associated with the historic drainage of peat bogs, which continue to emit GHGs over long timescales

Potential future emissions pathways

Building on the GHG emissions baseline, a long list of decarbonisation measures was identified by Ricardo technical leads. The options were discussed with SIC and other external stakeholders in a joint workshop, which was followed by one-on-one meetings with sectoral experts and SIC departments.

When identifying and prioritising mitigation measures, consideration was given to:



This process identified a variety of GHG mitigation measures that can deliver important economic, social and environmental benefits beyond GHG emissions. Some of the major opportunities include:

- Peatland restoration – this is the single most impactful mitigation measure for Shetland

- Improving standards of living and lowering fuel bills by retrofitting buildings and ensuring that everyone has access to affordable, low carbon heating and energy
- Leading the way on sustainable agricultural practices and paludiculture
- Contributing towards the decarbonisation of the wider UK energy system via large-scale renewable energy technologies and storage systems
- Becoming a hub of innovation for technologies such as green hydrogen, CCS and tidal power, which could include a micro-CCS pilot project at the Lerwick ERP

The other measures evaluated for each sector covered a range of options relating to energy efficiency, behaviour change, and low or zero carbon technologies.

Three future pathways were assessed:

The BAU scenario is intended to show the changes that could occur if no additional local action was taken to mitigate GHG emissions in the Shetland region, beyond those that are already planned and committed.

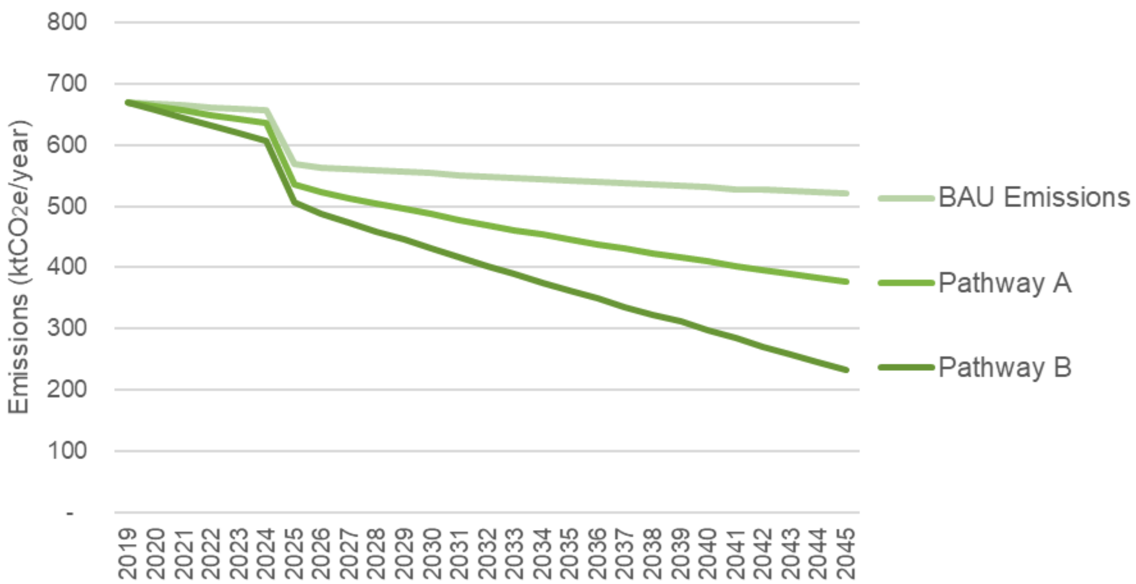
Then, opportunities to deliver additional local interventions were considered:

Pathway A asks: What can we realistically achieve with high levels of ambition?

Pathway B asks: How far could we theoretically go if money were no obstacle?

The figure below shows the emissions trajectory for all pathways modelled. The BAU scenario achieves a 20-25% reduction in Scope 1&2 emissions. Pathways A and B reduce Scope 1&2 emissions by c. 43% and c. 65% respectively, but neither one is sufficient to achieve net zero without some form of additional GHG removals.

Figure 1. Comparison of pathways modelled



The key messages from the pathways modelling are as follows:

- Electrification of buildings and transport, and connection to the mainland electricity grid, will have a very important role to play in reducing emissions from energy use in Shetland. **These could feasibly be reduced to net zero by 2045 if all fossil fuels are replaced with zero-emission alternatives, such as decarbonised grid electricity or green hydrogen.**
- However, a significant portion of emissions are associated with sectors that are difficult to electrify (e.g. aviation, marine vessels, etc.) or are not associated with energy use at all (e.g. land use and agriculture). At present it is not clear whether there will be technologies available by 2045 that can mitigate these sources of emissions.

- It is therefore likely to be difficult or impossible for area-wide emissions in Shetland to get to net zero by 2045 based on currently available technologies or mitigation methods, barring a systemic overhaul of the economy, land uses, consumer habits and social engagement.

However, although carbon capture and storage (CCS) technologies are not likely to be widely available in the near future for most of the UK, Shetland is in a unique position – literally and figuratively – to become an innovation hub for this and other low carbon technologies. For example:

- Its North Sea location is in proximity to suitable storage geologies
- There is an opportunity to reuse existing gas and oil infrastructure both on and offshore
- There is likely to be a large amount of renewable electricity generation in and around Shetland, and therefore a source of renewable power for CCS facilities
- As mentioned previously, there may be an opportunity for the ERP or other sites within Shetland to host pilot projects for small- or micro-scale CCS technologies.

This is already an opportunity that is already being pursued as part of the ORION project. There would be major wider benefits, to the UK and globally, if technological advances in this area could be achieved.

Other points to consider

Some of Shetland's key industries include oil and gas, agriculture, fishing / aquaculture, and tourism. There is also significant reliance on aviation and marine transport. These sectors will be particularly affected by the transition to a zero carbon global economy, which may reduce emissions regardless of whether any local mitigation measures are adopted. However, this will also have major implications for the local community and economy.

Therefore, it is also important to consider how Shetland will *adapt* to climate change – not just in terms of the environmental effects, but the social and economic ones as well. Although adaptation is out of scope of this report, this should be one of the key priorities going forward.

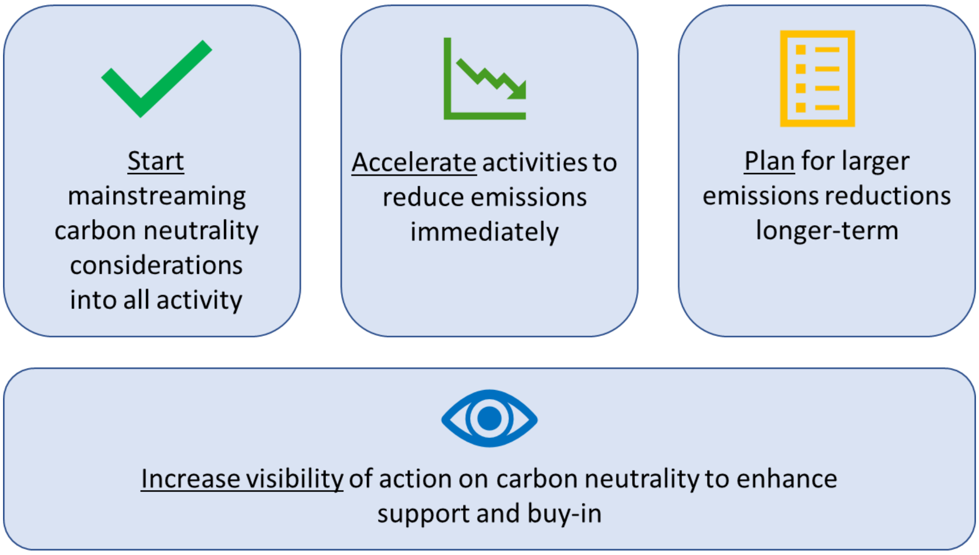
Conclusion

The GHG baseline assessment, pathways analysis and stakeholder engagement process undertaken during this study has highlighted important mitigation measures that must be adopted in Shetland in order to reduce emissions. In very broad terms, the key components to achieving this are (a) phasing out the use of fossil fuels and (b) working towards changing the way that land is used and managed in order to tackle non-energy-related emissions. Both of these require close engagement with the local community to ensure that the transition is fair and avoid any unintended negative social, economic or environmental consequences.

The emissions profile in Shetland makes it unlikely that net zero can be achieved across all sectors without CCS. With that in mind, it will be important to:

1) Maintain high levels of ambition while focusing on measures that can definitely be adopted by 2045;
2) At the same time, plan ahead to take advantage of new technologies or solutions that may become available in future years; and
3) Work with the local community and businesses to ensure that the economy and society are prepared for the wider-scale changes that will take place as the UK and the world transition to a net zero future.

Whilst there are a huge number of actions that will need to be taken to transition to carbon neutrality, they can be simplified into four main areas:



These measures offer the potential to transform the way that people live in Shetland for the better, improving standards of living and further strengthening this unique, highly resilient community.

1 Introduction

1.1 Context: Shetland's climate change commitments

The need for urgent action to reduce harmful greenhouse gas (GHG) emissions has never been clearer. The Glasgow Climate Pact, agreed at the COP26 climate conference in Scotland in November 2021, resolved to pursue efforts to limit the temperature increase to 1.5^{o}C above pre-industrial levels and recognised that doing so would require a reduction in global GHG emissions of 45% below 2010 levels by 2030 and to net zero around 2050. It is positive that around 90% of global emissions are now covered by net zero targets[1], many of them for 2050. However, some countries will not be expected to reach net zero emissions until after 2050. It is therefore only right that developed countries like the UK consider acting even faster. The 2019 amendment to the UK's Climate Change Act 2008 set a legally binding target for the UK as a whole to reach net zero emissions by no later than 2050, while the target for Scotland is even sooner, in 2045.

What is 'net zero'?

In the context of this study, and in line with the Scottish and UK Government's climate change commitments, term net zero refers to achieving a balance between the amount of greenhouse gases (GHGs) that is emitted *to* the atmosphere and the amount that is removed *from* the atmosphere. Both emissions and removals may arise from natural or anthropogenic sources, whether these are from energy use in transport, buildings, and industry; livestock digestion and soil tillage in agriculture; natural carbon sequestration from peatland; or technological solutions such as carbon capture and storage (CCS).

On 2nd January 2020, Councillors at the Shetland Islands Council (SIC) voted to acknowledge a climate emergency, recognising the need for immediate climate action. There then followed the recent formation of the Climate Change Programme, which led to the 'Shetland Islands Council Action Plan', published in January 2020. Extensive stakeholder and community engagement through the SIC Climate Conversation will feed into the future decarbonisation plan for Shetland.

A considerable amount of recent and ongoing work has already been done to understand what the next steps should be in the Shetland Islands' journey to net zero. These include, but are not limited to, work being undertaken as part of the ORION project (which looks at the future energy transition), the Neptune project (which focuses on port facilities and marine activities), and an assessment of energy production, sales and exports (carried out by Pure Energy). Building on those projects, SIC is now seeking to understand what credible **area-wide** GHG reduction pathways could look like, in order to set appropriate targets and identify priority mitigation measures.

[1] https://climateactiontracker.org/publications/glasgows-2030-credibility-gap-net-zeros-lip-service-to-climate-action/

1.2 What is a net zero routemap and why do we need one?

This report provides a strategic routemap for how Shetland as a whole can work towards achieving net zero emissions. (A separate report has been prepared for the Council's own emissions.)

A net zero routemap provides options for the strategic decarbonisation of an organisation, a public body, an industry sector or even entire regions over a set timescale. The aim is to take a high-level view of all known sources of emissions in order to identify suitable mitigation measures and start to develop a more detailed implementation plan. This is important because it helps to ensure that all relevant decision makers, including the Council, the local community, local businesses, Government, and others, can start to make informed decisions that are aligned with the urgent need to decarbonise our economy and lifestyles. It also enables the Council and other stakeholders to engage strategically with relevant delivery partners on their net zero journey.

1.3 Structure of this report

This report is structured as follows:

- Section 1 – Introduction
- Section 2 – Provides an overview of baseline GHG emissions plus additional context setting out historic trends, the spatial distribution of emissions, renewable technologies, and electric vehicle (EV) uptake
- Section 3 – Describes the 'Business as Usual' (BAU) emissions pathway, which indicates the potential trajectory to 2045 without further intervention measures
- Section 4 – Sets out two alternative pathways with higher levels of ambition, quantifying the potential impacts of intervention measures (where known) and discussing the relative risks and opportunities
- Section 5 – Summarises the key considerations for implementing the mitigation measures identified, along with high-level costs and timeframes
- Section 6 – Conclusion and next steps
- Appendices – Containing additional supporting information

2 Baseline assessment

This section of the report establishes the baseline situation regarding GHG emissions in the Shetland Islands. Consideration is also given to current and historic fuel consumption on a sectoral basis, deployment of local renewable energy technologies, and electrical vehicle (EV) uptake. These factors provide important context to inform the assessment of potential future trends.

2.1 Methodology

2.1.1 Standards for area-wide GHG emissions reporting

In the past few years, many UK Local Authorities have carried out assessments of their GHG emissions, often as part of a net zero or climate emergency strategy. This is not a legal requirement and to date there has been little by way of standardisation in terms of the scope and boundaries of the assessments; however, for practical reasons, most rely in part or in whole on the Local Authority CO_2 data that is published annually by BEIS. (That dataset will henceforth be referred to as 'LACO_2'.) This approach allows for like-with-like comparisons to be made between different jurisdictions, in a way that is consistent with the UK National GHG Inventory. However, the LACO_2 data only includes CO_2, not other GHGs, and the scope of the information reported for each LA is limited to the geographic boundary of that area.

Another option that some Local Authorities have taken is to develop a GHG inventory that is compliant with the Global Covenant of Mayors' Common Reporting Framework (CRF), which is a carbon accounting standard for cities. However, compared with other LAs, Shetland is highly unique in terms of its geography and economy, so the common approaches to GHG reporting exclude some activities and sources of emissions that are highly relevant to Shetland – the major examples being aviation, and the entire marine industry.[2] To be in line with the principles of ISO 14064, the emissions baseline should seek to be as complete and as relevant as possible. Therefore, this report describes some sources of emissions that are not typically included in area-wide inventories, in order to provide context, but some of these are not considered part of Shetland's baseline.

2.1.2 Scope of the assessment

GHGs considered

In the context of this report, and in line with the Scottish and UK Government climate change commitments, the term 'net zero' is understood to include not only carbon dioxide (CO_2), but all of the major greenhouse gases (GHGs), which include methane (CH_4), nitrous oxide (N_2O) and fluorinated gases or f-gases. Because these have different impacts on global warming, known as global warming potential or GWP, both the GHG emissions baseline and associated targets will be reported in units of CO_2 equivalent (CO_2e) to allow measurement and comparison of different gases.

Sources of emissions

In line with international reporting standards, when assessing GHG emissions on an area-wide basis, different sources of emissions are categorised into different 'scopes'. The table below shows how these emissions are *typically* categorised according to scope; however, as mentioned previously, in the case of islands such as the Shetland region, it is acknowledged that these categories do not necessarily apply in all cases.

Limiting the baseline to the geographic boundary risks excluding some major sources of emissions that are fully or mostly within control of SIC, or Shetland-based businesses, organisations or individuals. It is important that the Net Zero Shetland Routemap (NZSR) should seek to address all sources of emissions that fall within that sphere of influence. This is because, in the quest to reach net zero, it is important for LAs to understand the full range of emissions that they can reasonably seek to influence – and develop mitigation actions that have the biggest impact.

[2] The Scottish Government recognises the need to develop a more consistent approach to estimating emissions from islands, which is the subject of separate work.

Table 1. Definitions and examples of Scope 1, 2 and 3 emissions relevant to Shetland

Type	Definition	Examples
Scope 1	Direct emissions from fuel combustion and fugitive emissions within the Local Authority's geographic boundary	• Fuel combustion in buildings and road vehicles • Emissions from agriculture, waste and wastewater treatment, or landfill activities taking place within the Shetland region
Scope 2	Indirect emissions from purchased electricity, heat, steam or cooling that is generated elsewhere	• Typically, electricity would be generated outside the area boundary and therefore classed as Scope 2 – whereas in Shetland, at present the fuel combustion to produce electricity would be classed as Scope 1, but that will change (post-2024) when there is an interconnector to the UK grid
Scope 3	Other indirect emissions	• Journeys to/from the region that are outside the Local Authority boundary – by ferry or domestic aviation • Harbour tugs • Sullom Voe Port and vessels • Fishing, aquaculture and other marine sector emissions Other indirect emissions, such as supply chains for food, products and materials, are not included in this study. Emissions from the offshore oil and gas industry are also not included as these would be allocated to the end users of the oil and gas.

2.1.3 Data sources

The following data sources have been used to develop a CO_2e baseline for the island with our proprietary Net Zero Projections (NZP) tool. The overall approach is to use the LACO_2 data by default, and supplement this with additional information where data is available *and* it can be established that there is no double-counting. A more detailed comparison of the fuel types and sectors within each dataset has been provided separately during meetings with SIC.

Table 2. Sources of data used for the 2019 Shetland area GHG baseline

Source of emissions	Source of data
Energy use in domestic* and non-domestic buildings and facilities ** Excluding solid fuel use in domestic buildings; see below* Energy use for road transport Energy use and CO_2 emissions from agriculture Emissions from land use, land use change and forestry (LULUCF)	BEIS LACO_2 statistics (revised to account for the lack of UK electricity grid connection, the presence of the heat network, and coal/peat in domestic buildings as per the rows below)
Solid fuel use in domestic buildings Aviation Sullom Voe Terminal (SVT) Shetland Gas Plant (SGP) General marine	Energy Source Analysis/ORION
Internal and external ferries and harbour tugs	Neptune project
F-gases	UKGHGI prorated by population
Waste incineration and landfill and emissions from the Lerwick Heat Network	Detailed analysis carried out as part of NZCR
Wastewater treatment	UKGHGI prorated by population
Non-CO_2 emissions from agriculture	National Atmospheric Emissions Inventory (NAEI) mapping database[3]

Local Authority CO_2 data (LACO_2)

Information on CO_2 emissions at a local authority level is published annually by BEIS, two years in arrears.[4] The dataset covers sectors and activities that emit CO_2. However, at a national level, CO_2 only accounts for around 80% of total GHG emissions, meaning that a significant portion of GHG emissions are excluded.[5] The remaining 20% nationally comes from:

- Methane (CH_4), which is mostly associated with agriculture (e.g. livestock digestion) and waste management (e.g. organic waste decomposing in landfill);

[3] NAEI, 'UK Emissions Interactive Map' (2021). Available at: UK Emissions Interactive Map (beis.gov.uk)

[4] BEIS, 'Emissions of carbon dioxide for Local Authority Areas' (published 2021). Available at: Emissions of carbon dioxide for Local Authority areas - data.gov.uk

[5] BEIS, '2019 UK Greenhouse Gas emissions' (published 2021). Available at: 2019 UK Greenhouse Gas Emissions, Final Figures (publishing.service.gov.uk)

- Nitrous oxide (N_2O), which is mostly associated with the use of fertilisers but is also emitted during combustion of fossil fuels and some forms of industrial activities; and
- Fluorinated gases (f-gases), which are used in refrigerants and air conditioning systems and can leak out during the manufacturing, operation or disposal process.

Therefore, in order to provide a more comprehensive GHG emissions inventory for the Shetland region, with a more detailed breakdown of emissions by fuel type and sector, we have taken the BEIS CO_2 data as a starting point and supplemented it with more detailed analysis that draws from:

- Sub-national Fuel Consumption statistics – Used to disaggregate emissions from road transport, and emissions from energy use where the type of fuel is not specified within $LACO_2$
- Energy Consumption in the UK (ECUK) statistics – Used to estimate the split of domestic emissions by energy end use (e.g. space heating, hot water, etc.)
- National Grid Future Energy Scenarios – In the baseline, this is used to estimate the current amount of electricity used in EVs

This information is entered into the NZP tool, which is first used to disaggregate the CO_2 emissions estimates, and then convert them into CO_2 equivalent (CO_2e) rather than CO_2.

Solid fuel use in domestic buildings is reported in the $LACO_2$ dataset but for the purpose of this analysis, ESA data has been used instead. The data has been adjusted to include Shetland-specific emission factors for electricity, as explained in Appendix A. It has also been adjusted to reflect the presence of the Lerwick Heat Network, to avoid double-counting, since emissions from the heat network have been estimated separately.

Note on LULUCF emissions:

Following discussions with SIC, the baseline presented in this report utilises LULUCF estimates published as part of the national $LACO_2$ dataset. At the time that the baseline was compiled, there was no national statistical publication that reported emissions from non-CO_2 GHGs from the LULUCF sector at a local authority level. Therefore, unlike other sectors reported, the baseline figures for LULUCF include CO_2 only.

Information on non-CO_2 GHG emissions from this sector was subsequently published by BEIS in June 2022.[6] The data suggests that, when methane and nitrous oxide are included, GHG emissions from this sector would potentially be more than 30% higher. This would have a significant impact on Shetland's total emissions.

A separate study of carbon sequestration opportunities within Shetland has been undertaken by Ricardo as part of a parallel workstream, which includes an estimate of annual carbon flux from land use. Those figures are not intended to supplant the national dataset and are not directly comparable due to the different methodologies used, and the inclusion of non-CO_2 gases. However, they have been used to provide additional insight. For more information, refer to the report on carbon sequestration [provided separately].

When interpreting LULUCF emissions statistics, it is important to understand that there is significant uncertainty involved. This may be in the region of 30-50% when considering the carbon flux from grassland or cropland on peat soils.[7] There is also uncertainty associated with disaggregating datasets to a local authority level.[8] However, it is worth reiterating that these figures reflect the best available data and are subject to rigorous quality assurance as they form part of national statistical publications.

The overarching take-home point is that LULUCF emissions are likely to be very high in relation to other sources of emissions in Shetland. Therefore, this should be a priority area for further research and action.

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[6] BEIS, 'UK local authority and regional greenhouse gas emissions national statistics' (published 2022). Available at: UK local authority and regional greenhouse gas emissions national statistics - GOV.UK (www.gov.uk)

[7] DEFRA, 'UK Greenhouse Gas Inventory 1990-2019: Annexes' (published 2021). Available at: UK Greenhouse Gas Inventory 1990-2019: Annexes (defra.gov.uk)

[8] BEIS, 'Mapping carbon emissions and removals for the land use, land-use change & forestry sector' (published 2021). Available at: Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector: NAEI report 2019 (publishing.service.gov.uk)

Pure Energy Source Analysis (2020 Refresh) and ORION project data

Separate to the national datasets described above, information about solid fuel use in domestic buildings (coal and peat), along with fuel consumption in aviation, ferries, and harbour tugs has been taken from ORION project data, which is understood to derive from the Pure Energy Source Analysis. Information was provided in amount of fuel used per year (in GWh) and this was entered into the NZP tool to convert it to CO_2e.

Neptune project data

Data on the annual amount of fuel used by internal and external ferries and harbour tugs was taken from a separate analysis carried out by Ricardo as part of the Neptune project. Information was provided in amount of fuel used per year (in GWh) and this was entered into the NZP tool to convert it to CO_2e.

Other estimates

Emissions from f-gases are based on the UK totals, prorated by population.

Emissions from waste incineration and landfill have been estimated using waste quantities and NAEI emission factors, as part of a more detailed analysis carried out as part of the Net Zero Council Routemap (NZCR). Two sense-checking exercises were carried out: first, by taking the total for emissions from waste in Scotland as per the UK GHGI and prorating it by population; and second, by retrieving waste sector CO_2, CH_4 and N_2O emission data from the NAEI mapping tool. The results varied due to the different estimation methodologies and inclusion of slightly different emission sources, but indicate that emissions from waste management in Shetland are likely in the region of 10-20 ktCO_2e per year, which is in line with the NZCR analysis. To be clear, this will include emissions from waste that is managed in Shetland even if it is generated elsewhere.

Emissions from wastewater treatment were estimated in three ways: First by taking Scotland's total wastewater treatment emissions and scaling by wastewater volume; secondly scaling by population, and finally using a bespoke calculator tool produced by C40 Cities. As with solid waste, the results varied, but indicate that emissions from this source are likely in the region of 0.5-2 ktCO_2e per year.

Non-CO_2 emissions from agriculture (CH_4 and N_2O) were taken from the NAEI mapping tool, filtered by Local Authority and sector. These were converted to CO_2 equivalent units using appropriate Global Warming Potential (GWP) factors.

2.1.4 Basis for allocating emissions

The LACO_2 dataset allocates emissions on an end-user basis, and the same approach has been taken in producing this emissions baseline (with one exception – see next paragraph). So, for example, emissions from Lerwick Power Station are allocated to the electricity consumers across Shetland, not to the power station itself. This approach is helpful in understanding different types of energy demand and identifying suitable mitigation measures. Another consequence of this is that emissions from some major facilities located within Shetland will not be captured within that dataset if they are exporting fuel, as is the case with Shetland Gas Plant (SGP) and Sullom Voe Terminal (SVT). Estimated emissions from the SGP and SVT are provided for context only but are not considered part of Shetland's baseline emissions and are out of scope of the routemap in terms of identifying and recommending mitigation measures and actions. (For more information on allocating emissions to end users, see the LACO_2 Technical Report.[9])

Note that this approach is particularly complicated when it comes to emissions from waste incineration, since this is used to supply the heat network in Lerwick. Emissions from waste incineration are a sub-set of emissions from the heat network, since the latter is supplemented by oil boilers. Information on the number and type of heat network connections has been used to allocate those emissions to the relevant domestic and non-domestic end users.

[9] UK Local and Regional Carbon Dioxide Emissions Estimates for 2005-2019: technical report (publishing.service.gov.uk)

2.2 Results

2.2.1 GHG emissions from all sectors assessed

Results are presented in Table 3 below, covering Scopes 1, 2 and 3, along with emissions from SVT and SGP which are not considered part of the baseline for Shetland.

Table 3. GHG emissions in Shetland by sector and fuel type, 2019 (ktCO_2e)

	Solid Fuels	Fuel Oil	Electric -ity	Petrol/ Diesel	Aviation Fuel	Other/ No Fuel	Lerwick DHN	Total
Scope 1 & 2 emissions								
Non-Domestic	0	35.2	56.0	-	-	-	4.8	**96.0**
-Commercial	0	1.2	29.8	-	-	-	1.3	32.3
-Industrial	0	33.4	19.4	-	-	-	-	52.7
-Public Sector	0	0.6	6.8	-	-	-	3.5	10.9
Domestic	4.2	11.8	63.1	-	-	-	4.5	**83.5**
Road transport	-	-	-	37.1	-	7.5	-	**44.6**
F-gases	-	-	-	-	-	4.6	-	**4.6**
Waste & Wastewater	-	-	-	-	-	5.0	-	**5.0**
Agriculture	-	14.2	-	-	-	85.9	-	**100.1**
LULUCF *(CO_2 only)*	-	-	-	-	-	334.5	-	**334.5**
Scope 3 emissions								
Aviation	-	-	-	-	29.8	-	-	**29.8**
Ferries & Tugs	-	91.2	-	-	-	-	-	**91.2**
Misc. Marine	-	53.5	-	-	-	-	-	**53.5**
Other emissions – *Not part of Shetland's baseline but reported here for context*								
SVT & SGP	-	-	-	-	-	230.0	-	**230.0**

Notes:

1. LULUCF stands for 'land use, land use change, and forestry'. This category represents the movement of CO_2 between the atmosphere and different natural 'reservoirs' such as forests, soil, etc. Some human-induced effects, such as tilling the soil, result in CO_2 being emitted to the atmosphere, while others, such as planting trees, result in CO_2 being absorbed from the atmosphere. This category quantifies the net impact of all such activities taking place within the Local Authority boundary.
2. For some sectors, such as agriculture, emissions from energy use are not reported by fuel type, so these are listed in the 'Other/No Fuel' category, even though in reality they are likely to include some electricity, petrol, diesel, oil or other fuels. This is also the case for emissions from SVT and SGP. The 'Other/No Fuel' category also includes some emissions that do not result from energy use. For example, LULUCF emissions are affected by soil and plants absorbing CO_2 during respiration, and f-gases result from refrigerant leakage in air conditioning and cooling systems. Additional sources of emissions marked as 'Other/No Fuel' include:

   a. CO_2 from urea application, liming of soils and off-road agricultural machinery
   b. CH_4 and N_2O from livestock, manure management, and fertiliser use
   c. Surface transport-related emissions from:
      i. Vehicles that run on LPG
      ii. Aircraft support vehicles
      iii. Combustion of engine lubricants
3. Electricity use in road transport cannot currently be disaggregated from electricity use in buildings. However, for context, emissions from this source are estimated to be c. 0.3 ktCO_2e as of 2019.
4. The BEIS CO_2 data includes CO_2 emissions from energy use – that is, fuel use in agricultural facilities and processes – but does not include emissions from methane or nitrous oxide. In the agricultural sector, emissions are dominated by non-CO_2 gases. which have been estimated separately.
5. Unlike other categories reported, the GHG baseline for the LULUCF sector only includes CO_2, and not other GHGs, due to unavailability of data at the time that the assessment was carried out. If other GHGs are included, LULUCF emissions would potentially be more than 30% higher than shown. See Section 2.1.3 for more information.
6. 'Misc. marine' includes fishing, aquaculture, and Sullom Voe Port and associated vessels. This data was taken from the ESA/Orion project. Due to a lack of information on the end users of the fuel it has not been possible to confirm (a) that there is no double-counting with other categories or (b) that all of these emissions are definitely allocated to end users within Shetland.
7. Aside from the emissions associated with fuel use in aviation, there are other global warming impacts associated with the soot and water vapour released to the atmosphere. These are less well characterised but could mean that emissions from aviation are up to twice as high as those shown.[10]
8. Emissions from the ERP can be considered part of the waste sector, but because the heat feeds into the Lerwick DHN, in order to be consistent with the end user allocation approach, these emissions have been allocated to domestic and non-domestic buildings. Emissions from the heat network are higher than emissions from the ERP alone because it is supplemented with oil boilers. For context, emissions from the ERP are estimated to be c. 13 ktCO_2e as of 2019.
9. Emissions from the Sullom Voe Terminal and Shetland Gas Plant are reported for information but are outside the scope of the NZSR. That is because emissions from those facilities would be allocated to the end users of the fuel and would not be considered part of Shetland's GHG baseline.

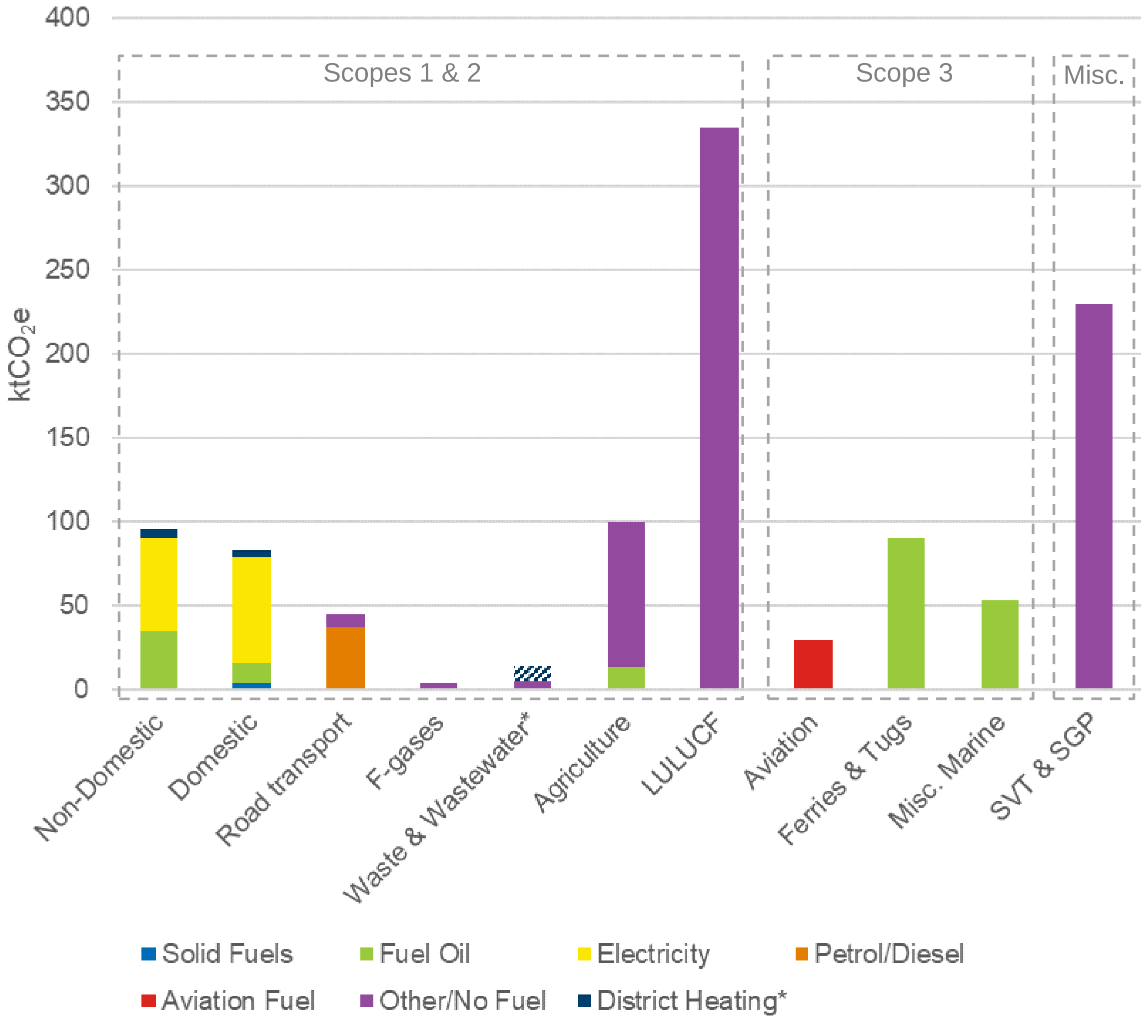
Figure 2 below shows the net GHG emissions for Shetland, based on the figures presented above. Again, it includes Scope 1, 2 and 3 emissions, along with those from SVT and SGP which are provided for context only.

These numbers should be interpreted with caution as in many cases they rely on modelled data. In particular, emissions from the agriculture and land use sectors and aviation are subject to significant uncertainty.[11]

[10] https://researchbriefings.files.parliament.uk/documents/POST-PN-0615/POST-PN-0615.pdf

[11] See Section 2.1.3 for further information.

Figure 2. GHG emissions in 2019, by sector and fuel type



** Emissions from the ERP are shown in the 'Waste & Wastewater' category as 'District Heating' purely for scale. As mentioned previously, they are actually allocated to end users in domestic and non-domestic buildings.*

Scope 1 and 2 emissions in Shetland are dominated by the agriculture and land use sectors. (It is worth noting that there is cross-over between these because most land use is associated with agricultural activity, but for ease of comparison with other Local Authority datasets, LULUCF has been retained as a separate reporting category.) Emissions in those categories mostly come from:

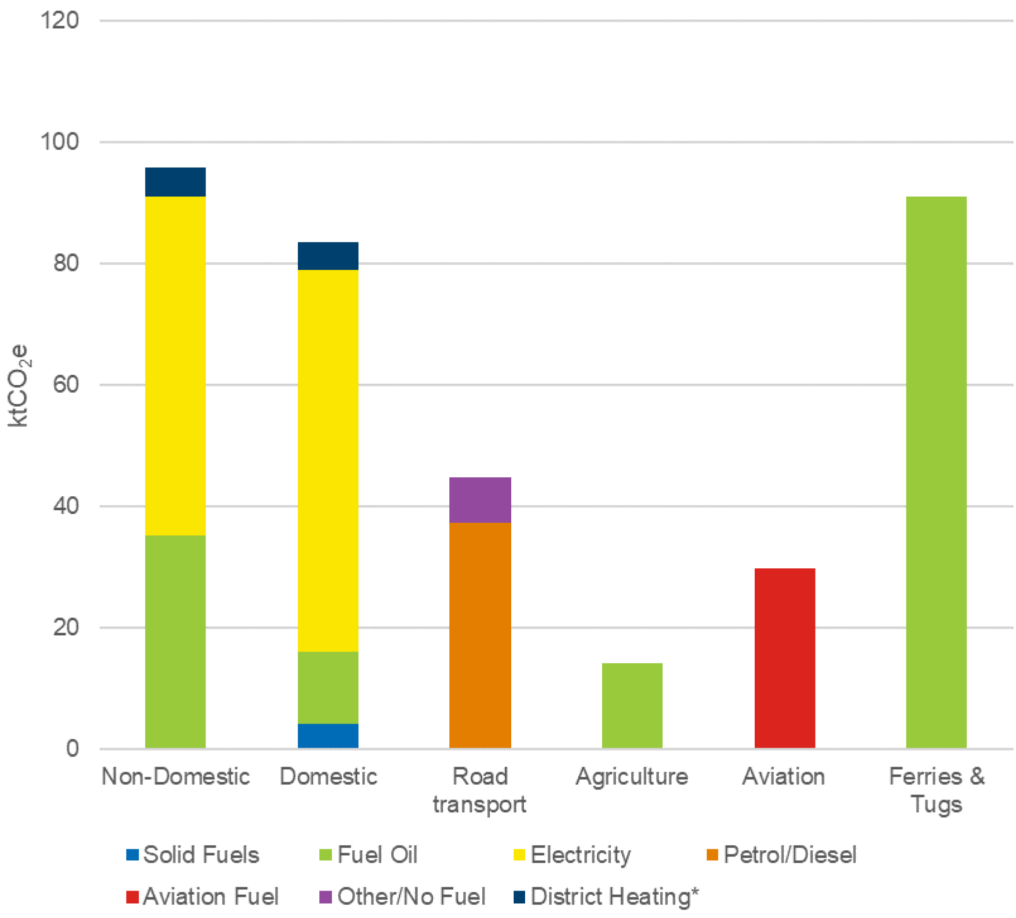
- Historic and recent changes in land use, the conversion of peat bogs to agricultural land and degradation of remaining peat bogs
- Enteric fermentation (i.e. livestock digestive processes)
- Manure management
- Fertiliser application
- Liming of soils

Of the remaining Scope 1 and 2 emissions, the majority are associated with energy use in domestic and non-domestic buildings and facilities, followed by surface transport. There is also a small contribution from f-gases, waste and wastewater treatment.

These results are somewhat unique compared with other UK Local Authorities; typically, either domestic buildings or road transport are the largest emitting sectors. In Shetland, the proportions are radically different, which reflects the rural setting, low population, mix of economic activities and reliance on aviation and shipping rather than road vehicles to transport people and goods.

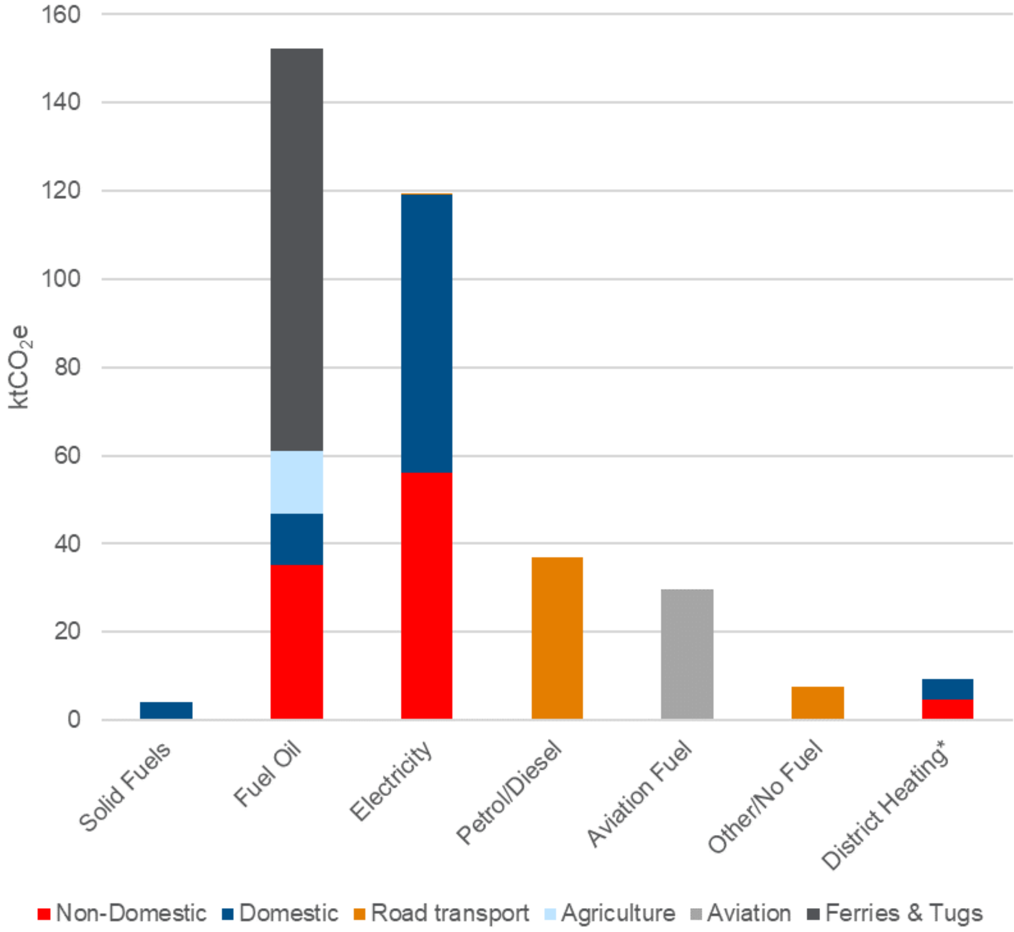
The following charts shows the same data as in Figure 1 but focus solely on emissions associated with energy use. These indicate that emissions from buildings (domestic and non-domestic) are roughly similar in scale to the emissions from transport (road transport, aviation, and ferries), at c. 180 ktCO_2e and 165 ktCO_2e per year respectively. Due to the uncertainties involved and the year-on-year variation, this is only an approximation, but provides helpful context. Within buildings, most emissions are associated with electricity use, whereas road, air and marine transport all rely on petroleum products.

Figure 3. GHG emissions associated with energy use – by sector



Considering emissions by fuel type rather than sector, fuel oil is the largest contributor, as shown in Figure 4, followed by electricity. This is despite the fact that much less electricity is used annually (in terms of GWh per year) – because unit for unit, emissions from electricity are much higher than any of the other fuels, and currently about three times higher than electricity from the UK grid.

Figure 4. GHG emissions associated with energy use – by fuel type



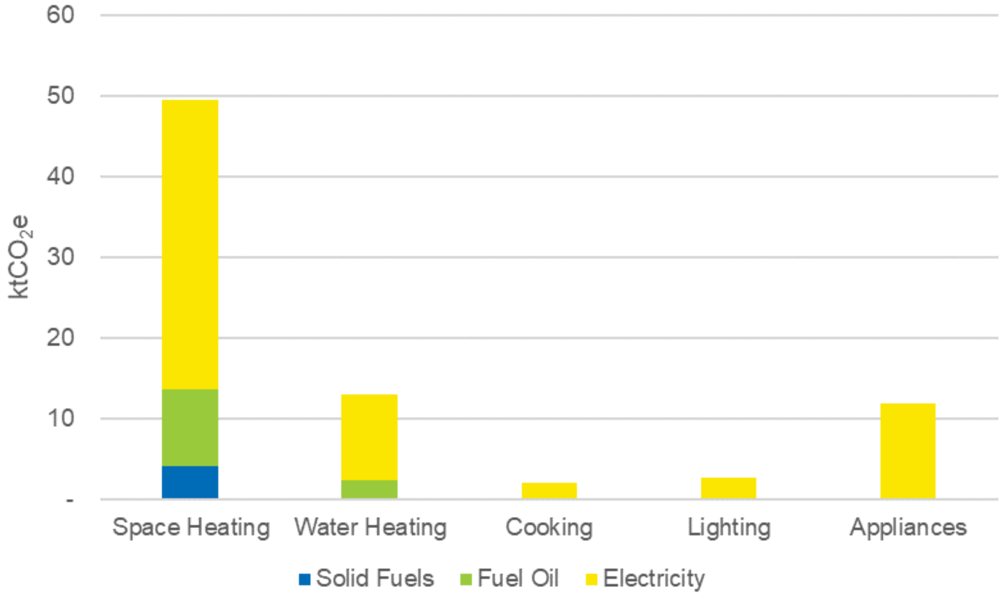
A more detailed discussion of emissions in the domestic, road transport and marine sectors is provided below.

2.2.2 Domestic emissions

Domestic fuel consumption and GHG emissions have been disaggregated by end use, based on ECUK statistics for the UK as a whole. Although the split of end uses varies depending on factors such as climate, tenure, income levels, occupant habits, and so on, the scale of variation is somewhat less than in other sectors. This is considered a reasonable rough estimate that can be applied to Shetland, albeit recognising that space heating in particular will be higher than shown.

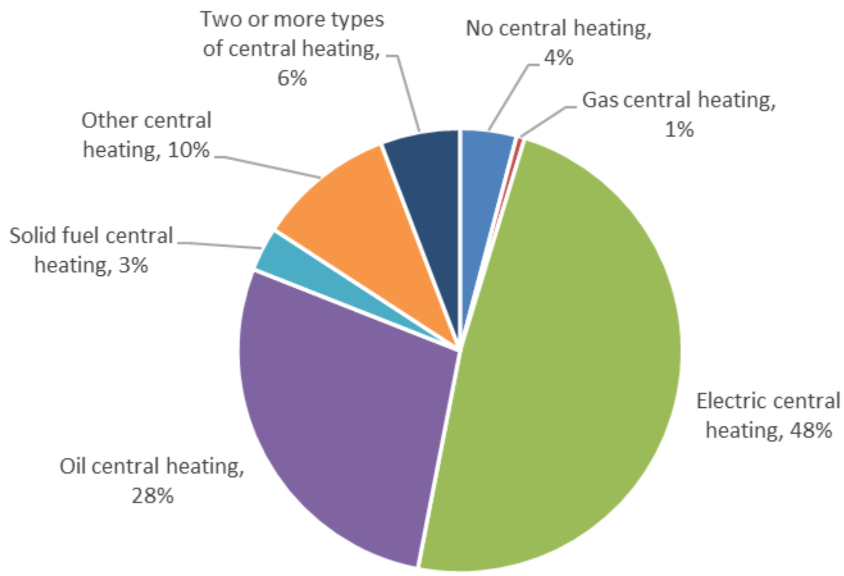
As shown below, the dominant end use is space heating. Although only about half of homes in Shetland are heated using electricity, it accounts for most of the emissions from the space heating category as it has a higher carbon intensity – at present – than coal, peat, wood/biomass or oil. Once Shetland connects to the mainland electricity grid, emissions from electricity will immediately drop to less than a third of their current level. As the electricity supply continues to decarbonise, most of the residual emissions from the domestic sector will be due to the fossil fuels used to supply heat. In other words, heat decarbonisation is the key priority measure in the domestic sector, from a GHG reduction perspective.

Figure 5. Estimated breakdown of domestic emissions by energy end use



In practical terms, that means replacing all fossil fuel heating systems in people's homes across Shetland. As shown in the pie chart below, which is based on 2011 Census data, this would impact around half of all properties.[12] It will also be important to ensure that households installing central heating for the first time use systems that can run on renewable energy, to avoid 'locking in' a future rise in emissions. (The Census records a small number of properties with 'gas' central heating. There is no natural gas connection on the islands so this is assumed to refer to LPG. As the Census is self-reported, it could also be due to human error.)

Figure 6. Types of domestic heating systems in the Shetland Islands. Source: Scotland's Census 2011



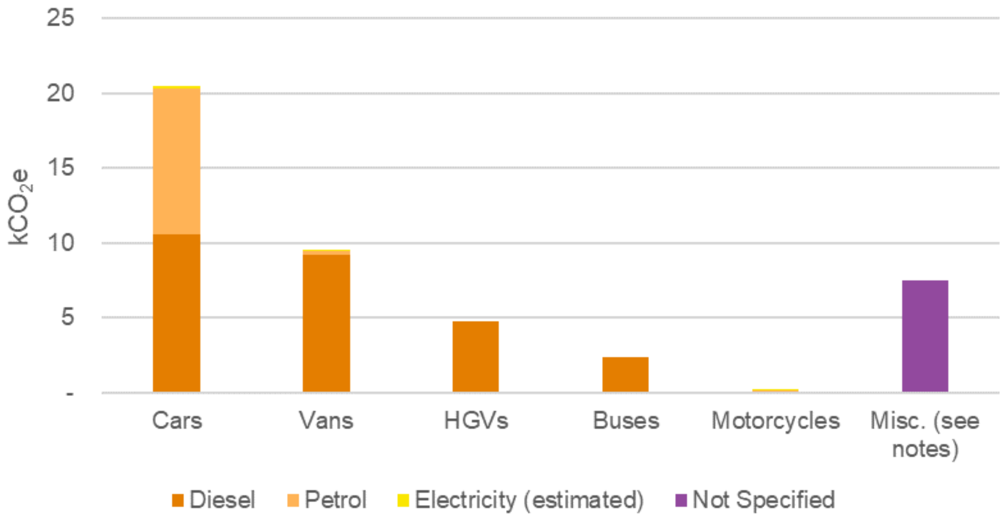
[12] Office for National Statistics, *'2011 Census, Table QS415EW'* (2011). Available at: https://www.scotlandscensus.gov.uk/search-the-census#/explore/snapshot

2.2.3 Surface transport emissions

LACO$_2$ data on surface transport was disaggregated by vehicle and fuel type using sub-national fuel consumption data. These datasets are based on highly detailed models of vehicle movements along the road network. They incorporate the DfT's Automatic Number Plate Recognition (ANPR) data, as well as vehicle licensing data from the DVLA, to model the fleet composition on different road types for each location in the UK. Results are presented below.

Based on this analysis, cars account for c. 45% of GHG emissions in the surface transport category. These emissions are split between diesel and petrol vehicles. Roughly 37% of emissions are from vans, HGVs, buses and motorcycles. The remaining emissions (based on the 'Other Transport' category in LACO$_2$ and labelled 'Miscellaneous' in the chart below) have not been disaggregated due to insufficient data.

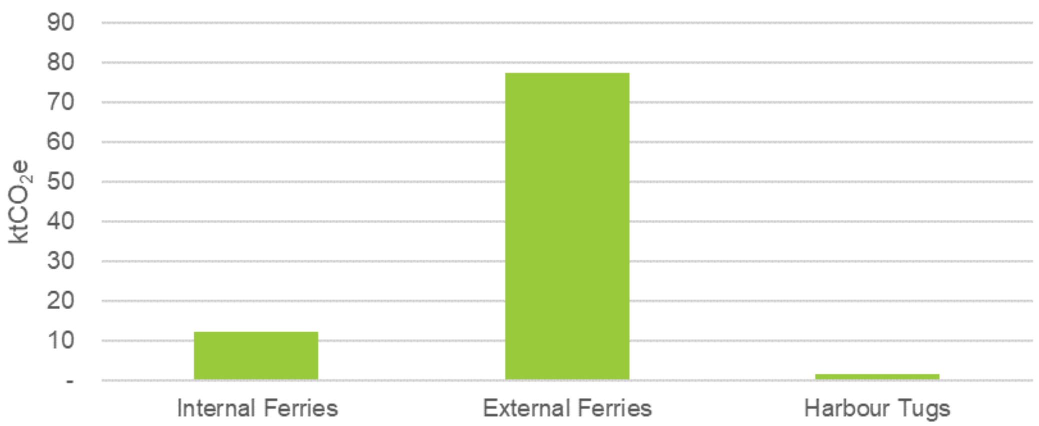
Figure 7. Estimated breakdown of surface transport emissions by vehicle type and fuel



2.2.4 Marine sector emissions

A breakdown of marine sector emissions is provided below. The figures include internal and external ferries and harbour tugs. Estimates are based on fuel consumption data as set out in the Pure Energy Source Analysis. All three are recorded as using marine gas oil, so the split of emissions reflects the annual fuel consumption for each category. The majority is associated with external ferries.

Figure 8. Marine sector emissions by vessel type. Source: Pure Energy Source Analysis (2020)



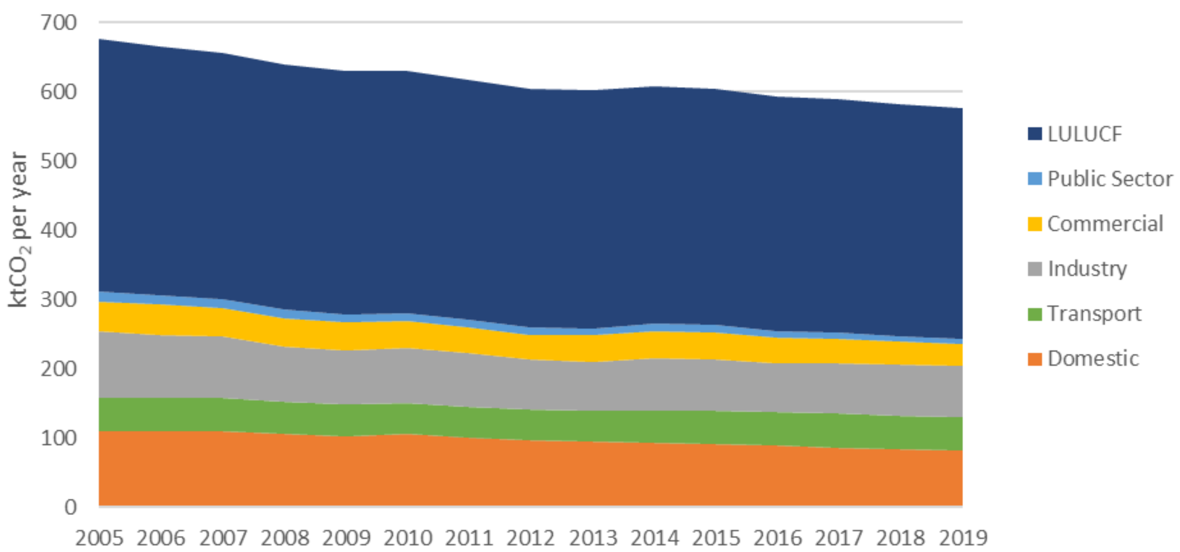
2.3 Additional context

2.3.1 CO_2 emission trends

In order to consider trends over time, we have referred to the $LACO_2$ dataset. The results have been re-calculated to account for the different emission factor for electricity use. As stated previously, this only considers CO_2 rather than all GHGs. Although it uses metered electricity data, other fuel types are based at least in part on modelled estimates. It excludes aviation and marine sectors for which historic data is not available at the time of writing. However, it still offers useful insight into major trends that are likely to have occurred since 2005.

As shown in Figure 9 below, total CO_2 emissions in the Shetland Islands decreased by around 15% from 2005-2019. Part of this is due to changes in fuel consumption, but part is also due to the uptake of renewable technologies. Electricity use decreased by roughly 14% in that time period, but emissions from electricity decreased by closer to 27% due to the lower emissions per unit of electricity consumed (see Appendix). This highlights the importance that grid decarbonisation will play in the future when there is likely to be a widespread shift to the use of electricity for other purposes such as heating and transportation. The carbon intensity ($kgCO_2/kWh$) of most fuels other than electricity remains comparatively stable, so changes in emissions from sectors that rely on fossil fuels (such as transport) generally scale with changes in fuel consumption.

Figure 9. Trends in CO_2 emissions in Shetland, 2005-2019



2.3.2 Spatial distribution of CO_2 emissions

The map below shows the spatial distribution of CO_2 emissions at a 1x1km grid level, as published within the NAEI mapping database. Note that this will not precisely align with the baseline emissions figures presented previously, because it comes from a different source and because it only shows CO_2 emissions (rather than all GHGs), allocated spatially rather than on an end user basis. However, it highlights that there are localised emission hotspots around the main road network and population centres.

The NAEI also reports several point sources[13] of CO_2 emissions, which are shown as pins on the map. These are associated with the district heating scheme along with individual manufacturing or commercial facilities. These include the 3 Sullom Voe Oil and Gas exploration sites, Lerwick Power Station, the waste incinerator / energy network, and the 2 BP Clair Ridge platforms. For further details, refer to the NAEI website.[14]

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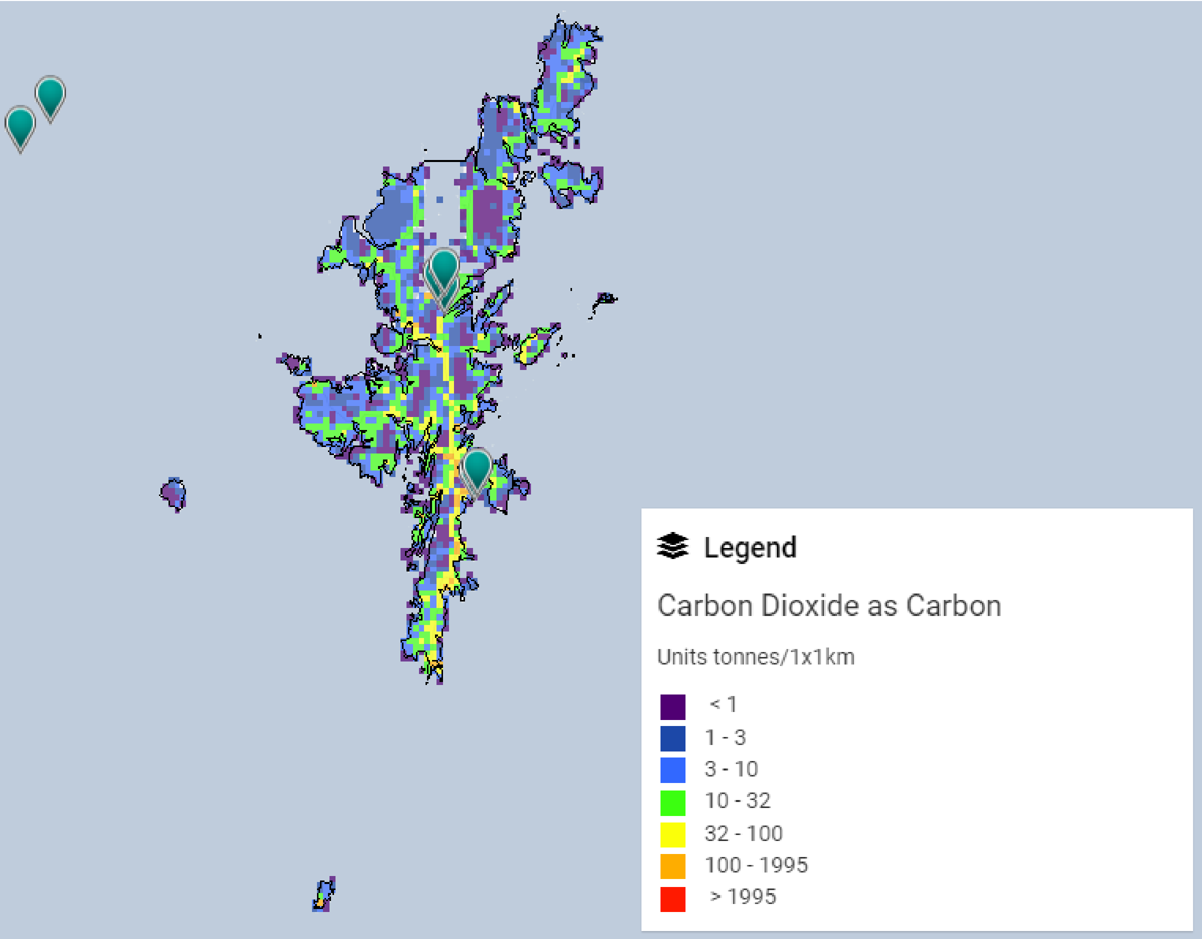
[13] For an explanation of what types of facilities count as point sources and how the information is collected, refer to the NAEI website: Emissions from NAEI large point sources - NAEI, UK (beis.gov.uk)

[14] UK Emissions Interactive Map (beis.gov.uk)

Figure 10. Total CO_2 emissions in Shetland, 2019. Source: NAEI



2.3.3 Renewable and low carbon energy

To estimate the number, size, and type of renewable energy installations in the Shetland region, we have referred to the following sources:

- The Regional Renewable Statistics (RRS) – Published annually by BEIS, this dataset only includes renewable electricity technologies and excludes those that only produce heat. The most recent data is for the end of 2019.
- Renewable Heat Incentive (RHI) statistics – This dataset covers technologies that provide renewable heat, including ground and air source heat pumps, biomass, and solar hot water.
- The Renewable Energy Planning Database (REPD) – An up-to-date list of renewable energy planning applications published quarterly by BEIS.
- The Heat Networks Planning Database (HNPD) – An up-to-date list of heat network planning applications published quarterly by BEIS.

The above datasets do not necessarily reflect all of the renewable energy installations in and around Shetland, particularly those that are offshore.

Table 4. Renewable electricity technologies in Shetland, at end of 2021. Source: BEIS (RRS)

	No. Installations (#)	Installed Capacity (MW)	Generation (MWh per year)
Photovoltaics	69	0.287	273
Onshore Wind	230	13.814	40,445
Hydropower	2	0.019	64
Wave/Tidal	1	0.500	153
Total	302	15	40,935

As of the end of 2021, there were 302 renewable electricity-producing installations. Collectively, these are estimated to produce more than 40 GWh of renewable electricity per year. (For context, electricity demand in Shetland in 2019 is estimated to have been c. 180 GWh.) This includes a number of large onshore wind farms; per the REPD, planning permission has been granted to a further 3 onshore wind farms that are awaiting construction. The solar PV capacity is comparatively small, with an average capacity of c. 4kW, suggesting that most of these are roof-mounted arrays. Shetland is also host to a tidal array which has been in operation since 2016.

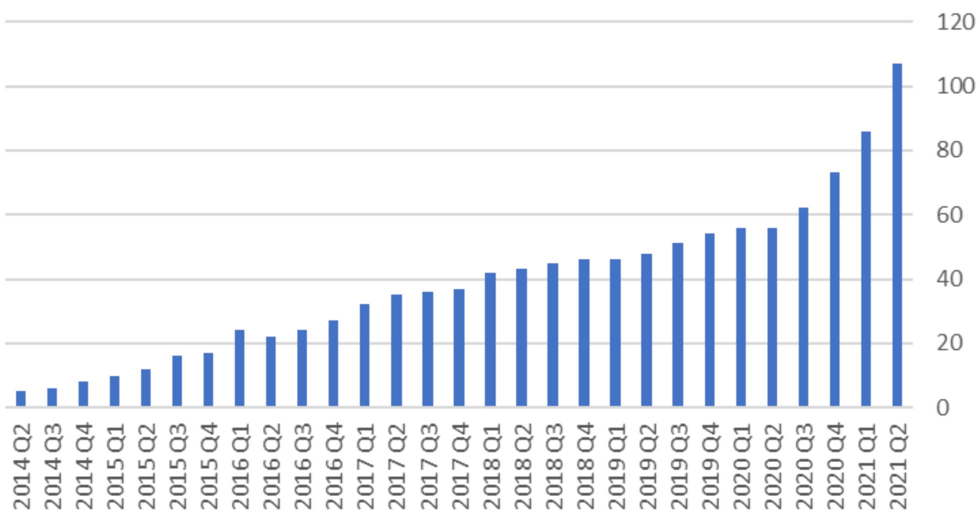
Aside from electricity, the RHI indicates that as of June 2021 there were 288 domestic and 12 non-domestic accredited renewable heating installations in Shetland. The RHI does not list details of the technology split at a Local Authority level, but these are likely to include a combination of heat pumps, biomass boilers and solar hot water technologies.

There is also a heat network that utilises waste heat from the incinerator in Lerwick. Although burning waste is not a renewable form of energy, heat networks can in principle be more efficient than individual heating systems, and also offer the opportunity to switch multiple properties onto alternative fuel sources at once. Therefore, could be classed as a low carbon heating option.

2.3.4 Ultra-low emission vehicles (ULEVs)

ULEV uptake has increased exponentially in recent years across the UK, albeit from a low base, and Shetland is no exception. As shown in Figure 11, by the beginning of 2021 there were more than 100 licensed ULEVs in the region, compared with just 6 in 2014.[15]

Figure 11. Licensed ULEVs in Shetland, 2014-2021. Source: DVLA/DfT



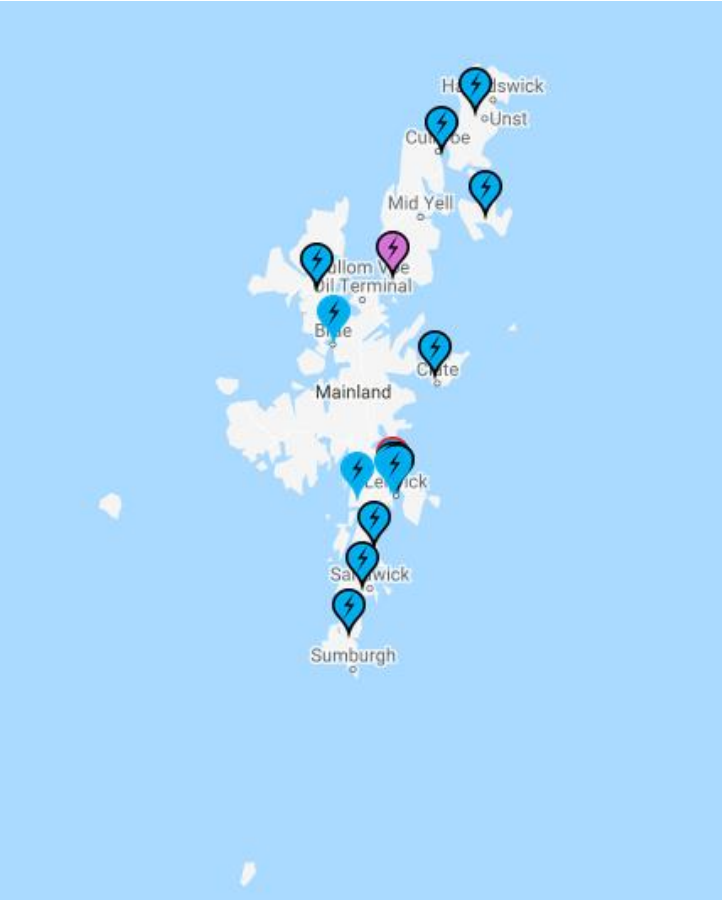
[15] DVLA/DfT, 'Statistical data set. All vehicles', VEH0132 Dataset, (last updated July 2021). Available at: [Vehicle Licensing Statistics - GOV.UK (www.gov.uk)]

Although the increase in uptake is an encouraging trend, ULEVs still represent a tiny proportion (0.6%) of licensed vehicles in Shetland. In order for Shetland to reach net zero, there would need to be essentially no use of fossil fuels in the transport sector. This would require a transformation in the use of renewable electricity and hydrogen powered vehicles, which should be supported by a decrease in the number of journeys travelled and rates of private vehicle ownership.

As of October 2021, there were 21 public charging points in the Shetland region, including 2 rapid charging points.[16] Their locations are shown in Figure 12 below. Putting these figures into context, this would equate to around 91.8 public charging points per 100,000 head of population.[17] This is much higher than the UK average of 38.7 charging points per 100,000.

It is assumed that there are also some non-public charging points not included in these statistics.

Figure 12. Locations of public charging points in Shetland. Source: Zap-Map



[16] DfT/OZEV, 'Electric vehicle charging device statistics: July 2021' (published August 2021), Available at: [Electric vehicle charging device statistics: July 2021 - GOV.UK (www.gov.uk)]

[17] DfT, 'Electric vehicle charging devices by local authority' (published October 2021). Available at: [maps.dft.gov.uk/ev-charging-map/]

3 The Business-as-Usual scenario

3.1 Definition

The BAU scenario is intended to show the changes that could occur if no additional local action was taken to mitigate GHG emissions in the Shetland region, beyond those that are already planned and committed.

As a starting point, we have referred to the BEIS Energy and Emissions Projections (EEP), which models the anticipated GHG reductions from adopted Government policies *'where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made'*. It also includes national-level economic and demographic trends, along with projected energy prices and technological improvements (e.g. better vehicle efficiency).

A sense-checking exercise was carried out to assess whether it was appropriate to apply these national trends at a local level – for example, by cross-checking national population growth projections with those for Shetland. This exercise, and discussions with SIC, showed that in many cases the situation in Shetland is different enough that applying the EEP trends across the board would not be appropriate. Therefore, the BAU includes a mixed approach, where some sectors include EEP growth curves, while others have been adjusted based on more locally specific data. Where this was not possible, variables are held constant. In practical terms this means that some future changes modelled as part of the net zero pathways might actually form part of the BAU, but this is not expected to have a significant impact on the results or recommendations.

3.2 Future trends

As part of the BAU modelling, we looked to capture any information that will affect the Shetland region's GHG emissions under BAU conditions. A summary is provided below.

Table 5. Summary of the modelled BAU trends

Measure	Description	Modelled BAU changes	Assumptions
Decarbonisation of the electricity grid	An interconnector to the UK mainland's electricity grid is due to be completed by 2025	A reduction in the emissions intensity of grid supplied electricity for all sectors (see Appendix)	Interconnector to UK mainland to complete by the end of 2024 Shetland Island grid emissions factor is assumed to reduce at the same rate out to the end of 2024 as it did between 2008 and 2018 From 2025 onwards, UK mainland grid emissions factors and projections to be used
Domestic energy use	The population of the Shetland Islands is projected to decrease slightly	EEP figures have not been used – instead, domestic emissions are held constant	Population change statistics from 2018 ONS projections[18] A small decline in population, replacement of solid fuel heating systems and uptake of energy efficiency measures is assumed to be offset by more electronic appliances and adding central heating to homes that currently have none
Uptake in electric vehicles (EVs)	Uptake of EVs is expected to increase rapidly due to falling costs and the Government's target of phasing out sale of new petrol and diesel engines by 2030	Fuel switch from petrol and diesel to electricity (cars, vans, and motorbikes) results in an increase in electricity consumed for EVs HGVs are held constant	The uptake curve for EVs is aligned with the National Grid 'Steady Progression' Future Energy Scenario (% of the fleet that is EV each year) The model re-allocates fuel consumption from petrol/diesel to electricity, adjusted for differences in fuel efficiency HGV movements are constant on the assumption that increasing economic output would more likely lead to higher emissions from shipping and aviation rather than HGV movements within Shetland
Commercial and industrial sectors	Changes in energy demand result from economic trends, energy prices, and Government policies	Based on EEP figures, with the exception of public sector emissions, where trends are based on the NZCR analysis and previous work undertaken by Ricardo on behalf of NHS Shetland	It is assumed that industrial and commercial activities will change broadly in line with wider trends although it is acknowledged that the nature of the industries in Shetland are unique
Aviation	Passenger numbers will increase, resulting in an increase in fuel use	Increase in demand for fuel and a proportional increase in non-fuel emissions	The annual growth rate is based on separate work undertaken by Ricardo on behalf of Highlands & Islands Airports Ltd.

[18] Population Projections for Scottish Areas (2018-based): Data Tables

Measure	Description	Modelled BAU changes	Assumptions
F-gases	Emissions from f-gases will generally decrease over time due to restrictions on refrigerants with higher global warming potential (GWP)	Based on EEP figures	Since industrial and commercial emissions have been modelled in line with the EEP, and most f-gases are associated with those sectors, the same trends have been applied
Waste & Wastewater	Quantities of waste and wastewater may change over time	Based on detailed analysis undertaken as part of the NZCR	The amount of waste burned in the ERP is assumed to remain constant because even if there is a decrease in the amount of waste produced within Shetland, this may need to be made up for via imports Wastewater emissions are assumed to remain steady
District heat network (DHN) decarbonisation	Two projects have been completed or are nearing completion since FY 19/20	Upgrade to the ERP plant has increased the efficiency of heat generation. Note that total waste incinerated does not change. Heat recovery from diesel power generators serving Shetland Islands electricity grid. Both projects result in a decrease in burning oil used by the DHN's peak load boilers.	The ERP upgrade results in the total heat provided by the ERP to the DHN to increase from 85% of total heat demand to 93%Heat recovery from the diesel generators is only modelled to the end of 2024 when the interconnector to the mainland UK electricity grid is completed. At which point the diesel generators are expected to be used as backup power sources and therefore not operated consistently When operational, heat recovery from the diesel generators is expected to satisfy 3% of the total DHN heating demand
Public sector decarbonisation	Planned and committed works to be undertaken by SIC and NHS Shetland will improve energy efficiency	Refer to the NZCR report for information on the BAU changes for SIC assets. No changes modelled for NHS Shetland (see 'Assumptions').	Note that since 'public sector' energy use and emissions in the area-wide analysis includes more than just SIC and NHS assets, the total % change in public sector energy use and emissions does not directly align with the NZCR model, but that data has been used to sense-check the assumptions. The planned and committed works by SIC and NHS Shetland will have a small impact on energy use, but the impact is not significant in the context of total area-wide emissions.
Land Use & Agriculture	The Scottish Government has stipulated a mid-term target for a 24% reduction in emissions from agriculture by 2032 compared with a 2019 baseline	No changes modelled in the BAU	The target applies to the sector as a whole and it is unclear to what extent the reduction would be achievable for agricultural activities in Shetland – this will be considered as part of the net zero pathways analysis[19]

[19] Ricardo GHG mitigation WWF Scotland 17Oct21.pdf

Measure	Description	Modelled BAU changes	Assumptions
Marine vessels	Natural replacement cycles and efficiency improvements will result in a decrease in energy use	Ferries and tugs are assumed to be replaced like-for-like but fuel consumption will decrease due to greater efficiency No change has been modelled for other marine vessels or marine sector activities due to lack of data	Refer to the NZCR and Neptune Project outputs for more information
Aviation	Passenger numbers will increase, resulting in an increase in fuel use	Increase in demand for fuel and a proportional increase in non-fuel emissions	The annual growth rate is based on separate work undertaken by Ricardo on behalf of Highlands & Islands Airports Ltd. This is not necessarily specific to Shetland but is considered more representative than if national datasets were used.

3.3 Results

3.3.1 Scope 1 and 2 emissions

The following graphs show how the above trends are expected to impact Scope 1 and 2 energy use and GHG emissions in Shetland.

Figure 13. Changes in Scope 1 and 2 energy use, 2019-2045

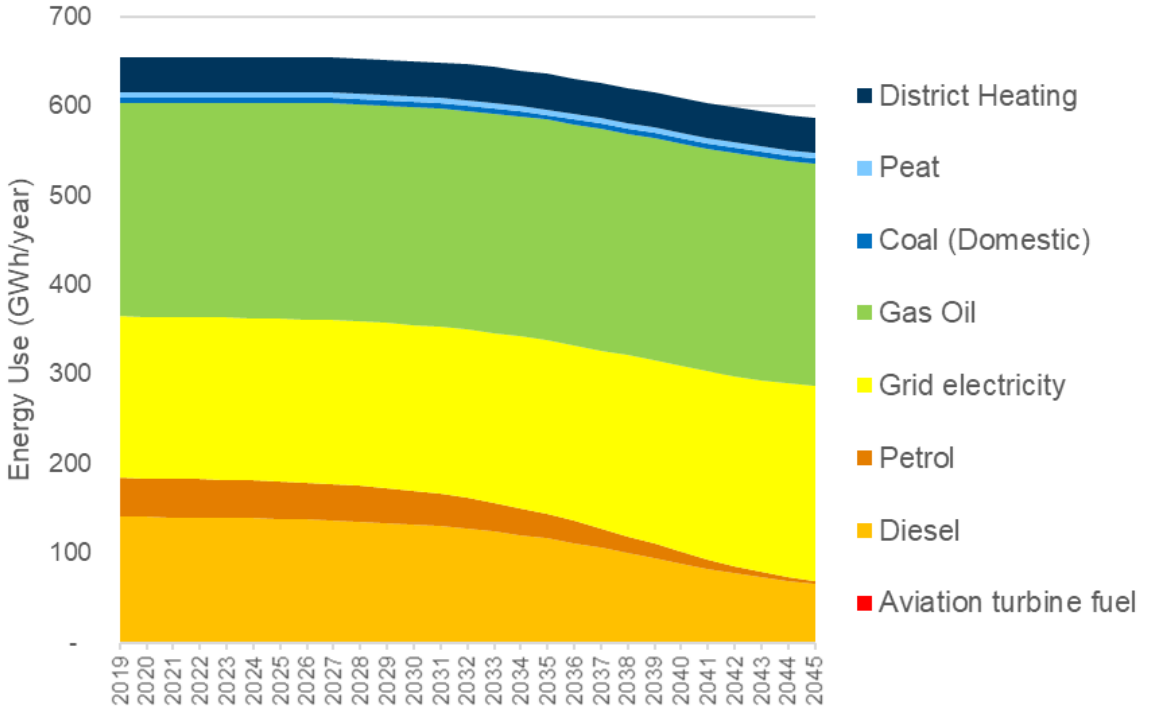


Figure 14. Changes in Scope 1 and 2 GHG emissions by fuel or source, 2019-2045

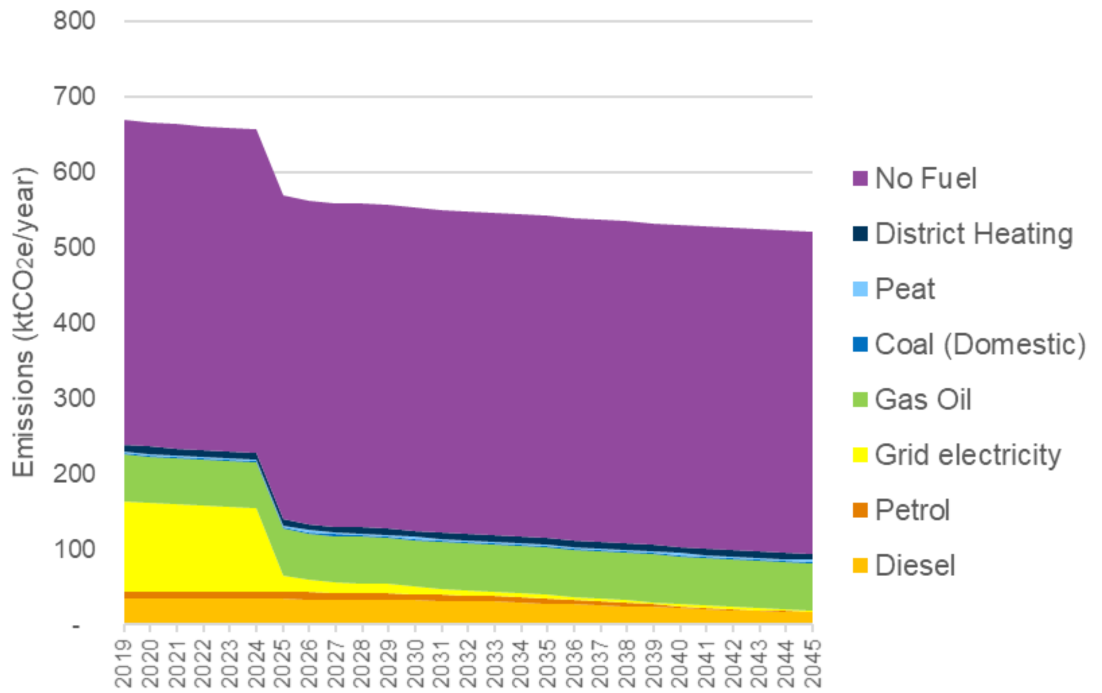
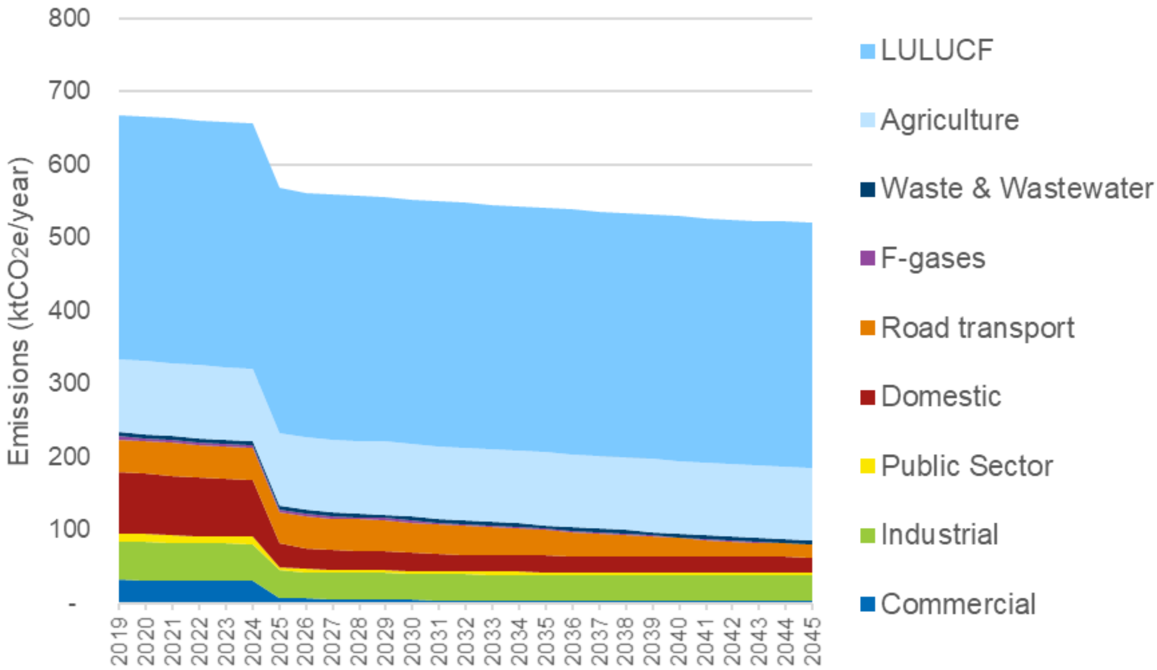


Figure 15. Changes in Scope 1 and 2 GHG emissions by sector, 2019-2045



Taking fuel consumption (Figure 13) as a starting point, broadly speaking the changes in energy use are fairly small over the timescale from 2019-2045. Industrial and commercial energy use, which is based on the BEIS EEP, generally changes by <1% year-on-year, and fuel consumption in other sectors is relatively constant. The most notable trend in terms of energy use is associated with the switch from combustion engines to electric vehicles. Because EVs are much more efficient, the *increase* in electricity demand is much smaller than the *decrease* in petrol and diesel consumption.

Together, these trends result in a gradual decline in Scope 1 and 2 energy use. However, despite energy use remaining fairly consistent, there is a significant and sharp decrease overall emissions in c. 2025. This is a result of decarbonisation of grid supplied electricity when the Shetland Islands connect to the UK mainland's electricity grid via an interconnector post-2024.

So, in the BAU scenario, Scope 1 and 2 emissions ***from energy use only*** would decrease from c. 240 $ktCO_2e$ in 2019 to c. 100 $ktCO_2e$ by 2045, a drop of nearly 60%. The change is almost entirely attributed to the grid interconnector and the shift to EVs. For context, according to the EEP, the UK as a whole would likely only see a c. 30% decrease in emissions in that timescale.

However, because Shetland's emissions are dominated by non-energy-related emissions from land use and agriculture, the impact on total Scope 1 and 2 emissions is much lower. When those are taken into account, total Scope 1 and 2 emissions would only drop by c. 20-25% by 2045.

3.3.2 Scope 1, 2 and 3 emissions

The following charts replicate those shown in Section 3.3.1 but also include Scope 3 emissions from aviation, ferries, harbour tugs, and other marine sector activities. Again, there is only a gradual change in fuel consumption, and the main change in emissions is associated with the grid interconnector. Unsurprisingly, the total change is much smaller. This is because marine vessels account for a higher proportion of energy use and emissions, and there are only marginal efficiency improvements modelled as part of the BAU. There is also a slight increase in use of aviation turbine fuel.

Figure 16. Changes in Scope 1, 2 and 3 energy use, 2019-2045

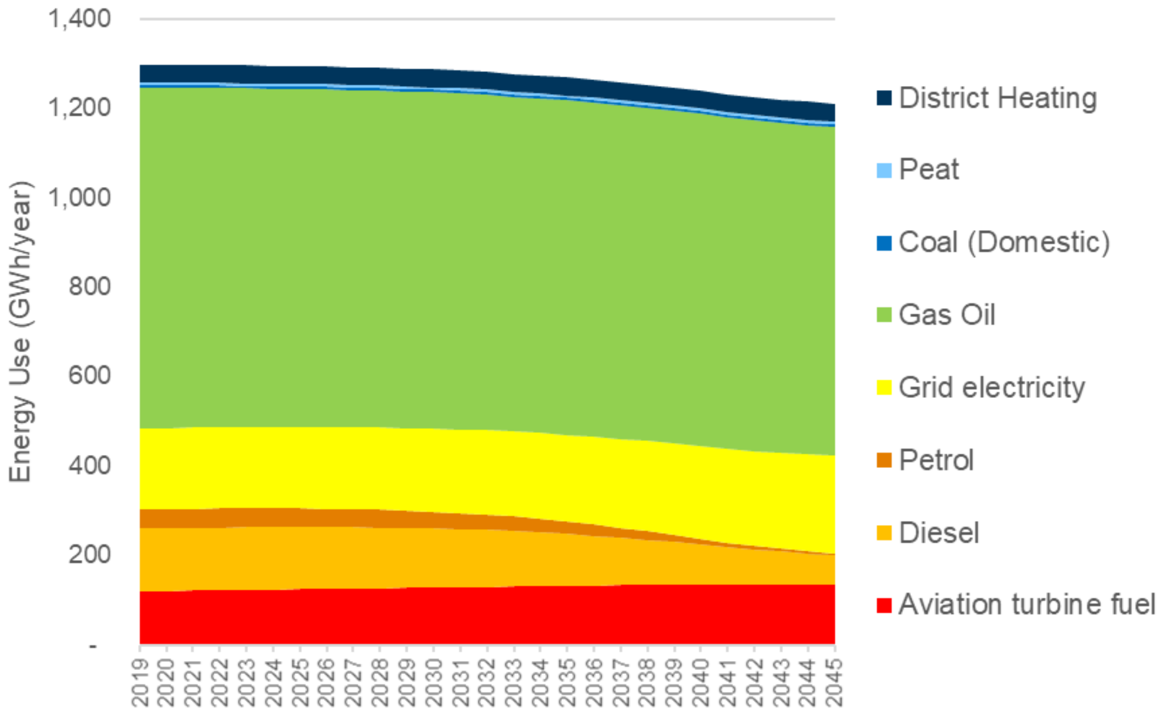


Figure 17. Changes in Scope 1, 2 and 3 GHG emissions by fuel or source, 2019-2045

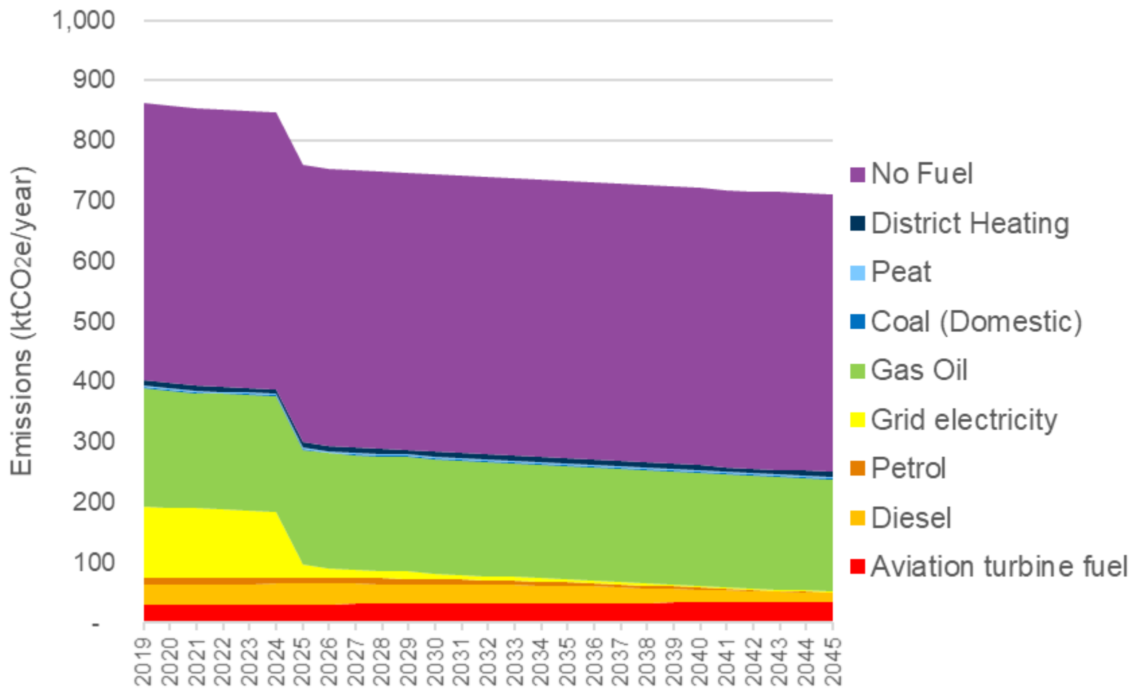
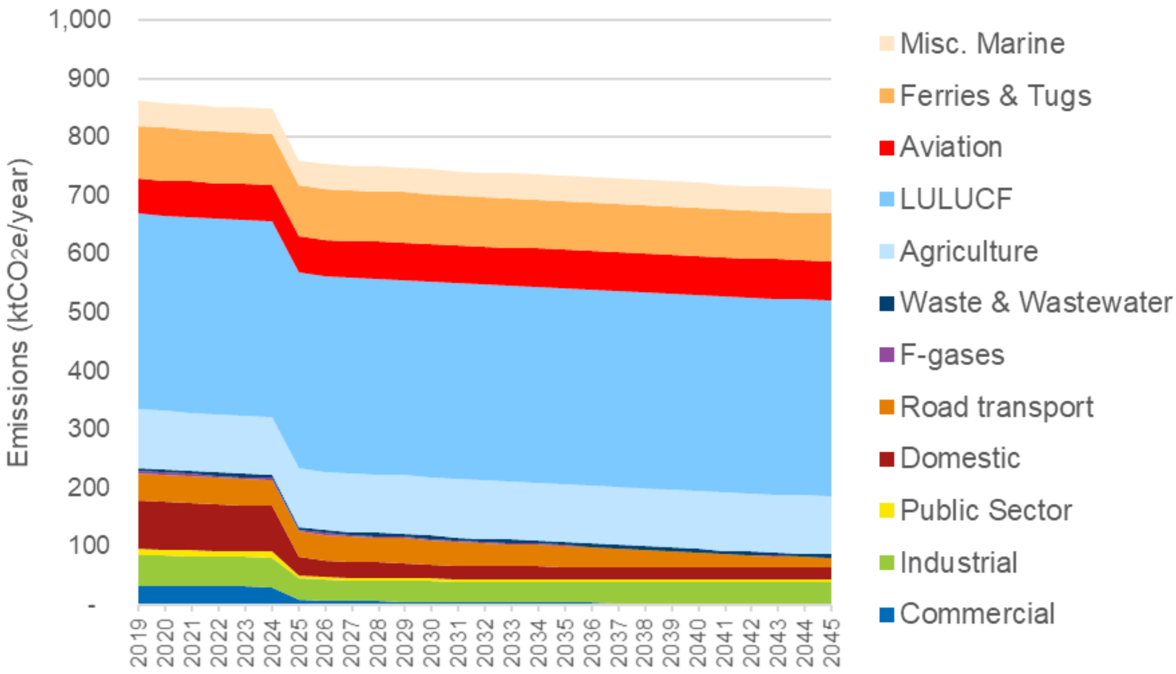


Figure 18. Changes in Scope 1, 2 and 3 GHG emissions by sector, 2019-2045



3.4 Key points and conclusions from the BAU analysis

The BAU results highlight the important role that electrification can have in terms of reducing GHG emissions. They also highlight a major challenge for Shetland, which is that a significant portion of baseline GHG emissions are associated with sectors that are difficult to electrify from a technological perspective, i.e. aviation and marine. From a non-technological standpoint, there is a further challenge, because unlike energy use in homes or private cars, SIC and other local stakeholders have less ability to influence or reduce *demand* for shipping and air travel. On the other hand, there are multiple ongoing projects being carried out with local stakeholders to investigate solutions for energy supply, aviation and the marine sector which could play an important part in ensuring that low and zero carbon technologies are adopted.

In addition to making it difficult to reach net zero emissions by any set target date, the uncertainty around technological solutions and lack of levers of influence also mean that Shetland's cumulative emissions between now and 2045 are likely to be higher in the short term, with mitigations ramping up over time. This means that the cumulative emissions – which are arguably more important from an environmental perspective – will also be higher than if it were possible to introduce mitigation options in the short- to medium-term. As a result, Shetland's emissions trajectory will be much less likely to comply with a Paris Agreement-aligned pathway.[20]

A note on LULUCF

LULUCF emissions are not shown in the BAU scenario above, but are worth considering from a qualitative standpoint, as the dominant source of GHG emissions in Shetland. Most of these emissions are associated with historic changes in land use and current land management practices that release carbon, previously stored in soil, into the atmosphere. Some of the issue lies with degraded peatlands, but the $LACO_2$ statistics indicate that a bigger issue is with peatlands that have been converted to grazing or cropland, which cover much of the land area of Shetland and continue to emit carbon. Emissions from these sources are expected to reduce over time, to some extent, due to ongoing and planned peatland

[20] Local and Regional Implications of the United Nations Paris Agreement on Climate Change (manchester.ac.uk)

restoration work – but they are impossible to eradicate or reverse unless there is a major, permanent, landscape-scale change across the Shetland Islands, including peatland re-establishment.

At a national level, these types of emissions would need to be dealt with, at least in part, through reliance on CCS technologies, once all practical steps to reduce emissions at source have been taken. However, since LULUCF is included in Shetland's GHG emissions 'balance sheet', it will probably be impossible for the region to claim to have reached net zero emissions without being able to prove that large-scale atmospheric carbon removals are also taking place.

4 Defining the pathways to net zero

4.1 Approach

In addition to the BAU scenario, this work has explored two accelerated scenarios, which explore the impact of a range of behavioural and technological measures aimed at further mitigating energy use and GHG emissions. A summary is below, and further details are provided in the following sections.

Pathway A asks: What can we realistically achieve with high levels of ambition?

The first net zero pathway, referred to as Pathway A, is a 'best guess' at what a high-ambition, but nonetheless realistic, future might look like. Conceptually it is similar to the CCC's 'Balanced' net zero pathway, which '*makes moderate assumptions on behavioural change and innovation and takes actions in the coming decade to develop multiple options for later roll-out (e.g., use of hydrogen and/or electrification for heavy goods vehicles and buildings).*'[21] Due to Shetland's atypical emissions profile, multiple adjustments have been made to this to reflect local circumstances more accurately.

Pathway B asks: How far could we theoretically go if money were no obstacle?

The second net zero pathway, referred to as Pathway B, explores the maximum reduction that could be achieved in a best-case scenario if key sectoral targets were met or exceeded. This would require higher uptake of more costly measures and the removal of various other practical obstacles. Because the aim is not only to reduce emissions, but also to reduce energy demands as much as possible, there are slightly different choices about the technology and fuel mix. Pathway B also assumes that all or most fossil fuel use in business and industry can be phased out, even where there is presently no information available as to the end use of those fuels, which makes it difficult to identify suitable mitigation measures at present. The other key difference is that Pathway B is more optimistic about opportunities to restore peatland and decarbonise agricultural activities.

Both of these pathways assess emissions through to the year 2045, which is the net zero target date for Scotland. As discussed in the Baseline report, the emissions profile for Shetland makes it unlikely that net zero emissions will be achieved by 2045 without the large-scale adoption of carbon removal technologies. Therefore, by looking at emissions through to the year 2045, it is possible to estimate the potential scale of residual emissions in that year and quantify the 'gap' to net zero.

The net zero pathways use the BAU scenario as the starting point for the analysis and therefore incorporate the same core assumptions about trends in energy demands, economic growth, population changes, and so on. All of the other changes are modelled as mitigation measures that would need to be adopted, whether via additional Government policies, local/regional initiatives, or through voluntary changes in consumer behaviour, business and industrial practices.

These pathways are intended to highlight the scale and direction of changes that could occur if the above measures were implemented. They are not intended as a projection or forecast of future energy use and emissions. It is also worth noting that, in reality, implementing these types of changes would almost certainly lead to dynamic impacts across different activities and sectors, thus affecting wider trends such as fuel prices. Those interactions are highly complex and have not been quantified in this study. Nonetheless, these scenarios provide a useful way to assess and prioritise potential interventions – and understand SIC's level of influence when it comes to achieving net zero emissions.

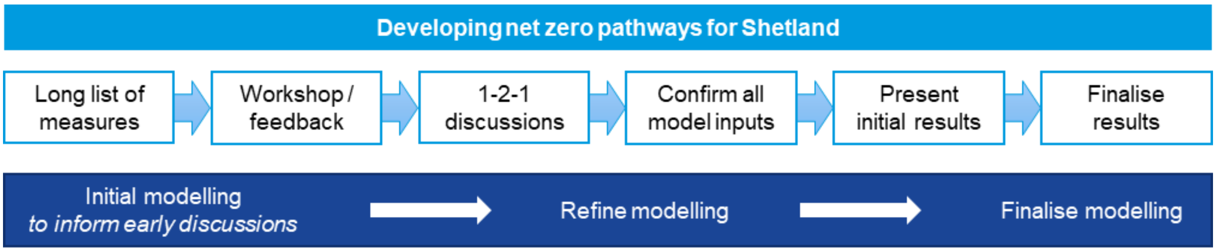
[21] The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (theccc.org.uk)

4.2 Decarbonisation interventions

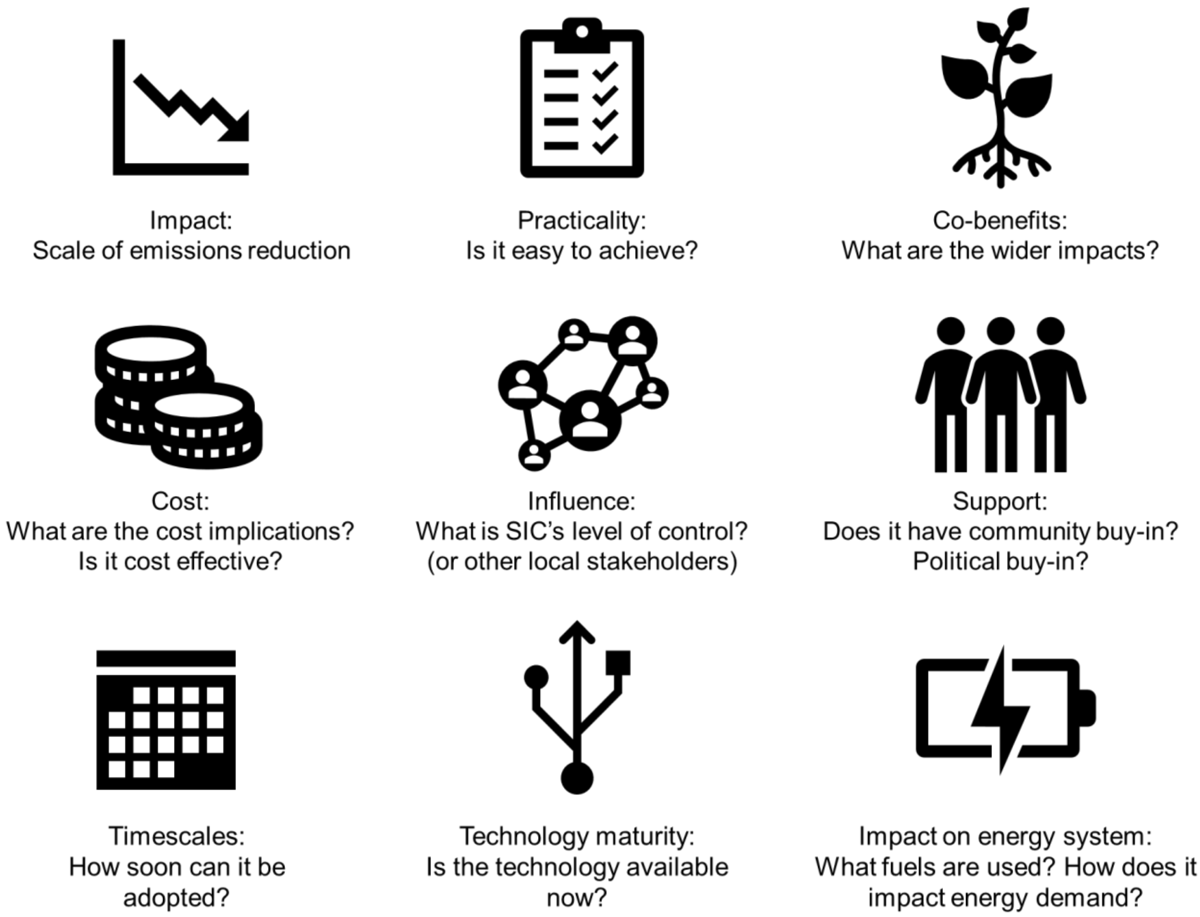
4.2.1 Selecting measures

A long list of decarbonisation measures was identified by Ricardo technical leads, based on a combination of factors including (but not limited to) the GHG baseline assessment, BAU scenario results, and a broader review of relevant policies, strategies, and targets. (Further details on the policy review are provided in Appendix A.) The options were discussed with SIC and other external stakeholders in a joint workshop, which was followed by one-on-one meetings with sectoral experts and SIC departments. The output of this process was a shortlist of measures to be taken forward to modelling, for which SIC provided sign-off.

After discussing initial results, the modelling was finalised – at least for the purpose of developing the NZSR. In practice, identifying decarbonisation interventions and developing emissions reduction plans is an iterative process that evolves over time. The following chapters reflect some of the identification, prioritisation, interactions and modelling loops that took place during the project, but the process will continue in future as SIC begins to implement the NZSR.



When identifying and prioritising mitigation measures, consideration was given to:



The measures discussed in the workshops covered the following topic areas; more information about how these are applied to each pathway is provided in later sections of this report.

Table 6. Mitigation measures considered during stakeholder workshops

Category	Mitigation measures considered
Transport	• Avoiding car journeys via behavioural and technological change • Replacing a proportion of remaining car journeys with walking, cycling and public transport • Reducing demand for LGV and HGV movements through measures such trip consolidation and logistics • Improving HGV efficiency through technology improvements and driver training initiatives • Uptake of electric vehicles (cars, vans, buses, and motorcycles) • Uptake of hydrogen (HGVs) • Uptake of sustainable aviation fuel (SAF) and electric/hybrid aircraft • Switching to use of electricity, green hydrogen, ammonia or other zero-emission biofuels in marine vessels
Energy system	• Connecting to UK mainland electricity grid in 2024/25 • Subsequent electricity grid decarbonisation taking place in line with BEIS projections (note, local large-scale renewables are assumed to contribute to this grid decarbonisation but have not been assessed separately) • Deployment of roof-mounted solar technologies on suitable buildings (note, other small-scale renewables such as wind and hydropower could also be used) • Efficiency improvements in the ERP and/or switching to heat pumps
Reuse, recycling and waste	• Preventing waste, increasing recycling rates, and introducing local composting to ensure no biodegradable waste is incinerated or sent to landfill • Employing landfill methane capture technologies and utilising CCS at energy-from-waste (EfW) plants
Business and Industry	• After implementing measures to address emissions from buildings and transport, switching any remaining fossil fuel demands to electricity, green hydrogen, or another zero-emission fuel source
Buildings	• Reducing heat and electricity demand due to fabric energy efficiency, smart heating controls, uptake of LED lighting and carry out upgrades to non-domestic heating, ventilation, and air conditioning (HVAC) systems • Connecting some buildings to heat networks, and then converting these to use renewable heat (e.g., electric heat pumps) • Buildings that do not connect to heat networks are assumed to switch to electric heating, heat pumps or green hydrogen to provide space heating and hot water

Category	Mitigation measures considered
Agriculture and Land Use	• Implementing measures to release land for peatland restoration or other carbon sequestration projects, such as paludiculture • Employing low carbon farming practices in soil, livestock, and manure management • Replacing fossil fuel use in agricultural machinery/facilities with electricity, green hydrogen or other zero-emission fuels • Restoring up to 2,500 ha of peatland per year

4.2.2 Modelling methodology

Future GHG pathways were modelled using the Ricardo Net Zero Projections (NZP) tool, which enables users to model the impact of implementing mitigation measures on a Local Authority's GHG emissions over time. The tool is essentially a 'What if?' calculator tool that relies on external validation of inputs, assumptions, and outputs to ensure its projections are sensible. At its core, the tool is an accounting system that calculates the change in energy use and fuel mix as a result of series of mitigation measures.

The tool is designed to enable the development of scenarios for reaching net zero by any given target year and allows the users to define mitigation measures for each line in the energy and emissions inventory. These scenarios can be used to build a baseline projection, assess the likely impact of planned measures, and model the impact of alternative strategies to reaching net zero. The scenarios can also be used to undertake sensitivity testing around the impact of changes in assumptions.

It is important to understand that this modelling is based on assumptions about the magnitude of energy or emissions reduction that is technically achievable within each sector. However, it makes no assumptions about the types of policies that would be needed to achieve this. To give an example, the NZP tool can estimate the change in emissions that would result from a 10% reduction in miles travelled by private car, but it cannot assess the impact of specific policy measures, such as 'Introduce a workplace parking levy to discourage people from commuting in private cars' unless the user inputs an assumption about the quantitative impact this would have. That type of information must be established via separate modelling, research, case study evidence or expert judgment.

On the last point, this study has drawn on several other recent or ongoing studies to provide inputs to the NZP tool and calculate future changes in emissions. The aim was to draw on prior work and align the results as much as possible. The following table summarises key data sources that were used to model future GHG pathways as part of the quantitative analysis. (Information on data sources used to calculate the GHG emissions baseline has been provided in a separate report.)

Table 7. Summary of data sources used

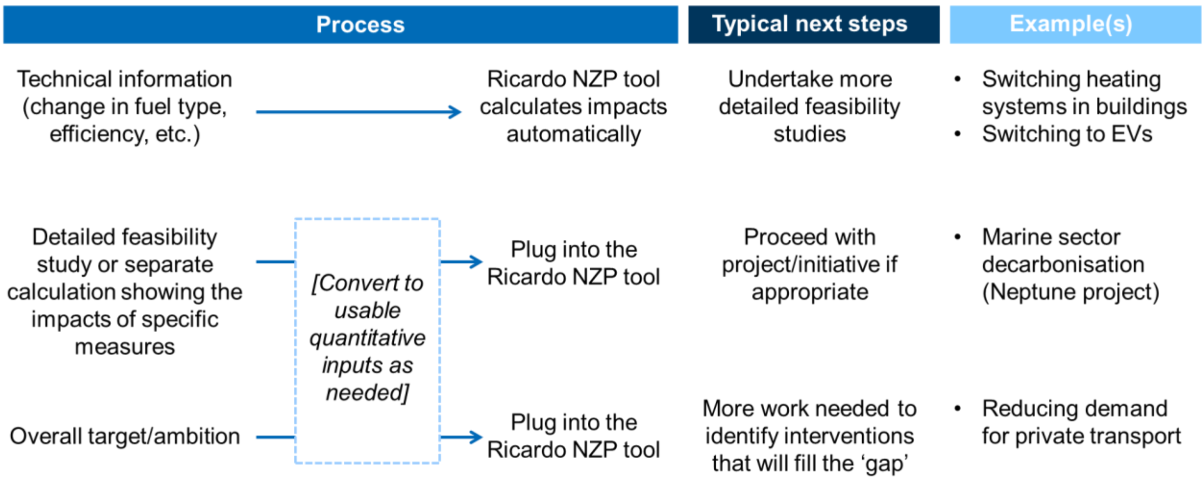
Data source	How was it used?
Shetland NZCR study	Used to sense-check assumptions about BAU changes in energy demand, rates of retrofit, and the uptake of different low carbon heating technologies Used to calculate changes in emissions from waste and the Energy Recovery Plant (ERP)
Neptune project	Used to identify suitable alternative fuels/technologies for each type of marine vessel Used to calculate potential changes in future energy use in the marine sector, accounting for the likely timescales of technology adoption

Data source	How was it used?
Highlands Islands Airports Ltd. Net Zero Routemap	Used to sense-check future growth in energy use and emissions in the aviation sector Used to identify suitable alternative fuels/technologies for different types of aircraft
Shetland NHS Net Zero Routemap	Used to sense-check future growth in energy use within NHS Shetland facilities and suitable mitigation measures

It is important to understand that, while some of the mitigation measures modelled in these pathways are supported by more detailed technical analysis, a few of them are based on high-level targets where further work would be required to identify the precise measures or policy mechanisms.

For example, the Scottish Government has a target of a 20% reduction in car kilometres, but the local measures needed to achieve this have not yet been defined for Shetland. The same applies to the 31% reduction in agricultural emissions that has been modelled in Pathway B. By contrast, the modelling assumptions for retrofitting domestic buildings, switching to low carbon heating systems, and transitioning to electric vehicles (EVs) are based on defined technical assumptions about the relative efficiency of those systems and the GHG intensity of different fuel types.

Figure 19. Sources of data, how they are used in the NZP pathways analysis, and typical next steps



4.3 Results of the net zero pathways analysis

Each of the net zero pathways were modelled to include the decarbonisation measures agreed with SIC and other stakeholders. This section covers the results of this modelling and sets out a narrative and graphical explanation of what each of the pathways could look like.

As described previously, Shetland is unique in that most Scope 1 & 2 emissions are _not_ related to fuel consumption. Furthermore, some sources of emissions are technically outside of the Local Authority's geographic boundary, and are therefore classed as Scope 3 emissions, so are excluded from the UK Government's Local Authority GHG emissions inventory – even though in practice they are mostly or entirely controlled by organisations and individuals based in Shetland.

In line with the approach taken by most other Local Authorities, and for comparability against the GHG emission statistics, progress against the overall net zero target will be defined in terms of Scope 1 & 2 emissions within the Local Authority boundary. However, to highlight the scale of impact that can be achieved for different sources of emissions, the analysis will *also* consider the overall changes in fuel-related Scope 1 & 2 emissions only, as well as all Scope 1, 2 and 3 emissions. This is shown in the chart below.

		Source of emissions		Scope of emissions	
Method no.	Description	Emissions from energy use	Emissions _not_ from energy use	Scope 1& 2 emissions *(within the boundary)*	Scope 3 emissions *(outside the boundary)*
1	Scope 1&2 emissions	✔	✔	✔	X
2	Scope 1&2 emissions from energy use only	✔	X	✔	X
3	Scope 1, 2 & 3 emissions*	✔	✔	✔	✔

**The Scope 3 emissions that have been assessed in this project include: Ferries, harbour tugs, fishing vessels, domestic aviation, Sullom Voe Terminal (SVT) and Shetland Gas Plant (SGP). They do not include other indirect emissions such as those associated with imported food or products. SVT and SGP are excluded because even though they are located within the area boundary, the fuels are exported, and are therefore classified as Scope 1 emissions for end users outside of Shetland.*

4.3.1 Pathway A

Pathway A asks: What can we realistically achieve with high levels of ambition?

4.3.1.1 Pathway intervention measures

An overview of the intervention measures modelled for Pathway A are set out in the table below.

Table 8. Pathway A - measures modelled

Category	Mitigation measures modelled

Transport	• Demand reduction measures are implemented to counteract the increase in travel that is likely to arise due to other factors such as changes in care at home; assumed to result in a net reduction of 0%
	• 5% reduction in LGV/HGV fuel consumption due to technology improvements and route optimisation plus 5% reduction in emissions from 'eco driving' training
	• Fuel switching:
	  • Cars, vans and buses switch to EV, reaching 100% by 2045
	  • HGVs switch to hydrogen in 2030s, reaching 100% by 2045
	  • All aircraft to switch to H_2, battery/hybrid or SAF
	  • All marine vessels switch to alternative fuels in line with Neptune project recommendations

Energy system	• Connecting to UK mainland electricity grid in 2024/25 • Subsequent electricity grid decarbonisation taking place in line with BEIS projections (note, local large-scale renewables are assumed to contribute to this grid decarbonisation but have not been assessed separately) • Deployment of roof-mounted solar technologies on c. 25% of buildings • Efficiency improvements in the ERP (see next row)
Reuse, recycling and waste	• Reduce waste produced in Shetland by c. 15%, increase recycling rates by c. 15% and introduce AD or composting for biodegradable waste in line with NZCR • Continue to operate ERP and heat network in Lerwick, importing waste to make up any shortfall if needed to ensure that it operates at maximum efficiency
Business and Industry	• After implementing measures to address emissions from space heating and hot water, 50% of remaining fossil fuel demands switch to electricity, green hydrogen, or another zero-emission fuel source

Buildings	• Demand reduction:
	  • Smart meters to help enable behaviour change (but minimal impact assuming many people already implement some measures)
	  • Efficient lighting, water fittings and appliances
	  • Energy audits and other initiatives for businesses to reduce energy use
	  • Implement retrofitting measures to achieve a c. 10% reduction in heat demand for domestic buildings and 5% reduction for non-domestic buildings, across the building stock as a whole[22]
	• Fuel switching:

[22] This is roughly equivalent to retrofitting all domestic buildings to an average EPC rating of C or B which is in line with the Scottish Government's targets set out in the Climate Change Plan Update. For non-domestic buildings, evidence suggests that retrofitting building fabric and services to a high standard can result in a c. 25-30% reduction in energy use. However, a low number has intentionally been used for the NZSR and particularly for Pathway A to reflect the lack of certainty as to the proportion of fuel that is used for space heating and hot water in non-domestic buildings in Shetland. This is to avoid overestimating the scale of improvement that can be achieved.

Category	Mitigation measures modelled
	• Phase out fossil fuel heating systems by 2045, replacing with electric (a combination of direct electric, storage, heat pumps, etc.) • Properties currently connected to the heat network remain on the heat network • Switch 100% of fossil fuel cooking/catering equipment to electric by 2045
Agriculture and Land Use	• Assume target of 2,500 ha/year peatland restoration is not achieved, and instead roughly 1/3 to 1/2 of this amount is restored • Assume a c. 5% reduction in non-fuel-related emissions from agriculture from low carbon farming and land management practices

4.3.1.2 Pathway mitigation potential

Scope 1 & 2 emissions

The following charts illustrate the mitigation potential of Pathway A. By 2045, the measures modelled in Pathway A could reduce Scope 1 & 2 emissions by roughly 43%, with 380 $ktCO_2e$ remaining.

Figure 20. Scope 1 & 2 emissions by sector under Pathway A

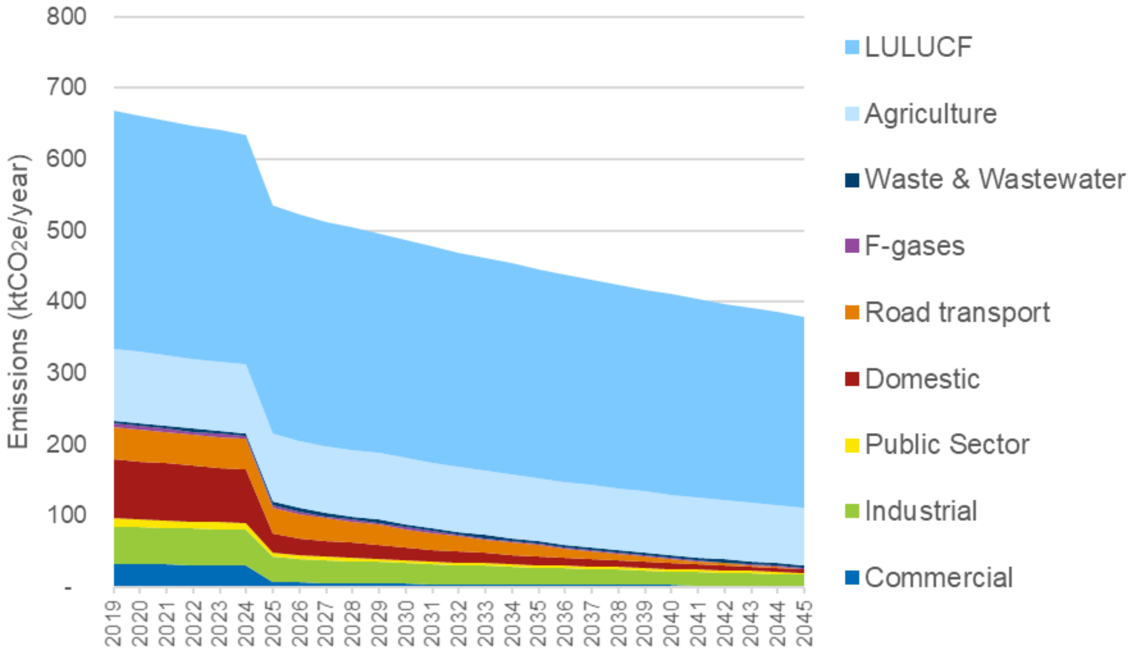
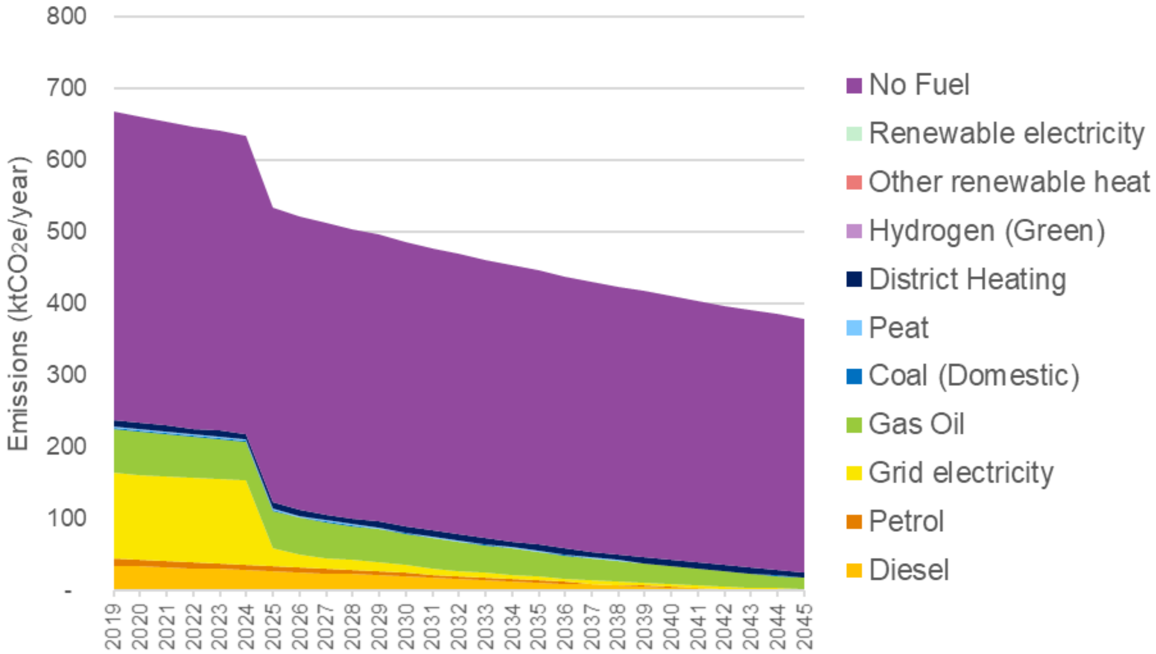


Figure 21. Scope 1 & 2 emissions by fuel type under Pathway A



The single largest reduction in emissions in Pathway A comes from peatland restoration. Pathway A takes a relatively cautious view of the 2,500 ha/year target for peatland restoration; it assumes that the target is not met and/or that the average GHG reduction per hectare is lower than anticipated.[23] Nonetheless, this results in a c. 20% reduction in LULUCF emissions – and because LULUCF emissions are the largest source of emissions in 2019, this has a major impact on the overall outcome.

The next most significant impacts are associated with changes in energy use and the wider energy system. As seen in Figure 20, there is a steep drop-off in 2024/2025 once the High Voltage Direct Current (HVDC) transmission link to the UK electricity grid is complete. (This is also responsible for most of the reductions in the BAU scenario.) Assuming that the majority of fossil fuel use then switches to decarbonised grid electricity, emissions from fuel consumption would be expected to drop significantly by 2045. Energy efficiency and behaviour change measures play a comparatively small role in reducing GHG emissions but are a key component of limiting electricity demands and deliver various other co-benefits (described in more detail below).

Non-CO_2 emissions from agriculture (from sources such as livestock, manure and fertiliser) are another significant source of emissions, which in Pathway A are only estimated to decrease by around 5%. This could be achieved through a combination of low-carbon farming practices. However, further consultation with farmers and crofters will be necessary in order to identify the specific measures needed to achieve this 5% decrease.

Examples of sustainable farming practices include, but are not limited to:[24,25]

- Optimising livestock performance and manure management
- No-till farming
- Reducing the use of fertilisers and/or changing the timing of nutrient application
- Crop diversification

[23] In the NZP tool, these are modelled in the same way.

[24] Farming for a Better Climate - Farming for a Better Climate

[25] Ricardo GHG mitigation WWF Scotland 17Oct21.pdf

- Use of cover crops
- Improving sward biodiversity

A research study commissioned by the Scottish Government[26] identified the following strategies to address emissions from peatland currently used for agriculture:

- *'Conservation agriculture (e.g. zero tillage systems).*
- *Seasonally raising water tables (between cropping cycles).*
- *Raising water tables year-round and replacing arable and horticultural crops with wetland agriculture, also known as paludiculture (e.g., bioenergy crops, Sphagnum for growing media or food/medicinal crops).*
- *Full restoration of semi-natural wetland habitats.'*

By 2045, the charts illustrate that residual emissions will mainly come from LULUCF (which will be dominated by emissions from grassland or cropland located on peat soils) and non-CO_2 gases in agriculture. In addition, Pathway A assumes that there will be some residual use of fossil fuels, particularly in the industrial, commercial, and agricultural sectors. This is because there is limited data on what exactly these fuels are used for, other than space heating and hot water, and the applications are likely to be highly sector- or industry-specific. This makes it very difficult to identify and model alternative fuels/technologies that could be used as GHG mitigation measures.

Recommendation: Obtain better data on current fossil fuel use in the commercial, industrial, and agriculture sectors, and work with businesses to understand how this can be reduced.

Figure 22 and Figure 23 provide a closer look at Scope 1 & 2 emissions *from energy use only*. Again, there is a steep drop-off when Shetland connects to the UK electricity grid, which immediately reduces these emissions by half. By 2045, there is an overall 89% reduction. The remaining 11% (26 ktCO_2e) is almost entirely due to fossil fuel use (see previous paragraph), mostly in the industrial sector. This pathway assumes that around 50% of fossil fuel use in the commercial and industrial sectors can and will switch to renewable electricity or green hydrogen, even if (as explained in the previous paragraph) the end uses of that fuel are currently unknown. Nearly all of the residual emissions, then, will be from the remaining fossil fuel consumption that cannot be displaced by a zero emission fuel.

However, while GHG emissions from energy use drop sharply if all energy is supplied with zero emission fuels, the changes in fuel consumption in Pathway A are considerably smaller, as shown in Figure 24. Most of the decrease is driven by a switch from combustion engines to EVs (in road transport) and heat pumps (in buildings) as both technologies operate more efficiently than their fossil-fuelled counterparts. This is accompanied by other demand reduction measures such as retrofitting and active travel, although these play a smaller role than increased efficiency. By 2045, the vast majority of energy use stems from a zero- or low-emission source, such as renewable electricity, green hydrogen, and the heat network.

[26] Peatland restoration and potential emissions savings on agricultural land: an evidence assessment (climatexchange.org.uk)

Figure 22. Emissions from energy use by sector under Pathway A (Scope 1 & 2)

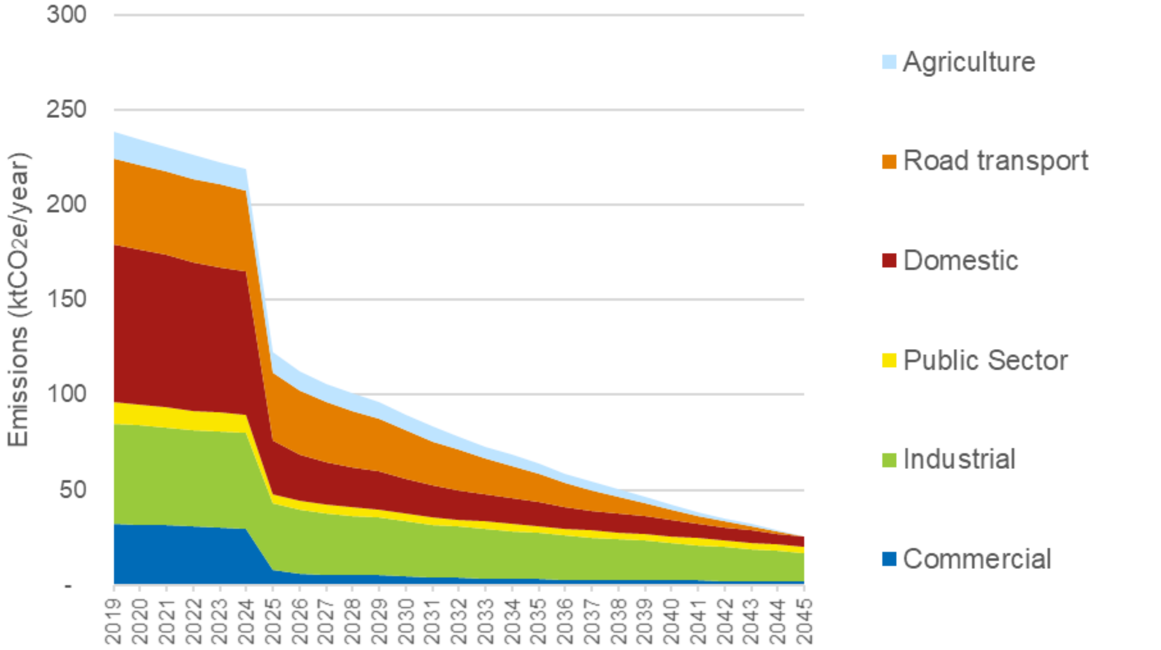


Figure 23. Emissions from energy use by fuel type under Pathway A (Scope 1 & 2)

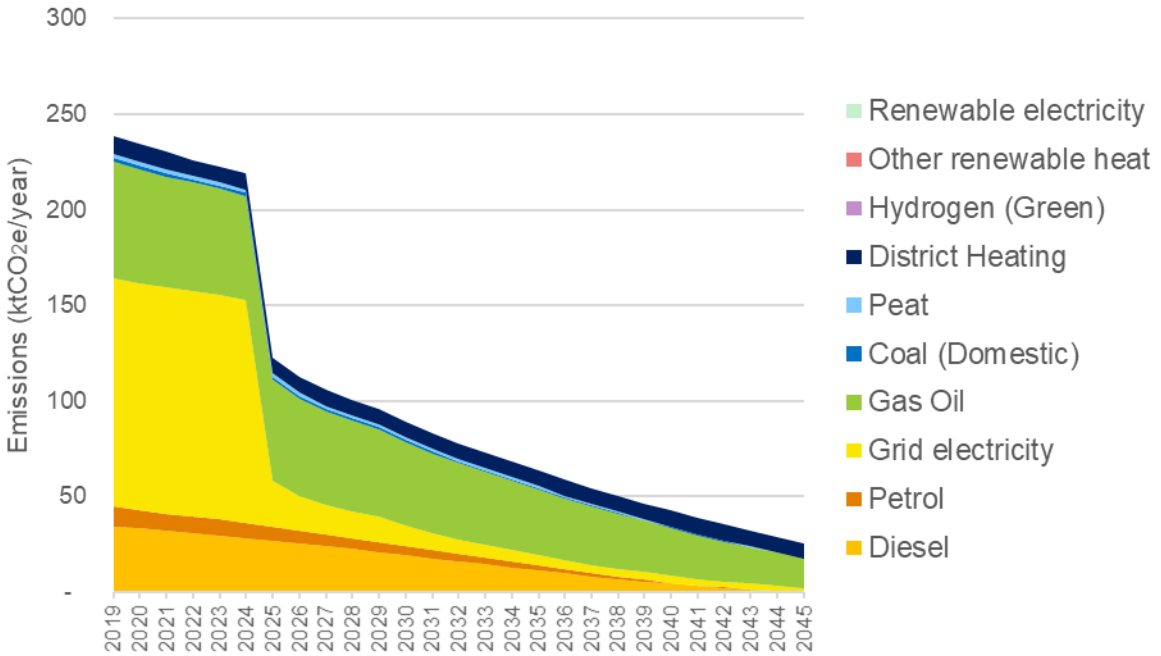


Figure 24. Energy use by fuel type under Pathway A (Scope 1 & 2)

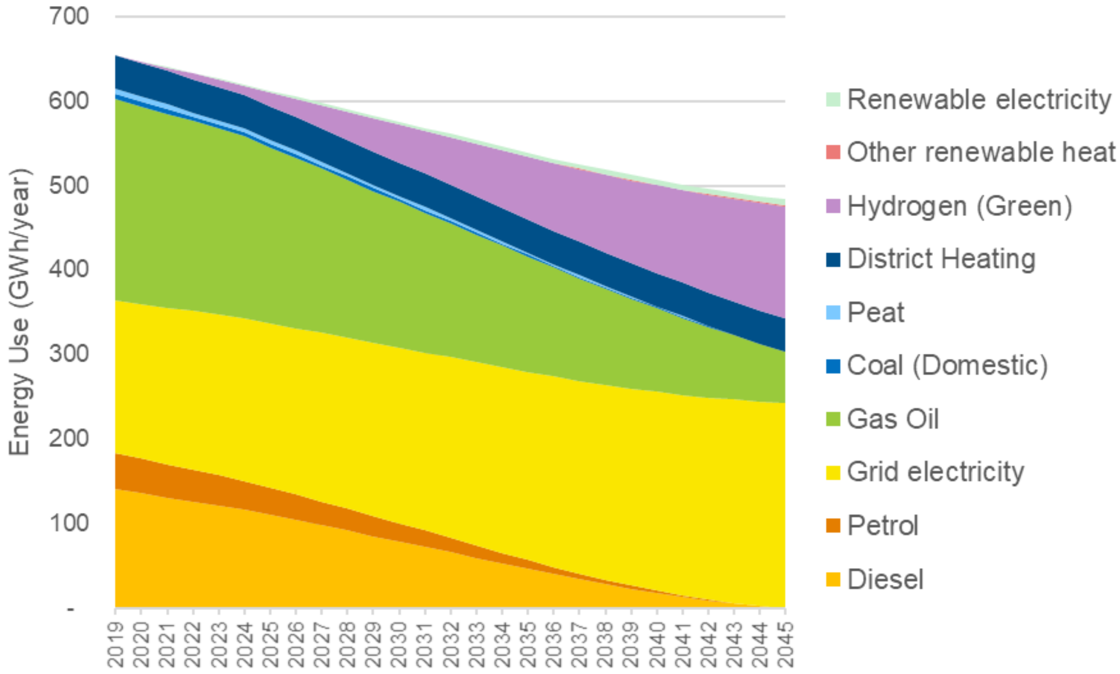
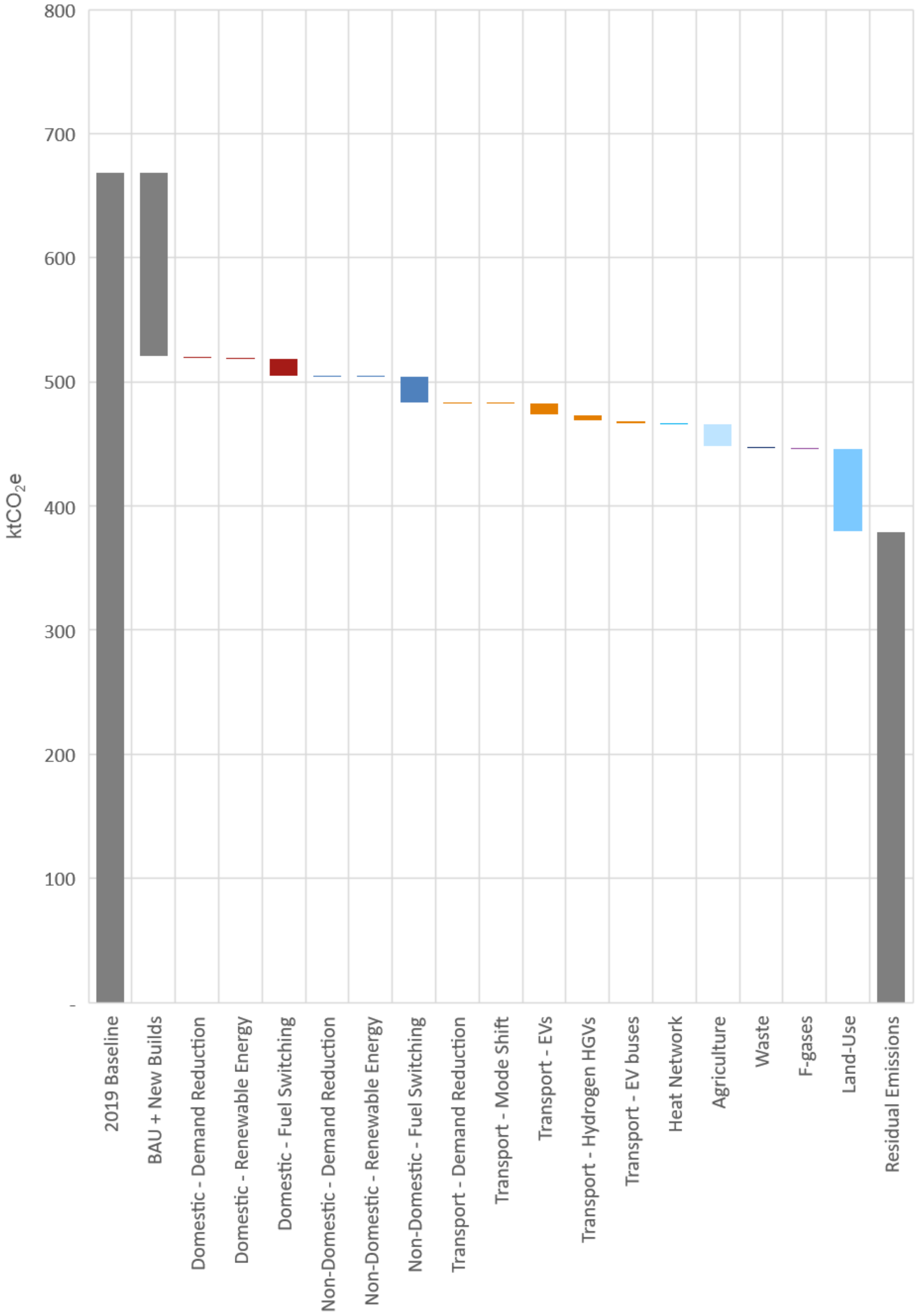


Figure 25 shows the impact of the mitigation measures for all Scope 1 & 2 emissions that have been modelled under Pathway A. The BAU changes without any additional mitigation measures result in a 22% decrease in emissions. In the domestic sector, the largest reduction can be observed for fuel switching, reducing total emissions by around 2%. This is also the case in the commercial, public, and industrial sectors which see the largest reductions (3%) through a shift to zero emission fuels. In the transport sector, the switch to EV cars and buses as well as hydrogen HGVs constitutes the major driver for decarbonising the sector by 2045. The remaining emissions in 2045 are primarily from agriculture, waste & wastewater treatment, LULUCF, and f-gases.

Figure 25. Emissions reduction by type of intervention measure under Pathway A (Scope 1 & 2)



As mentioned previously, the demand reduction measures across the domestic, commercial, public and transport sectors have a small impact, reducing emissions by around 2.3 $ktCO_2e$ (0.4%) by 2045.

However, in addition to reducing emissions directly, demand reduction also reduces the *indirect* emissions and other resource requirements (materials, minerals, land, water, labour, etc.) that are required to supply the energy. It also delivers wider co-benefits, such as improving energy security, reducing fuel bills, helping to alleviate fuel poverty, and mitigating other environmental impacts.

Why is it important to reduce energy demands if we are using 100% renewable energy?
Points to consider:

- **In some cases, demand reduction is a technological prerequisite for other mitigation measures.** For example, although heat pumps work in poorly insulated buildings, they operate at lower efficiencies, use more energy to keep the building at a comfortable temperature, and it will take the building longer to heat up. So, it is critical for heat pumps to be installed after or alongside energy efficiency measures. This is not only an issue of comfort, but also finances, as people will be less likely to switch to heat pumps before the gas boiler ban if this results in a substantial increase in their energy bills.
- Because it is likely that both cars and buildings will mostly utilise electricity, it is estimated that electricity demand could more than double nationally. It is therefore necessary to **reduce the strain on existing grid infrastructure**, which would require considerable reinforcement to expand capacity, likely resulting in higher energy costs. The electricity would also need to be supplied with renewables, such as large-scale wind and solar farms, which have implications for land use and landscape character, among other things.
- For activities where fossil fuels are not being replaced by electricity but some other alternative, in some cases it will be challenging or impossible to scale up unless demand reduces because of the **limited supply of other zero carbon fuels**. Examples include ‘green’ hydrogen (i.e., produced by electrolysis using renewable electricity) or ‘sustainable’ biomass (which in addition to issues of where it is sourced, would need to be accompanied by advances in carbon capture and storage technologies).

Scope 1, 2 and 3 emissions

The results presented above do not include emissions from aviation, ferries, harbour tugs, fishing vessels, SGP and SVT. If all of those Scope 3 emissions were included, emissions in 2019 would be approximately 1,073 $ktCO_2e$, decreasing to 640 $ktCO_2e$ in 2045, which is a 40% reduction. This is illustrated in Figures 3-7, 3-8 and 3-9, which replicate those shown previously, but this time include Scope 3 emissions.

Aside from the ‘step’ in emissions when the interconnector is completed, there is also a relatively steep decline in the mid to late 2030s which is associated with the presumed shift in zero emission marine vessels.

Figure 26. Scope 1, 2 & 3 emissions by sector under Pathway A

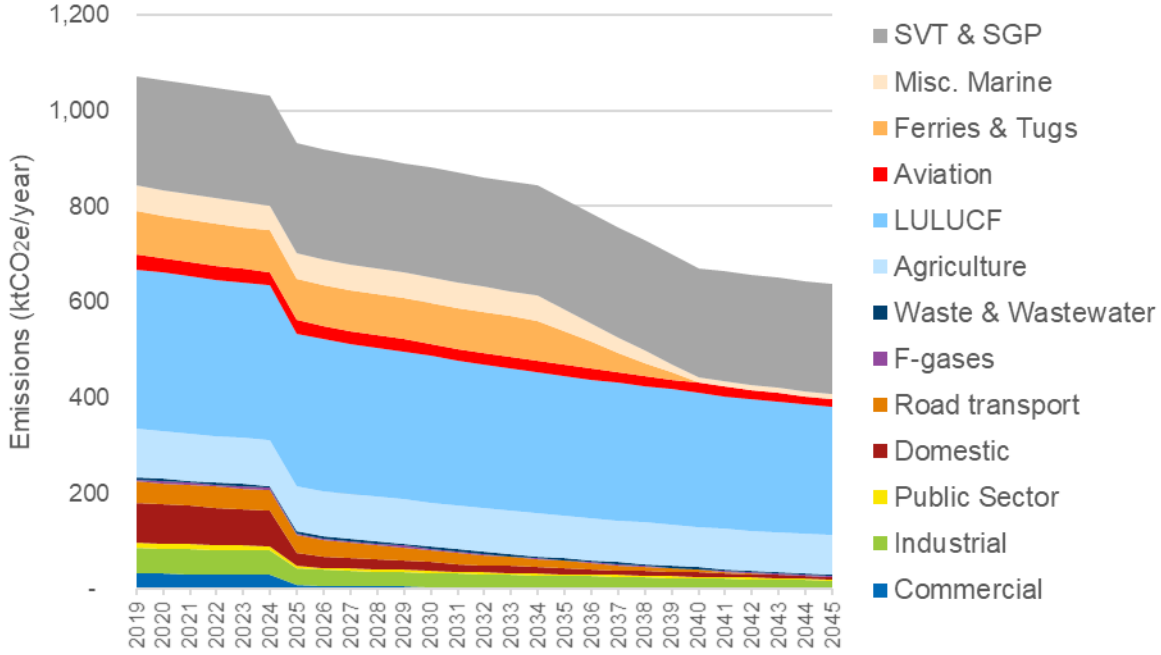
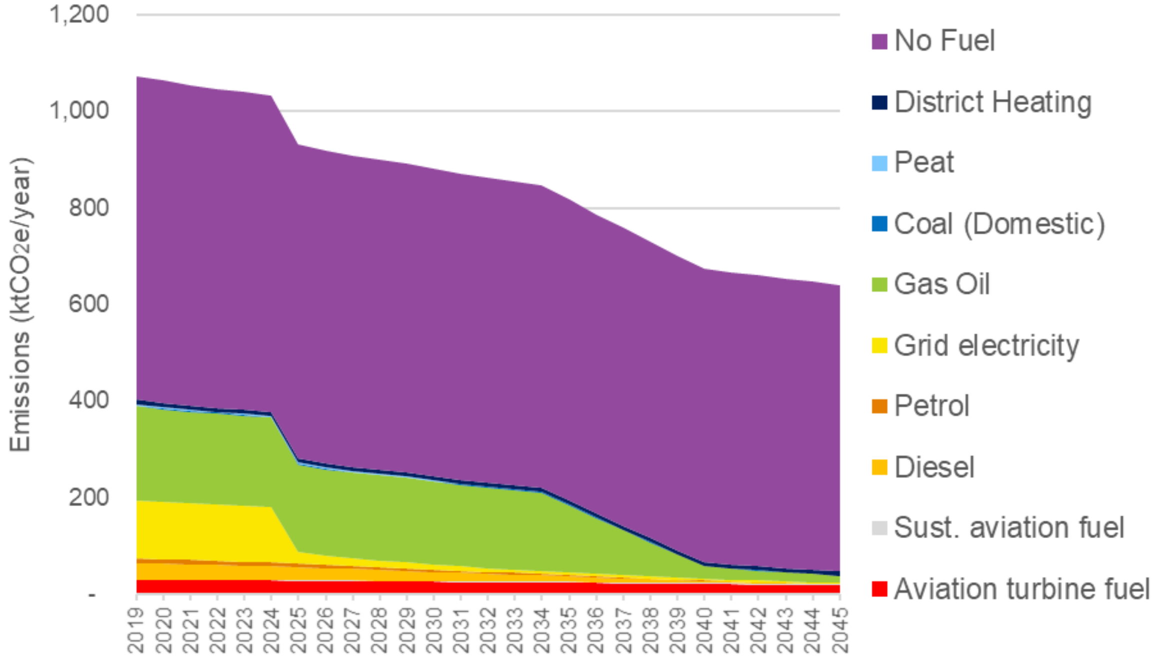


Figure 27. Scope 1, 2 & 3 emissions by fuel type under Pathway A



The key changes in Scope 3 emissions in Pathway A are as follows:

- **Aviation:** Pathway A assumes that 'sustainable aviation fuel' (SAF) is used with turbine fuel in a 50/50 mix. Since emissions from SAF are roughly 80% lower than turbine fuel, this results in a c. 40% reduction in emissions from aviation.[27]
- **Marine sector:** The changes in emissions in the marine sector are based on the assumptions and recommendations made in a separate report being produced by Ricardo EE as part of the Neptune Project (see Section 4.5.2 for more details).
- **SVT and SGP:** For the purpose of this study, no change in emissions from SVT or SGP have been modelled, although it is understood that separate decarbonisation strategies may be developed for those facilities.

Regarding these Scope 3 emissions, it is also worth considering how they would change in the context of an overall shift towards a zero carbon economy.

- **Aviation:** At the time of writing (June 2022) the UK Government has not proposed any policies to limit demand for aviation, but the CCC has indicated that a change in consumer behaviour or some form of restriction would be necessary for the UK as a whole to achieve net zero emissions by 2050.[28] In addition to impacting emissions from aviation, this would have knock-on effects on other sectors in Shetland, particularly tourism and hospitality, as it would affect travel to and from the archipelago.
- **SVT and SGP:** In order to meet the UK's commitments under the Paris Agreement, most if not all fossil fuel use globally would need to be phased out by 2050 at the latest, with radical reductions occurring in the short to medium term. If this were to happen, operations at these facilities would either cease, or they would undergo a significant change in use.
- **Marine sector:** In principle, changes in consumer preferences on fish consumption could impact marine sector emissions, causing them to increase or decrease.

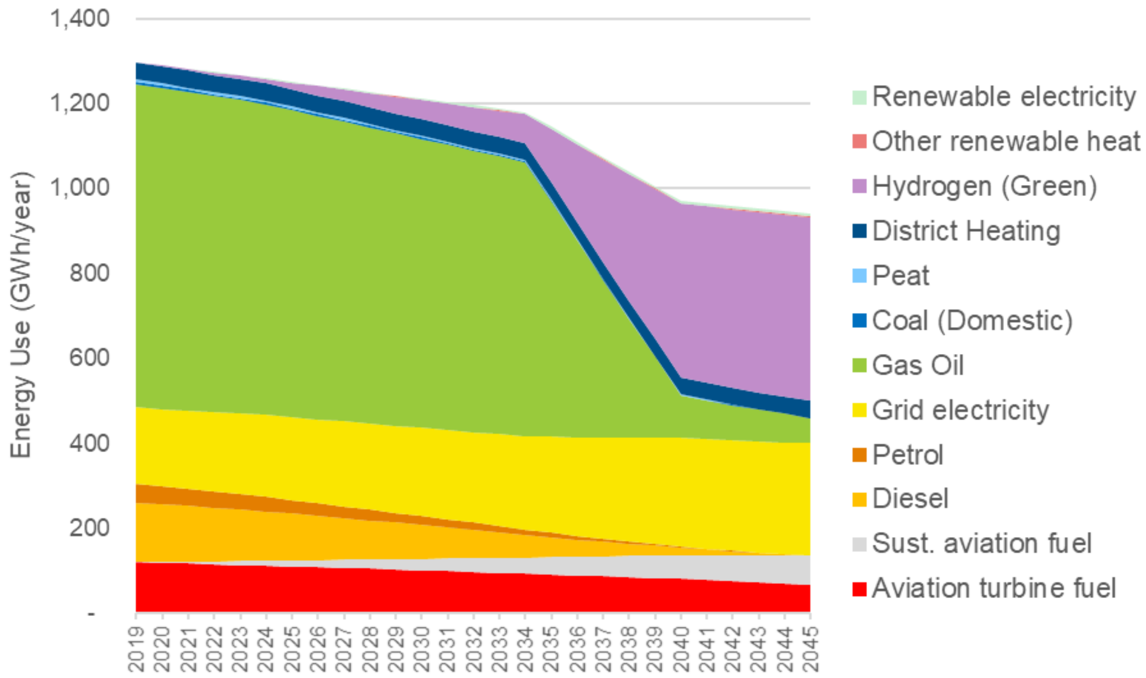
These factors would tend to reduce Scope 3 emissions from the assessed sources, even if no other mitigation measures were introduced. Although this would deliver benefits in terms of GHG reductions, it suggests that, alongside the mitigation measures described previously, **Shetland's future climate action planning should also include measures that will help the community, and local economy, adapt to the wider net zero transition**.

Figure 28 shows the associated changes in fuel consumption that would occur under Pathway A. The biggest differences are due to a shift towards SAF and electric or hydrogen marine vessels.

[27] In practice, the overall reduction for this sector could be higher if smaller planes switch to electricity or hybrid technologies, but data on different aircraft types was not available. Note that the 40% figure does not account for emissions from other sources, such as soot and water vapour.

[28] Compared with the Department for Transport's modelling, which suggests that there may be a 64% growth in airline passenger numbers by 2050, the CCC's net zero pathways allow for a maximum 50% increase in the 'Widespread Innovation scenario', while all other scenarios show either a 25% increase or a 15% reduction in demand. [Sector-summary-Aviation.pdf (theccc.org.uk)]

Figure 28. Energy use by fuel type under Pathway A (Scope 1, 2 & 3)



4.3.2 Pathway B

Pathway B asks: How far could we theoretically go if money were no obstacle?

4.3.2.1 Pathway intervention measures

An overview of the intervention measures modelled for Pathway B are set out in the table below.

Table 9. Pathway B - measures modelled

Category	Mitigation measures modelled

Transport	• Demand reduction measures are implemented to achieve a net 20% reduction in car kilometres compared with the baseline year (2019), which is assumed to *roughly* correspond with a 20% decrease in emissions (calculations account for the fact that walking and cycling will tend to displace shorter journeys)
	• 5% reduction in LGV/HGV fuel consumption due to technology improvements and route optimisation plus 5% reduction in emissions from 'eco driving' training
	• Fuel switching:
	  • Cars, vans and buses switch to EV, reaching 100% by 2045
	  • HGVs switch to hydrogen in 2030s, reaching 100% by 2045
	  • All aircraft to switch to H_2, battery/hybrid or SAF
	  • All marine vessels switch to alternative fuels in line with Neptune project recommendations

Energy system	• Connecting to UK mainland electricity grid in 2024/25 • Subsequent electricity grid decarbonisation taking place in line with BEIS projections (note, local large-scale renewables are assumed to contribute to this grid decarbonisation but have not been assessed separately)

Category	Mitigation measures modelled
	• Deployment of roof-mounted solar technologies on c. 40% of buildings (note, these technologies would supply some, but not all, of the electricity needs of those buildings; the modelling assumptions are based on a set amount of electricity being provided on-site but does not consider whether any remainder is exported or stored in batteries) • ERP achieves a roughly 85% reduction in emissions, which could potentially be achieved if it is fitted with CCS
Reuse, recycling and waste	• Reduce waste produced in Shetland by c. 20%, increase recycling rates and introduce AD or composting for biodegradable waste in line with NZCR • If additional waste is not imported, the shortfall is assumed to be met via high-temperature heat pumps • Assume that small-scale CCS becomes available in the timeframe between now and 2045 to reduce residual emissions from the ERP by 85% (in line with the NZCR '2040 ambitious pathway')
Business and Industry	• After implementing measures to address emissions from space heating and hot water, 100% of remaining fossil fuel demands switch to electricity, green hydrogen, or another zero-emission fuel source

Buildings	• Demand reduction:
	    • Smart meters to help enable behaviour change (but minimal impact assuming many people already implement some measures)
	    • Efficient lighting, water fittings and appliances
	    • Energy audits and other initiatives for businesses to reduce energy use
	    • Retrofit all buildings to highest possible EPC rating, achieving a c. 20% reduction in heat demand for domestic buildings and 10% reduction for non-domestic buildings, across the building stock as a whole[29]
	• Fuel switching:
	    • Phase out fossil fuel heating systems by 2045, replacing with electric (a combination of direct electric, storage, heat pumps, etc.) – note that this scenario assumes a higher proportion of heat pumps in order to reduce energy demands as much as possible
	    • Properties currently connected to the heat network remain on the heat network, which switches to using high-temperature heat pumps
	    • Switch 100% of fossil fuel cooking/catering equipment to electric by 2045

Agriculture and Land Use	• Assume target of 2,500 ha/year peatland restoration is not achieved, but roughly 1/3 of this amount is restored

[29] This is roughly equivalent to retrofitting all domestic buildings to an average EPC rating of B. For non-domestic buildings, evidence suggests that retrofitting building fabric and services to a high standard can result in a c. 25-30% reduction in energy use. However, a low number has intentionally used for the NZSR to reflect the lack of certainty as to the proportion of fuel that is used for space heating and hot water in non-domestic buildings in Shetland. This is to avoid overestimating the scale of improvement that can be achieved.

Category	Mitigation measures modelled
	• Assume a c. 31% reduction in non-fuel-related emissions from agriculture from low carbon farming and land management practices, in line with the Scottish Government target for the sector as a whole

4.3.2.2 Pathway mitigation potential

Scope 1 & 2 emissions

The following charts illustrate the mitigation potential of Pathway B. By 2045, the measures modelled in Pathway A could reduce Scope 1 & 2 emissions by roughly 65%, with residual emissions of 235 $ktCO_2e$.

Figure 29. Scope 1 & 2 emissions by sector under Pathway B

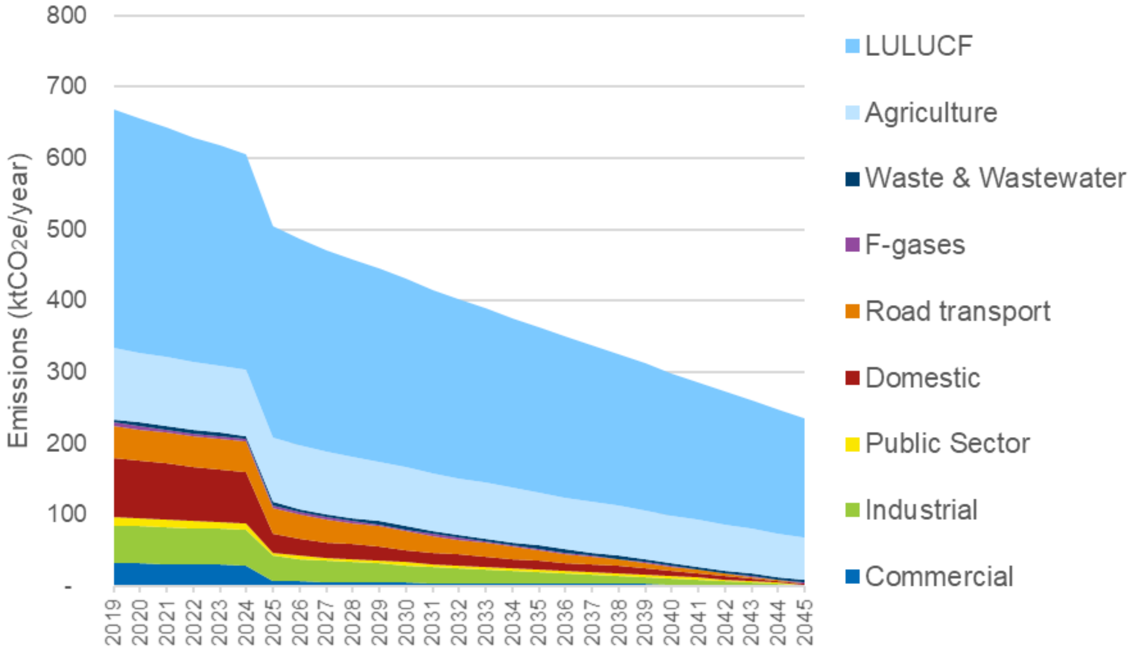
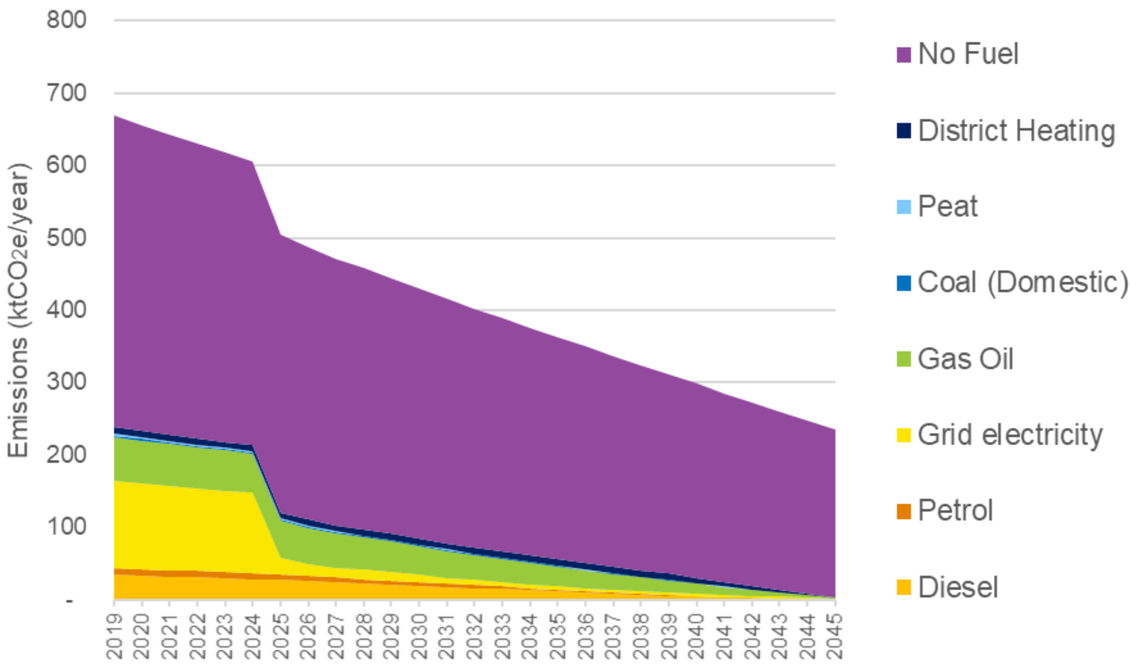


Figure 30. Scope 1 & 2 emissions by fuel type under Pathway B



Many of the key messages are the same as for Pathway A. The largest impact comes from peatland restoration, which reduces LULUCF emissions by around 50% equating to c. 25% of total Scope 1 & 2 emissions. This assumes that the target of restoring 2,500 ha of peatland per year is met. In Pathway B, the next largest impacts are from reducing non-CO_2 emissions from agriculture.

In terms of energy use, again, there is a steep drop-off in emissions around 2025 as a result of the HVDC transmission link to the UK energy grid. Pathway B has a higher level of demand reduction than Pathway A, with a 20% reduction in vehicle kilometres for cars, and more buildings retrofitted to a higher standard. In order to limit electricity demand as much as possible, Pathway B also includes a higher proportion of buildings switching to heat pumps as opposed to conventional electric heating systems. It assumes that nearly 100% of the remaining fossil fuels used in buildings and road transport can be displaced by decarbonised electricity or green hydrogen. Collectively, these measures would reduce energy-related emissions by roughly 98%.

Pathway B includes more ambitious changes in terms of waste, both the amount that is produced and how it is handled. In particular, it assumes that there will be a 20% decrease in the amount of waste that is generated, with a higher proportion also being recycled, composted, or sent to an anaerobic digestion facility (AD). (The Scottish Government is planning to ban any biodegradable municipal waste being sent to landfill by from 2025.[30]) CCS would then be fitted to the ERP to prevent any emissions from the small amount of residual waste that is incinerated. Alongside this, the heat network in Lerwick would switch over to electrically powered heat pumps.

As mentioned previously, it is important to note that some of these measures are based on targets or aspirations and are not yet backed up by specific policy proposals, alternative technologies, or behaviour change measures. This particularly applies to:

- Reducing demand for private transport – a Transport Strategy is being prepared by SIC that will consider options in more detail.
- Reducing non-CO_2 emissions from agriculture – discussions with local stakeholders indicated that further consultation and evidence will be needed to identify specific measures.
- Phasing out the use of fossil fuels in industry – at this stage there is insufficient data on which to base recommendations.
- CCS for the ERP – carbon capture at the scale required for the ERP is not a mature technology though there are pilot sites at this scale. Discussions with the heat network operators suggest that this is of interest and potentially the Shetland ERP could be used as another pilot site.

However, even with all these measures in place, net zero is not achieved by 2045, primarily due to hard-to-abate emissions in the agriculture and LULUCF sectors. Unlike CCS that could be fitted to the ERP exhaust, these emissions are highly dispersed, which means that unless they can be avoided entirely, they would need to be addressed through some form of carbon removal or offsetting elsewhere, such as direct air carbon capture and storage (DACCS). **This analysis indicates that the scale of improvement that could be achieved through local measures is not likely to be enough to reduce total Scope 1 & 2 emissions to net zero.**

Figure 31 and

Figure 32 provide a closer look at Scope 1 & 2 emissions *from energy use only*. By 2045, the energy-related emissions realise a 98% reduction, with c. 4 ktCO_2e remaining in 2045. Unlike Pathway A, which was modelled under the constraints of not knowing some of the fossil fuels that are used in commercial, industrial, and agriculture sectors and what for, Pathway B assumes that these can be switched to a zero-emission source.

[30] Biodegradable municipal waste landfill ban | Scottish Environment Protection Agency (SEPA)

Figure 32 shows the associated change in fuel consumption between 2019 and 2045. Akin to Pathway A, the reduction is driven by increased energy efficiency from EVs and heat pumps, and – to a lesser extent – demand reduction from retrofitting measures and a switch to active travel and/or public transport. By 2045, almost all energy comes from a zero-emission source, such as renewable electricity, green hydrogen, or the decarbonised heat network. Compared to Pathway A, this pathway assumes an overall lower energy demand in the target year, which is mainly driven by the removal of fossil fuels from the energy mix and lower electricity demand. However, the consumption of green hydrogen is assumed to be higher than under Pathway A, as this is assumed to displace a higher proportion of fossil fuel use in industry and agriculture.

Figure 31. Emissions from energy use by sector under Pathway B (Scope 1 & 2)

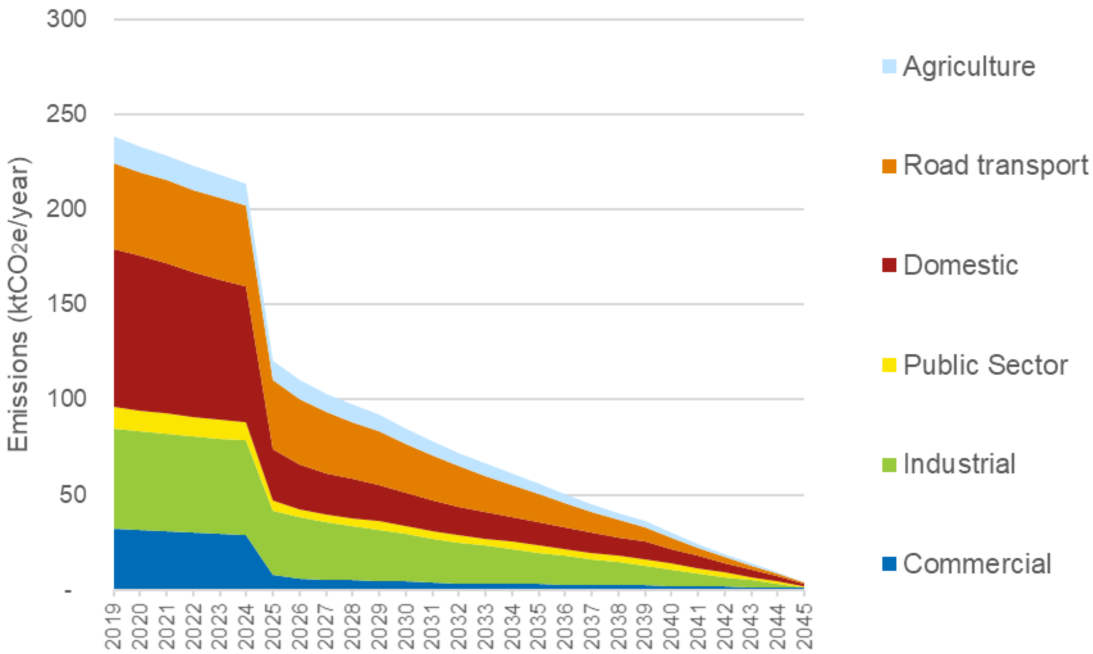
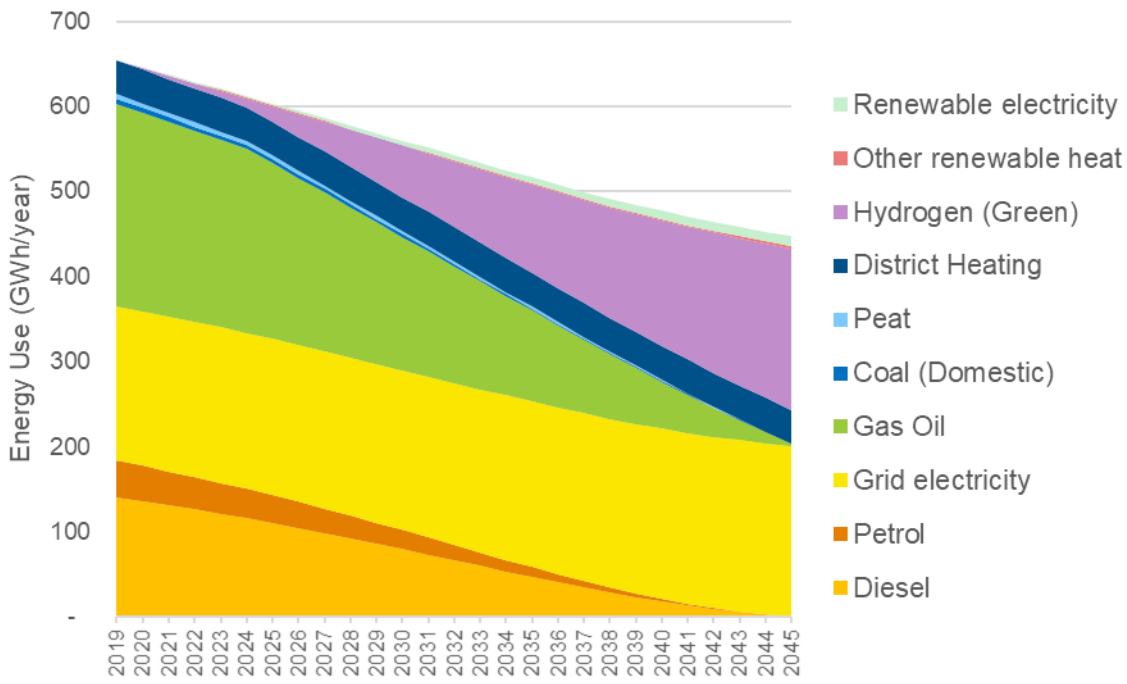


Figure 32. Energy use by fuel type under Pathway B (Scope 1 & 2)



The main differences between fuel consumption in 2045 when comparing Pathways A and B are:

- Gas oil and coal, which are still somewhat in use in Pathway A, are displaced with green hydrogen, so more green hydrogen will be needed to meet this demand.
- Grid electricity demands decrease because of reductions in car kilometres, more retrofitting in buildings, and greater adoption of heat pumps.
- The amount of fuel needed for the heat network decreases, both because of the switch to heat pumps and energy efficiency improvements in buildings.
- There is a slightly higher contribution from small-scale solar technologies, either PV or solar thermal (labelled as 'other renewable heat'), although this still only accounts for a small portion of the total.

The final mix of energy sources is highly sensitive to assumptions about uptake of heat pumps, how much fuel use in agriculture and industry shifts to grid electricity versus green hydrogen, and (to a lesser extent) demand reduction. This is explored in more detail in Section 4.5.2, but the key take-home point is that these variables alone could result in electricity demand being relatively stable, or increasing by up to 75-80%.[31]

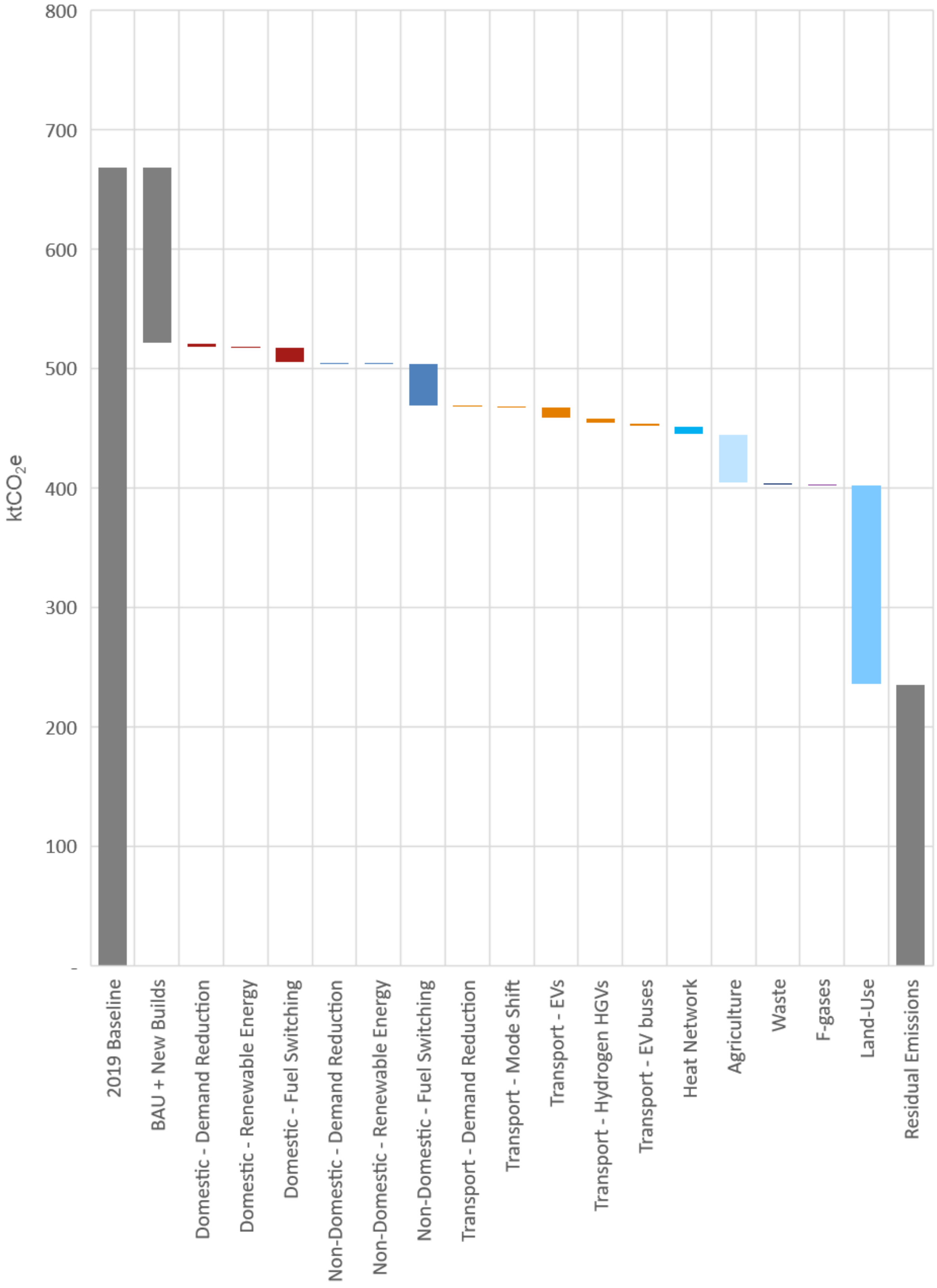
Figure 33 shows the impact of the mitigation measures modelled under Pathway B. The key differences, as discussed above, are:

- More energy demand reduction, particularly in buildings and road transport
- Phasing out most fossil fuels
- Bigger improvements in the agriculture and LULUCF sectors

These results reinforce the message that fuel switching, grid decarbonisation, and peatland restoration (accompanied by wider changes in land use and agricultural practices) will deliver the biggest reductions in Scope 1 & 2 GHG emissions in Shetland.

[31] This calculation does not consider the additional electricity that would be needed to produce green hydrogen in the first place. It only refers to energy use in road transport and stationary (land-based) buildings and facilities.

Figure 33. Emissions reduction by type of intervention measure under Pathway B



Scope 1, 2 and 3 emissions

The results presented above do not include emissions from aviation, ferries, harbour tugs, fishing vessels, SGP and SVT. If all of those Scope 3 emissions were included, emissions in 2019 would be approximately 1,073 $ktCO_2e$, decreasing to 496 $ktCO_2e$ in 2045, which is a 54% reduction. This is illustrated in Figures 33, 34 and 35, which replicate those shown previously, but this time include Scope 3 emissions.

Figure 34. Scope 1, 2 & 3 emissions by sector under Pathway B

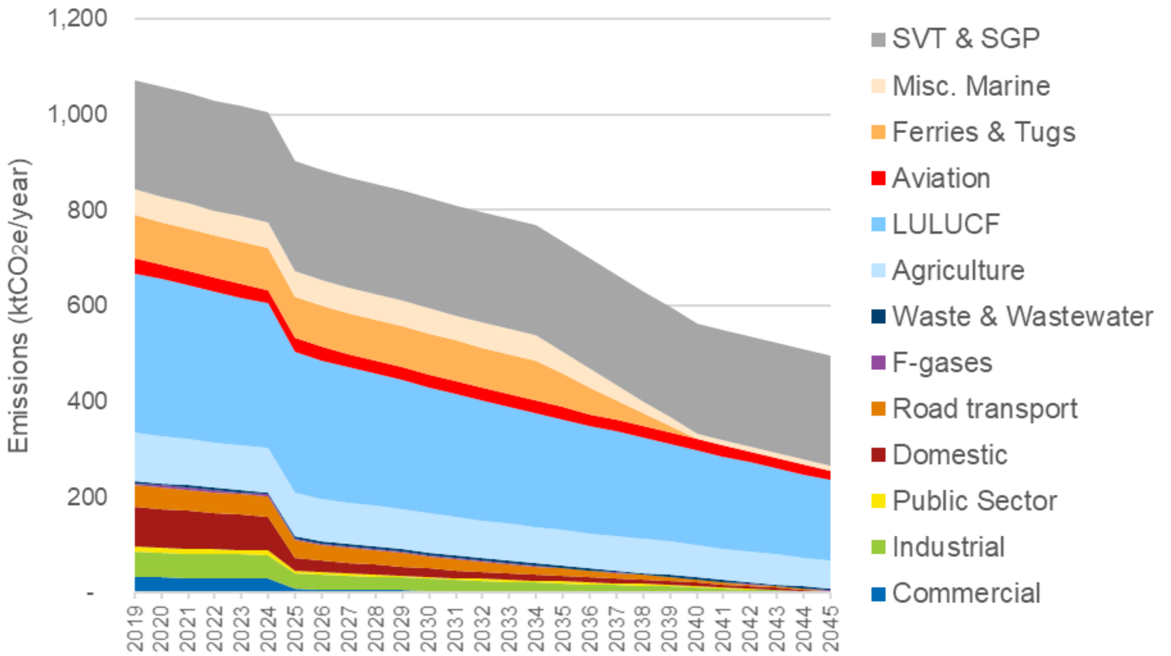


Figure 35. Scope 1, 2 & 3 emissions by fuel type under Pathway B

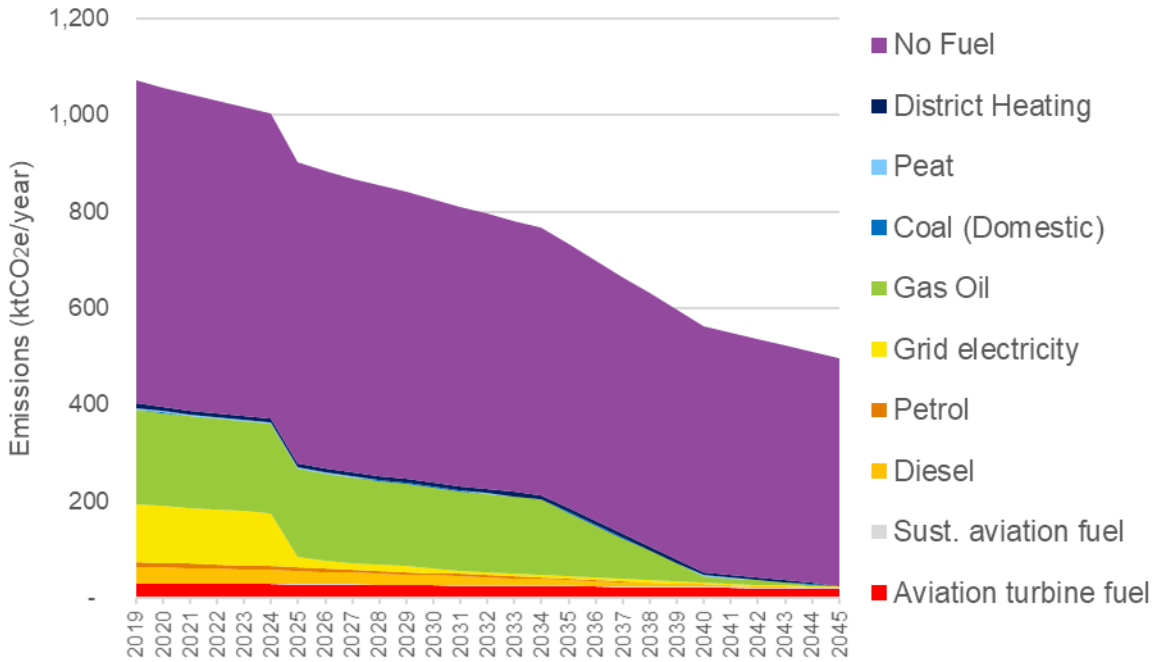
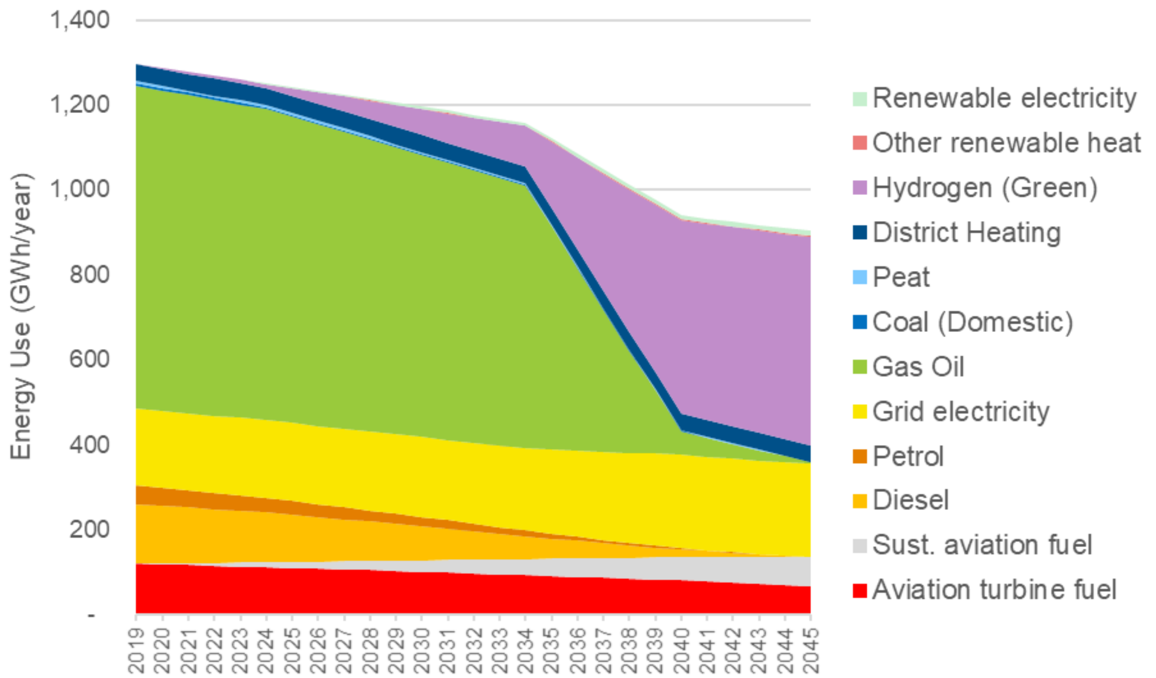


Figure 36. Energy use by fuel type under Pathway B (Scope 1, 2 & 3)



The key changes in Scope 1 & 2 emissions are described above. The key changes in Scope 3 emissions in Pathway B are the same as those described in Section 4.3.1.2 and have therefore not been restated.

4.3.3 Sensitivity testing: Electricity demand

The modelling results are highly sensitive to assumptions that impact the amount of energy consumed as well as the exact energy mix, specifically:

- Assumptions about whether industrial, commercial, and agricultural fossil fuels are switched to electricity or green hydrogen
- Assumptions about whether fossil fuel heating systems switch to heat pumps or whether they use regular electric heating, with the latter having a much lower efficiency
- Assumptions about demand reduction measures, such as active travel and retrofitting

This is important for several reasons, with the key ones being (a) implications for planning infrastructure upgrades and energy supply and (b) if the UK electricity grid does not decarbonise as fast as the Government hopes, then residual emissions in 2045 will depend much more on how much electricity is being used, which could potentially jeopardise the aim of energy use in Shetland being fully net zero.

To analyse the sensitivity of these assumptions, eight additional scenarios were modelled to assess the differences in energy demand by 2045, depending on the measures selected (see Table 10).

Table 10. Scenarios employed for sensitivity testing

Scenario	Pathway	Modifications to main pathway
A1	Pathway A	Fossil fuels in agriculture switch to electricity
A2	Pathway A	Fossil fuels in agriculture switch to green hydrogen
B1	Pathway B	Fossil fuels in agriculture switch to electricity
B2	Pathway B	Fossil fuels in agriculture switch to green hydrogen
B3	Pathway B	No demand reduction, fossil fuels in agriculture switch to electricity
B4	Pathway B	No demand reduction, fossil fuels in agriculture switch to green hydrogen

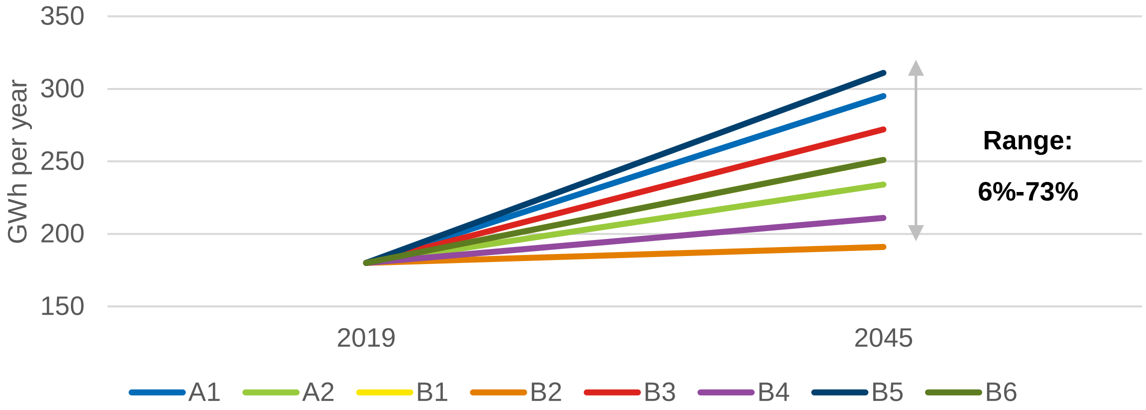
B5	Pathway B	No heat pumps, fossil fuels in agriculture switch to electricity
B6	Pathway B	No heat pumps, fossil fuels in agriculture switch to green hydrogen

It should be noted that the variables do not change the overall *emissions*, as both electricity and green hydrogen are assumed to be zero-emission fuels by 2045; however, the different assumptions would notably change the fuel consumption (see Figure 24 and

Figure 32).

The figure below illustrates the changes in electricity use between 2019 and 2045. *Note that the assumptions for B1 and B6 are very similar so B1 appears hidden in the graph.*

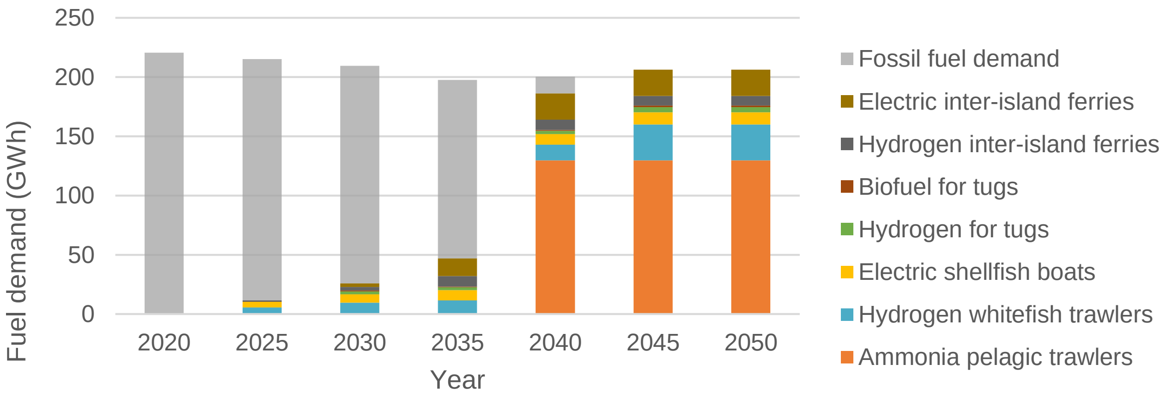
Figure 37. Sensitivity testing: Changes in electricity use (land-based activities only)



These results do not account for the substantial amount of additional electricity which would be required to create green hydrogen in the first place. They also only focus on electricity demand for land-based activities, i.e. they exclude the potential impacts of a shift to zero emission marine vessels or aircraft. The impacts of hybrid or electric aircraft have not been quantified as part of this study, but the chart below (which replicates the findings from the Neptune project) illustrates the changes that could occur due to the planned decarbonisation of marine vessels.

Key take-home point: Compared with 2019 levels, electricity demand for land-based activities could increase by anywhere from 6% to 73% between 2019 and 2045. The range would be much higher if accounting for the additional energy needed to produce green hydrogen.

Figure 38. Maritime sector fuel decarbonisation transition timeline. ***(Source: Neptune project analysis)***



Although not shown on the graphs, another major variable is what fuel the mainland ferries ultimately use, and (crucially) where they refuel. The outcome of that transition could add hundreds of GWh per year of additional green hydrogen, ammonia or electricity demand.

4.4 Indicative resource costs

4.4.1 Overview

This section presents a rough assessment of the resource costs of the proposed mitigation measures described above, *where sufficient data was available to support an estimate.*

Market research and case study evidence show that there is considerable variation in the costs of these measures even today. Bearing in mind the limited scope of this project and very high level of uncertainty in predicting the costs of climate mitigation measures years and decades into the future, the costs presented in this report are solely intended to indicate the order of magnitude of investment that may be required.

The calculations consider intervention measures taking place within Shetland, but do not include the costs of wider enabling measures that would also be needed. Examples include, but are not limited to:

- Upgrading the wider electricity grid network to support grid decarbonisation,
- Changes to the physical road network to facilitate a shift away from the use of private vehicles
- Any initiatives/campaigns that would be needed in order to promote or administer the measures.

These figures should be interpreted with great caution given the levels of uncertainty involved. Further work would be needed to validate these findings and to get more detailed and robust estimates. Also note that some of the measures could have impacts on Shetland's economy overall but those effects have not been quantified as part of this study.

4.4.2 Approach to estimating costs

Broadly speaking, the assessment considers the typical unit costs of each measure (e.g. price of a typical whole-house energy efficiency retrofit) and the number of units that are required (e.g. number of homes). The latter is based on outputs from the NZP tool and data collected as part of the baseline assessment, so the results align with the other modelling assumptions used in this report.

The table below summarises key assumptions about the cost of different measures and (where relevant) the uplift that was applied to reflect circumstances in Shetland. Note that the price year varies depending on the reference/source of information.

Table 11. Typical resource costs for selected measures

Cost assumptions	Pathway A	Pathway B	Uplift	Units	Ref.
Domestic retrofitting costs	£20,500	£35,000	30%	£/dwelling	1,2
Cost of domestic electric cooker	£500	£500	10%	£/unit	3
Cost of PV	£1,635	£1,635	30%	£/kWp	4,5
Cost of battery (to accompany solar PV)	£4,500	£4,500	0%	£/unit	5
Cost of LED lights per household	£300	£300	0%	£/dwelling	5,6
Cost of ASHP	£14,000	£14,000	0%	£/dwelling	5
Cost of hydrogen boiler (excl. H_2 storage and connection)	£3,000	£3,000	10%	£/dwelling	3
Cost of DEH	£5,000	£5,000	10%	£/dwelling	3
District heating ext. connection average	£7,500	£7,500	0%	£/connection	5
Non-domestic retrofitting (incl. LEDs and heating replacement)	£300	£375	30%	£/m2	1
Commercial electric cooker	£7,000	£7,000	10%	£/unit	3
Cost of PV (array size: 10-50 kWp)	£1,000	£1,000	30%	£/kWp	4
Average cost of EV car	£25,000	£25,000	0%	£/vehicle	3
Average cost of EV van	£30,000	£30,000	0%	£/vehicle	3

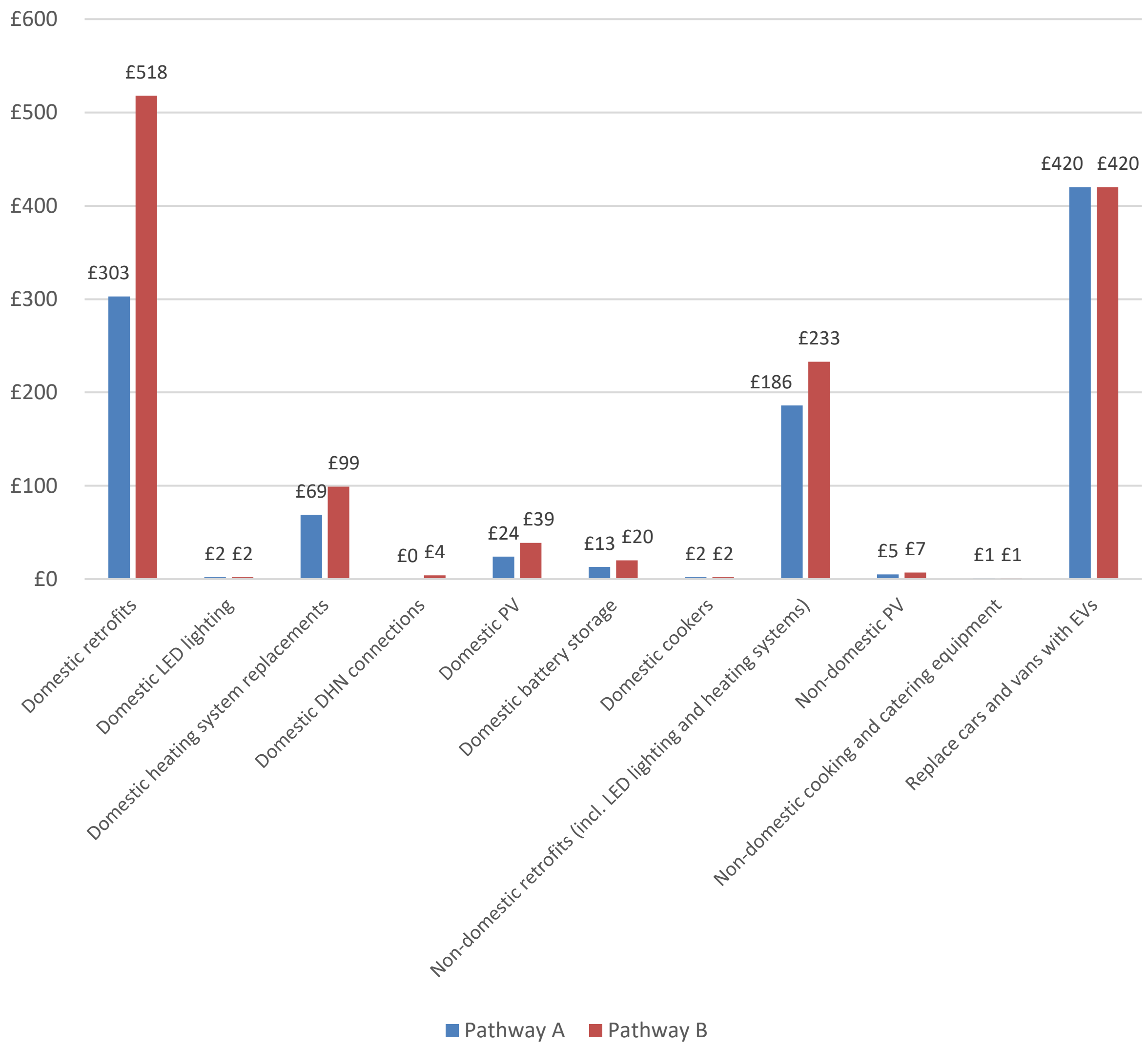
References

1. Committee on Climate Change, *'Costs and benefits of tighter standards for new buildings'* (2019)
2. Green Alliance, *'Reinventing Retrofit: How to scale up home energy efficiency in the UK'* (2019)
3. Ricardo market research
4. UK Government, *'Solar PV Cost Data'* (2021)
5. Information provided by SIC (note, because these costs are based on prices in Shetland, no uplift has been applied)
6. Terry et. al. *'Further Analysis of the Household Electricity Survey'* (2013)

4.4.3 Results

Results are shown in the chart below.

Figure 39. Indicative capital cost of key measures (£ million) – *refer to Table 11 for the price year*



These results indicate that the most significant costs (among those assessed) are associated with upgrading the building stock and replacing the vehicle fleet. As a very rough estimate, the scale of investment in the building stock – to upgrade the building fabric and replace fossil fuel heating systems – is estimated to be in the region of £360-600 million for domestic buildings and around £190-230 million for non-domestic buildings. Although energy efficiency upgrades and a switch to heat pumps would reduce energy demands from the building stock, the savings in energy bills will not be proportionate because of differences in the cost of energy, which are highly uncertain.

Replacing lighting with LEDs, and replacing non-electric cooking and catering equipment with electric models, is relatively low in cost, and the extra-over costs would be minimal if these systems are purchased as part of natural replacement cycles.

PV offers direct cost savings for building occupants and the payback period is considerably lower when electricity bills are high, with most systems paying for themselves within a few years. The chart above assumes that all domestic properties that have PV also receive home battery storage, although that would be optional if the property is connected to the electricity grid which would enable it to export surplus power.

The cost to replace existing cars, vans and HGVs with zero-emission alternatives is in the region of £400-500 million. It is worth noting that, given the increasing trend towards EVs and the Government's plans to ban the sale of new combustion engines within the next decade, the extra-over costs of switching to EVs are likely to be minimal even though the total costs are relatively high.

The cost of EV charging infrastructure to support the transition to a zero emission vehicle fleet would comprise a significant additional cost but is not reported in these totals. As shown in the table below, the cost of chargers varies widely depending on the type/speed of charger that is used. To obtain an accurate estimate of cost would require more detailed analysis of charging behaviour of different users and vehicle types, which is out of the scope of this project.

Table 12. Indicative costs of EV chargepoints

Type	Description	Indicative cost (£)
Domestic	Up to 7 kW	£500-1,000
Public – Standard	7 kW	£10,000
Public - Fast	22 kW	£13,000
Public - Rapid	43 kW	£34,000

Through discussions with SIC and local stakeholders, it is understood that the cost of peatland restoration in Shetland varies from around £3,000-5,000 per hectare. As a rough estimate, assuming that the ambition of restoring 2,500 hectares per year is met, this would equate to an investment of around £7.5 million to £12.5 million per year.

The calculations consider intervention measures taking place within Shetland, but do not include the costs of wider enabling measures that would also be needed. Examples include, but are not limited to:

- Upgrading the wider electricity grid network to support grid decarbonisation,
- Changes to the physical road network to facilitate a shift away from the use of private vehicles
- Any initiatives/campaigns that would be needed in order to promote or administer the measures.

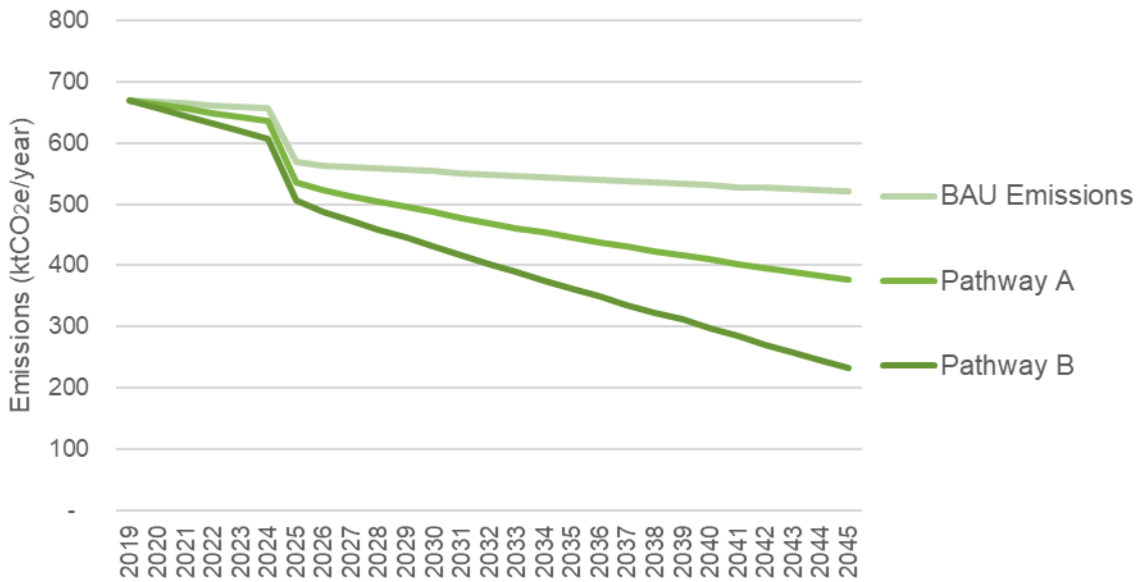
These figures should be interpreted with great caution given the levels of uncertainty involved. Further work would be needed to validate these findings and to get more detailed and robust estimates. Also note that some of the measures could have impacts on Shetland's economy overall but those effects have not been quantified as part of this study.

4.5 Summary of outcomes

4.5.1 Headline results

The figure below shows the emissions trajectory for all pathways modelled. The analysis demonstrates that Pathways A and B both ultimately lead to a reduction in area-wide emission by 2045 that is significantly greater than the projected 20-25% under the BAU scenario, but neither one is sufficient to achieve net zero emissions without some form of additional GHG removals.

Figure 40. Comparison of pathways modelled



4.5.2 Key messages

- Electrification of buildings and transport, and connection to the mainland electricity grid, will have a very important role to play in reducing emissions from energy use in Shetland. These could feasibly be reduced to net zero by 2045 if all fossil fuels are replaced with zero-emission alternatives, such as decarbonised electricity or green hydrogen.
- However, a significant portion of emissions are associated with sectors that are difficult to electrify (e.g. aviation, marine vessels, etc.) or are not associated with energy use at all (e.g. land use and agriculture). At present it is not clear whether there will be technologies available by 2045 that can mitigate these sources of emissions.
- It is therefore likely to be difficult or impossible for area-wide emissions in Shetland to get to net zero by 2045 based on available technologies and realistic mitigation measures, barring a systemic overhaul of the economy, land uses, consumer habits and social engagement.
- Some of Shetland's key industries include oil and gas, agriculture, fishing / aquaculture, and tourism. There is also significant reliance on aviation and marine transport. These sectors will be particularly affected by the transition to a zero carbon global economy, which may reduce emissions regardless of whether any local mitigation measures are adopted. However, this will also have major implications for the local community and economy.
- With that in mind, some of the most important recommendations arising from this study are:

    1) Maintain high levels of ambition while focusing on measures that can definitely be adopted by 2045;

2) At the same time, plan ahead to take advantage of new technologies or solutions that may become available in future years; and

3) Work with the local community and businesses to ensure that the economy and society are prepared for the wider-scale changes that will take place as the UK and the world transition to a net zero future.

- In some crucial respects, these three points are more important than the headline percent (%) GHG emissions reductions arising from mitigation measures in Shetland.
- Although climate adaptation is outside the scope of this routemap, all of the GHG mitigation measures and other actions will also need to consider ways to make Shetland more resilient to the now-inevitable impacts of climate change.
- With that said, this study has identified a variety of GHG mitigation measures that can deliver important economic, social and environmental benefits beyond GHG emissions. Some of the major opportunities include:
  - Peatland restoration – *this is the single most impactful mitigation measure for Shetland*
  - Improving standards of living and lowering fuel bills by retrofitting buildings and ensuring that everyone has access to affordable, low carbon heating and energy
  - Leading the way on sustainable agricultural practices and paludiculture
  - Contributing towards the decarbonisation of the wider UK energy system via large-scale renewable energy technologies and storage systems
  - Becoming a hub of innovation for technologies such as green hydrogen, CCS and tidal power, which could include a micro-CCS pilot project at the Lerwick ERP
- It is important to acknowledge the risks of a ‘high electrification’ strategy for decarbonising Shetland’s energy supply. If the national grid does not decarbonise as fast as the Government hopes, then residual emissions will be higher. This would need to be addressed through additional measures to further limit demand for transport and energy use in buildings.
- Other notable findings:
  - Reaching net zero emissions from energy use will rely on being able to identify and adopt zero-emission technologies to displace all fossil fuels, including those used in business and industry, for which there is currently limited data.
  - In terms of future energy demand, this study has assumed that most fossil fuels switch to electricity or green hydrogen. There is a very large range of potential future outcomes, which has major implications when planning for future infrastructure upgrades and energy supply.
- Finally, it is worth noting that there may be significant emissions from other marine sector activities that are controlled by stakeholders based in Shetland (particularly aquaculture) that have not been assessed. However, there may also be opportunities to promote ‘blue carbon’ sequestration in the form of projects such as kelp farming. This is an emerging field of study that would merit more detailed analysis.

4.5.3 Tackling residual emissions

The emissions profile in Shetland makes it unlikely that net zero can be achieved by 2045 without some form of additional carbon offsetting or removals. Our analysis suggests that, although land use changes and peatland restoration present the biggest opportunities to reduce emissions, these will not be sufficient to achieve net zero overall. It is likely that achieving net zero Scope 1 & 2 emissions would therefore rely on some form of carbon offsetting outside of Shetland (which is not recommended as the resources would be better spent on local projects), and/or the use of carbon removal technology.

According to a report published in 2020 by the CCC:[32]

> *'Options for GHG removals include bioenergy with carbon capture and storage (BECCS), Direct Air Capture of CO_2 with storage (DACCS) and wood in construction. BECCS and DACCS involve long-term geological storage of captured CO_2, whereas wood in construction involves a decades/centuries-long temporary store of biogenic CO_2 in the buildings stock.'*

Whereas for most locations CCS is not expected to become available in the short to medium term, Shetland is in a unique position – literally and figuratively – to become an innovation hub. For example:

- Its North Sea location is in proximity to suitable storage geologies
- There is an opportunity to reuse existing gas and oil infrastructure both on and offshore
- There is likely to be a large amount of renewable electricity generation in and around Shetland, and therefore a source of renewable power for CCS facilities
- As mentioned previously, there may be an opportunity for the ERP or other sites within Shetland to host pilot projects for small- or micro-scale CCS technologies.

This is already an opportunity that is already being pursued as part of the ORION project,[33] but the pathways analysis shows that CCS will also be key for Shetland to reach net zero emissions. There would also be major wider benefits, to the UK and globally, if there are technological advances in these technologies.

[32] Sector-summary-GHG-removals.pdf (theccc.org.uk)

[33] Bids invited for two carbon storage areas off Shetland | Shetland News (shetnews.co.uk)

5 Implementation

5.1 Factors to consider

Whilst a detailed action plan is outside the scope of this routemap, it is important to identify how the Council, along with the local community and businesses, can begin to drive towards net zero by outlining the key aspects of an implementation plan and highlighting some of the most important next steps.

The pathways detailed in this report are indicative of how emissions in Shetland can be reduced using available technologies, but in reality, there are many variations to these pathways that could achieve the same outcomes by 2045. It must also be reiterated that the Council cannot at this stage commit to the decarbonisation measures and technologies modelled in this study, as further detailed feasibility work and technology development is required. The Council must monitor technology developments, engage suppliers to determine financial and technical suitability, and only then adopt the appropriate technologies.

An area-wide net zero implementation plan, therefore, should be an evolving document that identifies where the key decision points are, and what information, further feasibility studies and enabling measures need to be implemented ahead of those decisions points in order for the Council and other stakeholders to make informed decisions.

Table 13. Summary of key considerations for an area-wide net zero implementation plan

Consideration	Comment
Local data collection	Achieving net zero will require stakeholders and decision-makers to have an accurate understanding of existing sources of emissions, both to identify suitable mitigation measures and to track progress over time. In order to make like-with-like comparisons against other Local Authorities, SIC can refer to statistics on fuel consumption and GHG emissions that are published annually by BEIS. However, in a unique context like Shetland, the nationally standardised calculation approach may not provide the most detailed or accurate picture. This study has assessed several alternative data sources that could be used to supplement the BEIS statistics, the pros and cons of which are set out in a separate report. Going forward, it is recommended that SIC should gather more data on energy use in Shetland. Previous studies have assessed energy ***sources***; future data collection should also consider energy end ***users*** and end ***uses***, with a particular focus on non-domestic sectors. Another key area where more data collection would be valuable relates to land cover, and in particular, the condition of peatland. It is understood that work on this topic is already under consideration; this should be prioritised.
Progress monitoring	Due to the relative lack of data on energy end uses within non-domestic sectors, at this stage it would be difficult to set interim GHG emission targets for Shetland as a whole. SIC should monitor progress using available energy and GHG emissions datasets, either using those published by BEIS or using local data (see above). For some sectors or sub-sectors, such as road transport or social housing, there is relatively more certainty about the measures or technologies that can be adopted, and it may be appropriate to set sector-specific decarbonisation targets, i.e. in the Transport Plan. Where specific decarbonisation measures or policies are implemented, these should be designed to include relevant data collection mechanisms and KPIs to

Consideration	Comment
	facilitate *quantitative* progress monitoring. This will enable the Council to continually feed lessons learned back into their net zero implementation process.
Technology readiness	This study has calculated potential decarbonisation trajectories over 20 years into the future. Over that 20-year period, there are expected to be significant advances in low carbon technologies in all sectors. It is crucial that the Council remains abreast of technology developments or other new research relevant to key emissions sources in Shetland. This is particularly relevant for agriculture, waste management, marine vessels, and aviation.
Pilot projects	As more low-carbon technologies become commercially available, it is important that these technologies are trialled to demonstrate that they are suitable for use in Shetland. As well as helping to demonstrate technology compatibility, pilot projects will help to de-risk capital investment and identify considerations for full scale roll out. Particular examples could include, but are not limited to: Heat pump installations, EV car clubs or bike hire schemes, and green hydrogen heat networks. SIC should also remain engaged with pilot programmes being run by other Councils or comparable areas, e.g. the CXC Carbon Neutral Islands Project, to share lessons learned and best practice.
Feasibility studies	The measures outlined in this report require further technical and financial feasibility studies to fully scope and cost measures into projects. Feasibility studies must also focus on other non-technical considerations, such as disruption to service and decanting of building occupants as an example.
Funding	Significant capital investment is required by the Council to achieve net zero under all scenarios. As such, the Council should seek to capitalise on sources of central government decarbonisation funding. Some funding examples are provided in the NZCR; refer to that report for further information. This is an area subject to considerable change (see, for example, the funding initiatives announced in the Scottish Government's Climate Change Plan Update) so it will be important for SIC to keep abreast of developments.
Engagement with other Councils	For a Scotland-wide transition to net zero, it is crucial that local authorities engage and share any lessons learned. The Shetland Islands have some unique challenges with respect to service delivery due the geographical constraints of the islands, however there will be valuable lessons for the Council to learn from projects that other local authorities are running.

In addition to Table 13, there are some more specific implementation considerations for each emissions source or topic area.

Table 14. Considerations per emissions source or topic area

Topic area	Key considerations
Road transport	The Scottish Government has announced a target of achieving a 20% reduction in vehicle kilometres by 2030. This target is expected to be much harder to achieve in Shetland than elsewhere due to its geography and dispersed settlement pattern. It is understood that a Local Transport Plan is being prepared which, along with future studies, will consider suitable targets and metrics that can realistically be achieved in Shetland. Stakeholders have highlighted that, factors such as demographic changes and economic growth would tend to push demand for

Topic area	Key considerations
	transport up, rather than down. Therefore, any targets and KPIs for road transport should consider *per capita* energy use and emissions, not just totals. This study has shown that, because road transport accounts for a relatively small proportion of total GHG emissions in Shetland, demand reduction in this sector will not have a major impact; however, the scale of the challenge in reaching net zero means that there is very little scope to pick and choose measures. A series of 'Community Conversations' workshops suggested notable support for better walking, cycling and public transport links, along with EV bike hire schemes. Under Transport Scotland targets, the Government is proposing to prohibit the sale of new petrol or diesel vehicles by 2030. As the prices of EVs and combustion engine vehicles converge, the availability of EV charging infrastructure is considered to be the major obstacle to uptake, so provision of suitable infrastructure should be a priority. The cost of doing this will decrease if there is less demand for private vehicles. There are particular opportunities for EV car clubs and carpooling schemes, recognising that some communities in Shetland already have a culture of carpooling. There is also the potential to co-locate renewable energy technologies with EV charging points, as in solar canopies over car parks. This study has not assessed the impacts of fixed links in detail. Based on discussions with stakeholders and community members, it is likely that this would result in more car journeys overall, with the potential to displace some ferries. Given the uncertainties around whether and how these different transport modes will decarbonise, the overall impacts from an energy and emissions standpoint are not clear. On the other hand, there are considerable social and economic benefits of fixed links. These could contribute to improving the community's resilience, in particular opening up a wider range of job opportunities, which will be important when having to adapt to the now-inevitable impacts of climate change. It is recommended that any consideration of fixed links should include a more detailed assessment of the potential embodied carbon impacts, along with the anticipated impacts on the transport network.
Energy supply	One of the many unique features of Shetland is that it is a net exporter of energy, both in the form of fossil fuels and (once the interconnector is complete) renewable power. The energy transition for Shetland will therefore not only depend on the technology solutions that are adopted by end users on the islands themselves – which could potentially be influenced via local policies and initiatives – but will also be influenced by factors such as aviation and shipping, which are subject to much wider, global trends. This makes it difficult to anticipate future changes in energy demands and plan for suitable infrastructure upgrades. This work has drawn on research and analysis carried out as part of the ORION project, which considers different future energy solutions for Shetland, and the Neptune project, which specifically focuses on marine sector decarbonisation. Sensitivity analysis suggests that, although energy demand reduction in road transport and buildings should still be addressed, this will have a small impact on energy demands compared with factors such as: • Whether local industries and buildings switch to electricity or green hydrogen – this could result in electricity demand nearly doubling

Topic area	Key considerations
	• Where marine vessels refuel/recharge and what type of fuel they use – if using green hydrogen produced in Shetland, for instance, this could result in electricity demand doubling *again*. Reducing energy demand in buildings and road transport should still be seen as important, particularly for social and economic reasons, even though the environmental impact will be comparatively small. This is because of the high cost of fuel, decreasing people's energy bills, helping to tackle fuel poverty and ease the burden on local businesses. It will also help to mitigate (to some extent) the infrastructure upgrades that will be needed to support the energy transition. More broadly, it is about making sure that everyone does their fair share to reduce demands on resources where they can. The pathways modelled as part of this work assume that road vehicles will largely switch to EVs, while buildings will mostly be heated using direct electric heating or electrically-powered heat pumps. However, it is important that any implementation plan should remain flexible as to the preferred solutions. The overarching priority must be to ***phase out the use of fossil fuels***, whether these are replaced with renewable electricity, green hydrogen, or some alternative. Assuming the fuels are zero carbon, once deployed there will be no major difference in annual emissions, but in order to reduce cumulative emissions, it is ***strongly*** recommended to prioritise proven technologies that can be adopted as soon as possible.
Reuse, recycling and waste	Waste is among the most challenging emissions source to decarbonise because it is fundamentally linked to the provision of low-cost heat from the ERP to Lerwick's DHN. Some of the key challenges are set out in the NZCR. Due to the complexity of waste management on the Shetland Islands, and the fundamental role waste has in reducing fuel poverty through the provision of low-cost heat, it is highly recommended that the Council develop a net zero aligned waste management strategy. In particular, this should include measures to ensure that no biodegradable waste is sent to landfill or the ERP.[34] The priority should be to reduce food waste in the first instance and handle any remaining waste via composting (at home or centralised) or anaerobic digestion. This is important in order to tackle methane emissions. There are logistical hurdles to both recycling and composting, particularly if materials need to be shipped or processed elsewhere, but feedback from stakeholders and the Community Conversations indicated support for these types of initiatives, which could potentially create local business opportunities.
Business and industry	Energy use in stationary buildings and facilities on land is dominated by non-domestic sectors as opposed to domestic buildings. This project has reviewed a variety of data sources on energy use and, following consultation with SIC, has used figures that underpin the UK Local Authority Greenhouse Gas Emissions Statistics and Sub-National Fuel Consumption Statistics. However, these are based in part on modelled data and will inevitably not reflect the exact quantities and end uses of different fuels in Shetland. There is a paucity of accurate data on the end

[34] The Scottish Government intends to ban biodegradable waste being sent to landfill by 2025. Action to tackle climate change - gov.scot (www.gov.scot)

Topic area	Key considerations
	uses of fuels in non-domestic sectors, and particularly for agriculture and marine sectors which play such an important role in Shetland. Therefore, one of the key recommendations of this study is for SIC to engage with businesses to collect better data on how much energy is used, and what it is used for. This is important in order to identify sector-specific mitigation measures (i.e. behaviour change, energy efficiency and use of renewable energy-powered technologies). This can also form the basis for awareness campaigns, encouraging businesses to report and reduce energy use and emissions, campaigns to avoid food and plastic waste, etc.
Buildings	The two big priorities for buildings are (a) reducing energy demands and (b) phasing out the use of fossil fuels. The Scottish Government's Heat in Buildings Strategy proposes that private rented and owner-occupied properties must be upgraded to a minimum EPC rating of 'C' by 2028 and 2033 respectively, and for social rented properties to be upgraded to a minimum EPC dating of 'B' by the end of 2032. As set out in the NZCR, SIC's focus should be on updating social rented properties and Council-owned buildings, but more broadly the Council can help to promote Government funding schemes, signpost towards energy advice, raise awareness of heat pumps and renewable energy systems, and potentially facilitate adoption of technologies like PV via group purchasing schemes. One of the consistent messages that has come from the stakeholder workshops and public conversations is about the difficulty of finding skilled labourers and contractors, and the high cost of materials in Shetland. SIC should work with Government to tap into any available funding and lobby for additional funding related to training schemes, alongside any local initiatives. There is potential to utilise heat networks to serve some existing buildings[35] where there is a suitable heat source available. This option has been mentioned, for instance, in the context of a combined heat and power (CHP) system that could be co-located with a green hydrogen production facility or AD plant. There could also be opportunities to develop heat networks that use ground or water source heat pumps in conjunction with local renewable energy systems (e.g. hydropower or tidal arrays). However, it is crucial to avoid 'locking in' future reliance on any heat sources that may be difficult to decarbonise in future, particularly if there is a zero emission alternative that can be adopted sooner.
Land use and agriculture	Based on available data, drained and degraded peatland results in the single largest source of emissions on land in Shetland. The scale of these emissions is partly due to agricultural practices (both historic and current), but also due to Shetland's geology – the very nature of the soil. There are also other sources of emissions associated with agriculture, such as livestock digestion and fertiliser use. Agriculture: There are a host of unique challenges associated with farming in an environment like Shetland. For this sector in particular, it is very challenging to prove that a mitigation measure will result in a net decrease in emissions globally, rather than the source of emissions just moving elsewhere. Further engagement with farmers and crofters is necessary to identify mitigation options that are

[35] New buildings should be constructed to achieve very low heat demands; this generally makes heat networks non-viable.

Topic area	Key considerations
	acceptable. It is understood that the structure and availability of grant funding is one of the biggest hurdles to adopting certain types of environmentally friendly practices. The Community Conversations workshops highlighted local interest in polycrubs and community food growing, although again it is necessary to ensure that these activities do not contribute further to emissions or have other negative environmental impacts. More broadly, there is an urgent need to start think long-term about the impacts of climate change on agriculture itself, which might require changes in agricultural practices and crops that are resilient to climate change. There is a role for SIC to engage with the Government and other stakeholders to develop a longer term climate change adaptation plan for the sector. Peatland restoration: The data indicates that there is an urgent need to restore peatland. There is considerable ongoing attention to this issue, including from external organisations that are interested in funding future work. Barriers include, but are not limited to, a lack of skilled labourers and equipment, and difficulty in accessing some sites. SIC should continue to work with the Shetland Amenity Trust, Shetland Peat Restoration and other local stakeholders to accelerate these projects as much as possible. Alongside this, there are opportunities for Shetland to be at the forefront of trialling paludiculture, which if successful could be rolled out elsewhere. Peatland reinstatement: Consideration needs to be given to peatland *reinstatement* on land that is currently used for agriculture, at a landscape scale. This would have major implications related to agriculture and tourism, along with social history and culture. This is a highly complicated topic area, and it is clear that a considerable amount of further stakeholder engagement will be required to identify solutions that can substantially mitigate these emissions while still being acceptable to the community. It is considered likely that reaching net zero in Shetland would require emissions from land use and agriculture to be mitigated, at least in part, via carbon removal technologies (see below).
Marine sector	The decarbonisation trajectory for marine vessels has been aligned with the ongoing Project Neptune work that is focused on decarbonising the Shetland Islands' maritime industries. The outcomes of this piece of work detail which vessels are compatible with which low carbon propulsion systems, as well as fuel storage, refuelling and charging infrastructure requirements. Due to its location, both residents of and visitors to Shetland are reliant on marine transport, more so than elsewhere. There are a range of technology options that could decarbonise these sectors, but it is not yet certain which will be adopted or on what timescales. Aside from the upfront cost of the technologies, there is a real chicken and egg situation when it comes to the availability of suitable fuels/energy sources. This makes it difficult to plan for appropriate infrastructure as noted previously. However, there are still opportunities to influence local solutions. There could be an immediate focus on decarbonising smaller vessels that are used for inter-island transport and fishing.
Aviation	There is currently little certainty of which technologies will be available to decarbonise the aviation sector. Similar to the issue with shipping (see above) there

Topic area	Key considerations
	is a chicken-and-egg situation in terms of a wider shift within aviation. As such, the Council should keep abreast of technology developments, engage suppliers as aircraft approach end of life to determine financial and technical suitability of low carbon alternatives for specific routes, and only then adopt the appropriate technologies. Emissions from aviation, particularly associated with Shetland's tourism sector, will depend in significant part on consumer demand for flights and central Government policy on this issue. The UK Government's recently-released Jet Zero Strategy[36] (2022) does not include any proposals to limit aviation demand. However, the CCC has advised that unrestricted demand growth is not compatible with the UK's climate change commitments barring a technological breakthrough[37], so in the long term it is highly likely that this policy position would change.
LULUCF	Peatland restoration and peatland reinstatement, if adopted at scale, may be the mitigation measure with the biggest potential impact on area-wide GHG emissions. The Council should begin exploring opportunities to restore this land and to subsequently develop a dedicated peatland restoration strategy and implementation plan. The sooner this is implemented, the better, to maximise the amount of carbon that is sequestered.
Carbon removals	Due to the hard-to-abate sources of emissions in Shetland, it is considered unlikely that the area will reach net zero emissions without some form of carbon removal technology becoming available. It is understood that CCS is being considered as part of the ORION project. Any progress that can be made in regard to CCS will benefit not only Shetland, but the UK and rest of the world, so this should be considered a priority area.

[36] Jet Zero strategy: delivering net zero aviation by 2050 - GOV.UK (www.gov.uk)

[37] https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf

5.2 Indicative timelines

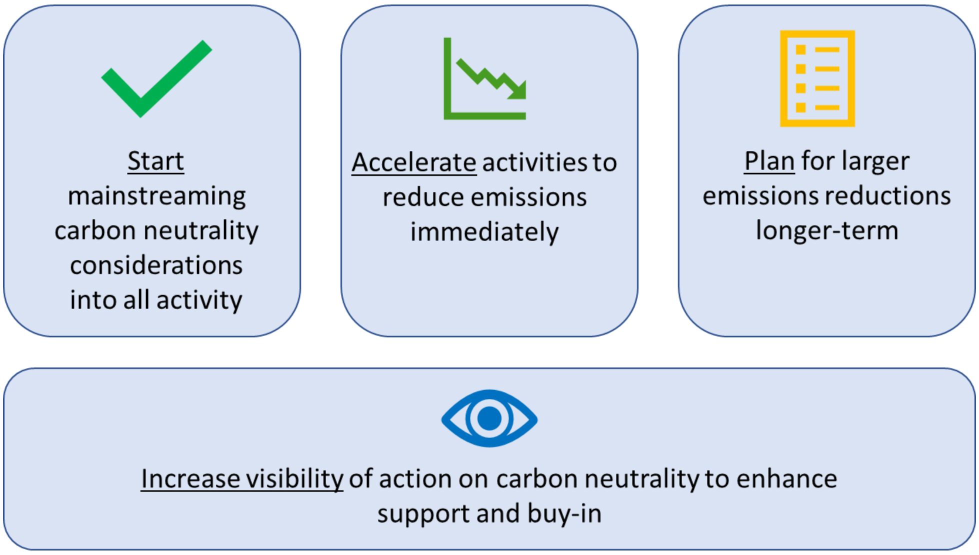
The figure below provides an indicative timeline for implementing measures identified in the pathways analysis. Broadly speaking, activity in the next few years should include feasibility studies for opportunities such as heat networks, along with development of net zero-aligned strategies for waste, transport, EV charging networks, and so on. Whilst it is important to retain flexibility in the event that new technologies or fuels (particularly green hydrogen) become available from the mid-2020s onwards, in light of the need to reduce emissions as fast as possible, there should be an emphasis on proven measures that can be adopted in the short term, including retrofitting buildings, electric heating and vehicles, and peatland restoration. Another key priority should be starting to engage with the community regarding climate change adaptation, given that key sectors of Shetland's economy will be among those most affected. Decarbonisation of the agriculture, marine and aviation sectors is more likely to take place in the medium to long term, with technologies such as CCS not likely to become available until the 2030s onwards.

Sector / Main Topic	Measures
Domestic	Upgrade social housing
	Upgrade private rented & owner-occupied housing
	Some buildings switch to electric heating or heat pumps
	Some buildings switch to green hydrogen or alternative fuel
	Zero emission heating regulations require all remaining buildings to switch fuels
Industrial & commercial	Engage with I&C sectors to understand energy end uses and identify suitable measures
	Awareness campaigns and local initiatives e.g. voluntary reporting on EE and waste reduction measures
	Some buildings switch to electric heating or heat pumps
	Some buildings switch to green hydrogen or alternative fuel
	Zero emission heating regulations require all remaining buildings to switch fuels
Public sector	*[See NZCR for further information about SIC-owned assets and vehicles]*
	Develop heat decarbonisation / feasibility studies to facilitate access to funding etc.
	Upgrade buildings in line with Scottish Government ambitions
	Some buildings switch to electric heating or heat pumps
	Some buildings switch to green hydrogen or alternative fuel
	Zero emission heating regulations require all remaining buildings to switch fuels
Heat networks	Feasibility study/ies for heat networks
	If appropriate, deploy heat networks
Reuse, recycling and waste	Feasibility study/ies for composting and AD
	AD plant for Lerwick bio waste
	Implement CCS in Lerwick ERP
	Awareness campaign for food waste reduction and home composting
	Waste reduction campaign
	Increase recycling rates
Road transport	Develop plans for public transport improvement, behaviour change (e.g. ridesharing, car clubs), public awareness and EV charging strategy
	Undertake detailed work to identify infrastructure upgrades; incorporate these into local policies/strategies
	Implement infrastructure upgrades to support active travel
	Behaviour change initiatives and awareness campaigns
	Deploy EV chargepoints
	Cars, vans and buses transition to EV
	HGVs transition to zero emission e.g. green hydrogen
Agriculture	Engage with farmers and crofters to identify environmentally friendly agri practices
	Adopt and promote measures that have been identified
	Lobby Government for more funding and outcomes-based schemes

Sector / Main Topic	Measures	2022-2025	2025-2030	2030-2035	2035-2040	2040-2045
	Community polycrubs and local food growing					
	Paludiculture research/trials and subsequent adoption (if appropriate)					
Land use	Area-wide data collection and develop strategy for peatland restoration and reinstatement					
	Engage with local community to identify potential areas for peatland reinstatement					
	Engage with Government and other stakeholders/third parties who are offering funding					
	Carry out accelerated programme of peatland restoration and reinstatement					
Marine sector	Plan for infrastructure changes in line with Project Neptune outcomes					
	Solutions for smaller vessels owned & operated within Shetland					
	Keep abreast of developments in global shipping and preferred tech. options					
	Wider marine sector transition to alternative fuels/technologies					
Aviation	Keep abreast of developments in aviation and preferred tech. options					
	Solutions for smaller aircraft owned & operated within Shetland					
	Wider aviation sector transition to alternative fuels/technologies					
Wider issues	Undertake a climate change risk and vulnerability assessment for Shetland					
	Develop a climate change adaptation plan					
	Establish Shetland Climate Change Steering Group – as a place-based anchor organisation to drive forward action and report on progress					
	Implement measures to ensure resilience of physical, social, health and other infrastructure					

6 Conclusion

Whilst there are a huge number of actions that will need to be taken to transition to carbon neutrality, they can be simplified into four main areas:



- **Start** mainstreaming carbon neutrality considerations into all activity. All actions that are not compatible with carbon neutrality, such as installing more fossil fuel heating systems or building more road infrastructure, should be challenged, and economic and social policies need to be 'carbon-proofed'.
- **Accelerate** activities to reduce emissions immediately. Activities that can get the market moving, working with key stakeholders that have significant influence, such as the Council themselves, social housing providers and key commercial landlords, are needed to speed up the rate of emissions reductions over the next few years.
- **Plan** for larger emissions reductions in the longer-term. In the meantime, work needs to be done in the next few years to prepare the ground for much greater scale of change later in the decade, for example addressing skills gaps, or developing innovative local policy and financing mechanisms.
- **Increase visibility** of action on carbon neutrality to enhance support and buy-in. All of the above needs to be done in a way that demonstrates what is happening and inspires others to act.

The GHG baseline assessment, pathways analysis and stakeholder engagement process undertaken during this study has highlighted important mitigation measures that must be adopted in Shetland in order to reduce emissions. In very broad terms, the key components to achieving this are (a) phasing out the use of fossil fuels and (b) working towards changing the way that land is used and managed in order to tackle non-energy-related emissions. Both of these require close engagement with the local community to ensure that the transition is fair and avoid any unintended negative social, economic or environmental consequences.

Some of the major opportunities highlighted by this work include:

- Peatland restoration – this is the single most impactful mitigation measure for Shetland
- Improving standards of living and lowering fuel bills by retrofitting buildings and ensuring that everyone has access to affordable, low carbon heating and energy
- Leading the way on sustainable agricultural practices and trialling techniques such as paludiculture
- Contributing towards the decarbonisation of the wider UK energy system via large-scale renewable energy technologies
- Becoming a hub of innovation for technologies such as green hydrogen, CCS and tidal power, which could include a micro-CCS pilot project at the Lerwick ERP

The emissions profile in Shetland makes it unlikely that net zero can be achieved across all sectors without some form of carbon removal technology becoming available. Alongside climate change mitigation, which is the focus of this routemap, it is also important to consider how Shetland will adapt to climate change – not just in terms of the environmental effects, but the social and economic ones as well. With that in mind, it will be important to:

4) Maintain high levels of ambition while focusing on measures that can definitely be adopted by 2045;
5) At the same time, plan ahead to take advantage of new technologies or solutions that may become available in future years; and
6) Work with the local community and businesses to ensure that the economy and society are prepared for the wider-scale changes that will take place as the UK and the world transition to a net zero future.

These measures offer the potential to transform the way that people live in Shetland for the better, improving standards of living and further strengthening this unique, highly resilient community

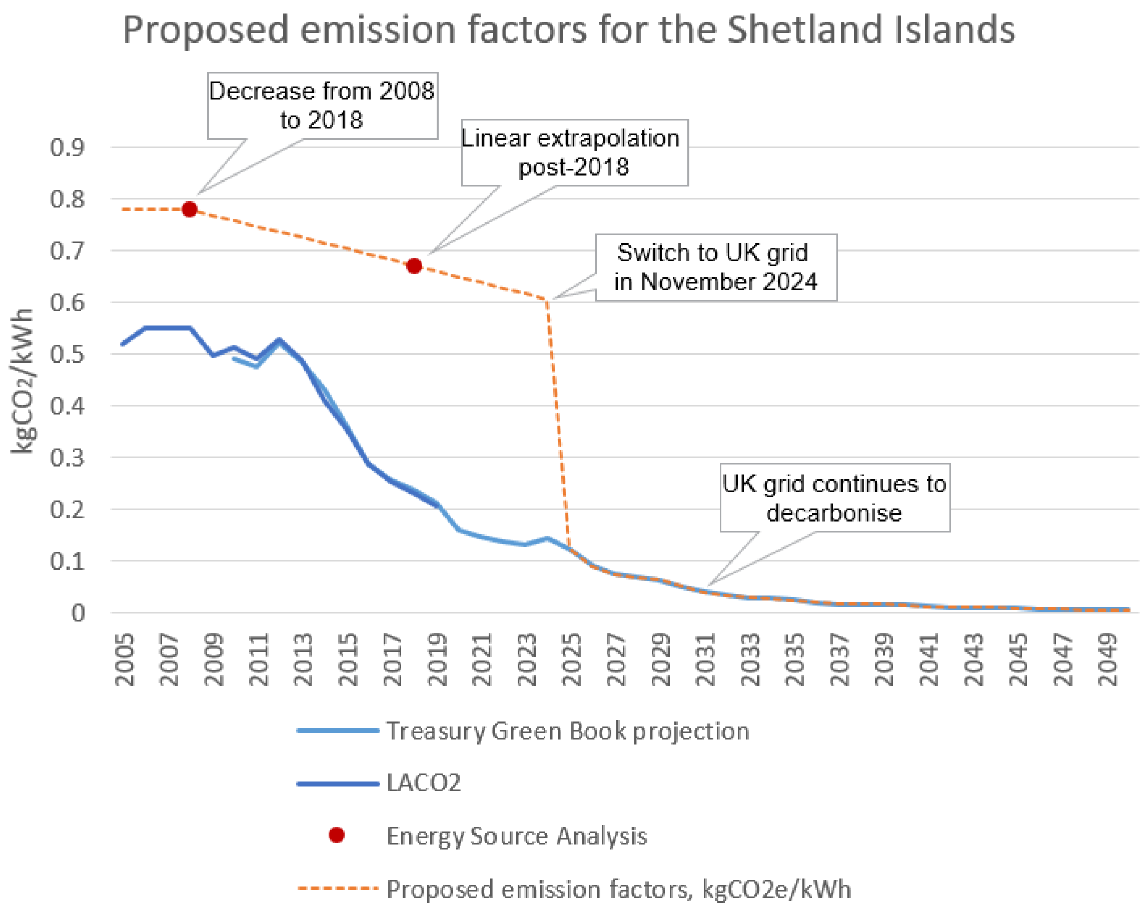
Appendix A. Estimating emissions from electricity generation in Shetland

Because Shetland is not currently connected to the UK electricity grid, this analysis has used bespoke emission factors when estimating emissions from electricity on an end-user basis.

Emission factors for 2008 and 2018 were provided as part of the Pure Energy Source Analysis Refresh (2020). There was a decrease in emissions during that time, due to higher uptake of renewables. We have used linear extrapolation post-2018 on the assumption that this trend will continue.

As of the end of 2024 we have assumed that the UK grid connection will be complete, at which stage the emission factor for Shetland will match that of the rest of the UK. On this basis, we have used Treasury Green Book figures when estimating future emissions post-2024.

These assumptions have been used to re-calculate LACO2 electricity data for Shetland, which by default uses the same UK grid emission factor. They have also been used to inform future emissions in the BAU and net zero scenarios.



Appendix B.Opportunities to accelerate change

B.1 Introduction

This Appendix summarises the policy review and influence mapping exercises that were undertaken in order to develop appropriate targets and mitigation measures for Shetland. It is divided into different sections according to the 6 themes identified by SIC:

- Transport
- Energy system
- Reuse, recycling and waste
- Business and Industry
- Buildings
- Land use and agriculture

Each section begins with a high-level overview of the key changes that will need to occur in order to reach net zero. This is followed by a summary of relevant policies, targets and strategies relevant to that sector. Then, there is a short discussion of the key opportunities, challenges, and areas of influence that SIC and other stakeholders may be able to leverage, to support the necessary changes.

Our review accounted for policies at the UK-wide, national (i.e., Scotland) and local level. A number of UK policies have been announced in the last year, including but not limited to the Government's Net Zero Strategy, Industrial Decarbonisation Strategy, Transport Decarbonisation Strategy and Heat and Buildings Strategy. In Scotland there has also been the recent Climate Change Plan Update 2018-2032. At the local level, key documents include the Islands Growth Deal[38], the Shetland Local Development Strategy 2014-2020[39], SIC's Corporate Plan "Our Ambition 2021-2026"[40], the Shetland Transport Strategy 2018-2028[41], the Orkney and Shetland Area Waste Plan[42], and the Shetland Local Housing Strategy 2011-2016[43] (currently being updated for 2022-2027).

B.2 Transport

What needs to happen to reach net zero?

- To reach net zero, all vehicles will need to utilise 100% renewable energy – whether that is renewable electricity, hydrogen, or biofuels. Based on current technologies, electric vehicles (EVs) are likely to be the first choice for cars, vans, and most other vehicles, with the exception of heavy goods vehicles (HGVs), which are more likely to run on biofuels or hydrogen.
- This transition will require a massive increase in the provision of EV charging facilities, along with much more renewable electricity generation. The only way this will be achievable on a national or global scale is by radically reducing demand for travel, which includes changes in consumer habits and switching towards walking, cycling, car clubs/ridesharing, e-scooters (where appropriate) and public transport.

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[38] Islands Growth Deal

[39] Shetland Local Development Strategy 2014-2020

[40] SIC's Corporate Plan "Our Ambition 2021-2026"

[41] Shetland Transport Strategy 2018-2028

[42] Orkney and Shetland Area Waste Plan

[43] Shetland Local Housing Strategy 2011-2016

Table 15. Relevant policies and strategies in the transport sector

UK-wide	National	Local
The Transport Decarbonisation Plan • Ambition for half of journeys in towns/cities to be walking or cycling by 2030 • Delivery of 4,000 zero emission buses and associated infrastructure • Increase average road vehicle occupancy • National e-scooter trials • Local Authority toolkit on sustainable transport (published in April 2022) • Ban sale of new petrol and diesel cars and vans by 2030, and all new cars and vans to be zero emission at tailpipe by 2035 • Consult on phase-out of internal combustion engine HGVs	Scotland National Transport Strategy • Phase out petrol and diesel cars from the public sector fleet and also phase out the need for any new petrol and diesel light commercial vehicles by 2025 • Phase out the need for new petrol and diesel cars and vans in Scotland by 2032 • Decarbonise scheduled flights within Scotland by 2040 Climate Change (Emissions Reduction Targets) Act 2019 (Scotland) • Net zero by 2045 with the latest and interim emissions reductions targets of 75% by 2030 and 90% by 2040 • Councils are required to reduce their operational GHG emissions to meet a net zero target by 2045 at the latest Update to the Climate Change Plan (2018-2032) • Reduce car kilometres by 20% by 2030 • New petrol and diesel cars phased out from 2030 • Remove fossil fuelled HGVs by 2035 • Majority of new buses zero emission by 2024 • Scheduled flights within Scotland decarbonised by 2040 • Government-owned low emission ferries increased to 30% by 2032 • Passenger rail decarbonised by 2035	Shetland Transport Strategy 2018-2028 • Strategic objective to “conserve Shetland’s environment by enabling the reduction of detrimental transport impacts on Shetland’s unique natural resources”. SIC’s Corporate Plan “Our Ambition 2021-2026” • Continue to support delivery of environmentally sustainable transport services (including transition to greener technologies and fuels). Highlands and Islands Airports Limited Strategy 2021-2026 • Create the world’s first zero emission aviation region in the Highlands and Islands.

	Cleaner Air for Scotland (2021) National Walking Strategy (2014) Cycling Action Plan for Scotland (2017-2020) Low Carbon Scotland: A Behaviours Framework (2013) Scottish Planning Policy (2020)	

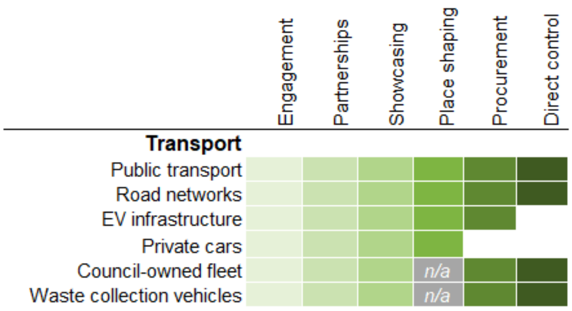
Key challenges and the relevant major players are shown below.

Table 16. Key challenges and major players in the transport sector

Key challenges include…	Major players
Isolated and dispersed settlements on Shetland	This limits opportunities to adopt active travel, which normally displaces shorter journeys, and also presents challenges in expanding the use of public transport. SIC can play a role in developing the Transport Strategy for Shetland but residents and businesses will need to buy-in to any mode shift initiatives.
Influencing consumers to choose low emission vehicles	National and local governments can play a role via awareness campaigns, but this is largely down to market forces. (Analysis by organisations such as Cambridge Economics, Element Energy and Deloitte indicates that the price of traditional fuel vehicles and EVs will converge in the next few years.)
Behaviour change and travel habits	As above, the role of local government may involve awareness campaigns, but they can also have an influence by delivering towns and places that facilitate sustainable travel (see below).
Design of towns and roads to facilitate sustainable travel	Urban planning is within SIC's remit as an LPA, and SIC is also responsible for managing and maintaining Shetland's roads. Transport Scotland plays a strategic role in setting transport policy nationally, while Local Transport Plans are produced by ZetTrans (an independent statutory body whose resources are provided and serviced by SIC).
Providing renewable electricity and other supporting infrastructure	SIC has already installed a number of EV charging points and are likely to continue to be involved in the procurement of EV charging infrastructure. The Council is also looking at producing an EV charging strategy. However, some of this infrastructure will also be provided by businesses and home/landowners. For more information on energy, see section B.3.

Alternative fuels for interisland transport	SIC runs inter-island ferries and air services, and so have some control over these sources of emissions. However, technological developments (i.e., development of viable alternative fuels and technologies) are a major constraint here. Other operators of aircraft or ferries would also need to be engaged. For more information on energy, see Section B.3.

What areas can SIC influence the most?



- SIC owns and operates local bus services, inter-island ferries, and some aircraft, so exerts a significant level of direct control over public transport and inter-island transport.
- While SIC are able to procure public access EV charging points, they will need to rely on showcasing, partnerships, and engagement to successfully encourage uptake of private EVs. SIC does, however, exert direct control over road networks, and should make sure that the road network prioritises pedestrians, cyclists, and public transport where appropriate.
- Additionally, the Council needs to ensure that any significant new developments are located and designed to reduce demand for travel and encourage active/sustainable transport options. This would have co-benefits for air quality, public health, etc.
- For assets directly controlled by SIC, the planned EV charging points (co-located with renewable power generation and battery storage) need to be rolled out and it needs to be ensured that the vehicle fleet is 100% low emission. Refer to the NZCR for more information.

B.3 Energy system

What needs to happen to reach net zero?

- A fundamental transformation of the UK energy system is needed to phase out fossil fuels by 2050 at the latest (2045 in Scotland). In the Energy White Paper (2020) the Government envisions that electricity use could double, meaning that the deployment of renewable technologies – along with battery storage and improvements to grid infrastructure – will need to scale up at an unprecedented rate. Analysis presented in this report confirms that (a) electricity use is likely to increase dramatically and (b) there is a high level of uncertainty in the scale of this increase.
- The Government has announced an ambition to deliver 40GW of offshore wind power by 2030, potentially enough to power all homes in the UK. However, to ensure security of supply, it will be important to work towards a diverse system that includes large- and small-scale solar, wind, tidal power, hydropower, and bioenergy, among other technologies. Alongside significant upgrades to infrastructure, energy storage, grid balancing and the availability of export routes, this will require a shift in thinking such that there is a presumption in favour of renewable energy projects of all scales.

Table 17. Relevant policies and strategies in the energy sector

UK-wide	National	Local
'Net Zero Strategy: Build Back Better' HM Government (2021) • Increase offshore wind from 10GW (2019 levels) to 40GW by 2030 • Support renewables with nuclear power including small modular reactors • *Note: only some aspects apply to Scotland* •	Climate Change (Emissions Reduction Targets) Act 2019 (Scotland) • Net zero by 2045 with the latest and interim emissions reductions targets of 75% by 2030 and 90% by 2040. • Councils are required to reduce their operational GHG emissions to meet a net zero target by 2045 at the latest. Scotland's Sustainable Housing Strategy 2013 • Key goals of HEEPS: end fuel poverty, lower fuel bills, lower emissions and increase economic growth, attracting companies to invest in energy efficiency • Target "For people to live in warm, high quality, affordable, low carbon homes by 2030"	SIC's Corporate Plan "Our Ambition 2021-2026" • Support the identification and delivery of a robust, green Shetland electricity distribution grid, which reaches across all of Shetland, and enables further public, community and commercial 'greening'. Islands Growth Deal • 10% average reduction per year in carbon emissions for all three island groups over the next ten years. • Decarbonise the energy sector via the Shetland Clean Energy Project.

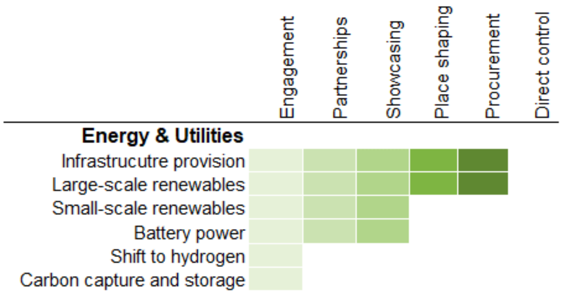
Key challenges and the relevant major players are shown below.

Table 18. Key challenges and major players in the energy sector

Key challenges include…	Major players
Reducing costs and financial barriers to enable further uptake	At a national level, Ofgem regulates gas and electricity markets and funds certain types of energy infrastructure projects (including the Shetland Interconnector). It also manages financial incentive schemes such as the Renewables Obligation, Renewable Heat Incentive, and the Sustainable Export Guarantee. BEIS provides funding for emissions reduction projects (SALIX), heat network feasibility studies (via the Heat Network Deployment Unit), and other research. The Scottish Government has announced a variety of funding initiatives as part of the CCPu.
Upgrading existing grid infrastructure	While the Shetland Islands are not currently connected to the mainland grid, the Shetland Interconnector will soon connect the islands to the national electricity grid. At this point, National Grid will become the key player for the transmission network. The distribution network operator

	(DNO) for electricity in the Shetland Islands and surrounding areas is Scottish and Southern Electricity Networks (SSEN).
Identifying and allocating areas for large-scale renewable energy projects	Local Authorities play a role by identifying suitable areas for renewable energy projects and setting planning requirements. SIC, for example, supports a number of renewable energy projects on the islands, and recently granted planning permission for the Viking Wind Farm. Other key players include community groups, along with organisations and businesses that deliver renewable energy projects. Given Shetland's geography it is likely that some of these will be located offshore, so the Crown Estate Scotland is also a key player.

What areas can SIC influence the most?



- Although electricity for Shetland is currently generated 100% within Shetland, once the archipelago is connected to the mainland electricity grid, SIC and local stakeholders will have relatively limited influence over the decarbonisation of this electricity supply. SIC will still be able to play an indirect role through engagement, partnerships and in its capacity as an LPA. This might include:
    - Demonstrating and showcasing the feasibility and benefits of projects, particularly green hydrogen, CCS, small-scale renewable energy and battery power projects on council-owned land or properties, or other innovative pilot projects such as tidal power
    - Playing a coordinating role (e.g., through community energy projects) and supporting strategic planning (e.g. promoting co-location of hydrogen production plant and heat networks to allow surplus heat to be used beneficially)
- In terms of infrastructure provision and large-scale renewables, SIC plays a key role, having recently granted planning permissions for the Viking Wind Farm (due for completion in 2024) and also supporting a number of other renewable projects.
- The Council should also seek to lobby the Government for additional support and funding, and also lobby on topics such as fair energy prices and regulatory changes to facilitate hydrogen production.

B.4 Reuse, recycling and waste

What needs to happen to reach net zero?

- At present there are no technologies that entirely mitigate the GHG effects of methane at source when it is emitted by landfill and sewage treatment. Waste (and wastewater) is therefore a sector that may need to rely on negative emissions technologies to reach net zero by 2045 – technologies that are not yet commercialised. Therefore, to avoid these emissions, it will be necessary to radically reduce waste generated overall, stop sending biodegradable waste to landfill in the 2025-2030 timescale, and separate all remaining waste to enable even higher recycling rates.
- Some waste products can be used to provide bioenergy, thus displacing fossil fuels. Energy recovery with carbon capture and storage will need to be deployed to any waste incineration facilities (EfW) to make sure that all available resources are used.

Table 19. Relevant policies and strategies in the waste sector

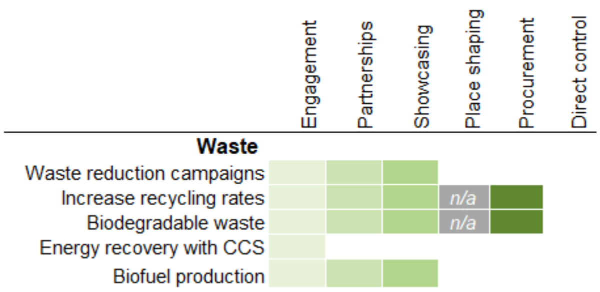
UK-wide	National	Local
'Net Zero Strategy: Build Back Better' HM Government (2021) • 'Near elimination' of landfilling biodegradable municipal waste by 2028 *(unclear if this applies to Scotland as support only applies to England)* • Eliminate all avoidable waste by 2050 (see 25 Year Environment Plan) • Use all non-recyclable waste for energy • *Note: only some aspects apply to Scotland* The 25 Year Environment Plan (2018) • Zero avoidable plastic waste by 2042 • Zero avoidable waste by 2050 • Maximise resource efficiency • *Note: only some aspects apply to Scotland*	Making Things Last: a circular economy strategy for Scotland • Reducing emissions through reducing the use of resources • Products to be designed to last longer, increasing reusing, repairing and recycling. • By 2025, aim to reduce waste arisings by 15% compared to 2011, ≤5% of waste to go to landfill, a 70% recycling/ composting rate and to reduce all food waste arisings by 33%. Update to the Climate Change Plan (2018-2032) • Stop landfilling of biodegradable municipal waste by 2025 • By 2025, ≤5% of waste to go to landfill, realise a 70% recycling/ composting rate • Accelerate landfill gas capture • Reduce food waste by 33% by 2025 compared to 2013. • Move towards circular economy Climate Change (Emissions Reduction Targets) Act 2019 (Scotland) • Net zero by 2045 with the latest and interim emissions reductions targets of 75% by 2030 and 90% by 2040. • Councils are required to reduce their operational GHG emissions to meet a net zero target by 2045 at the latest.	Orkney and Shetland Area Waste Plan • Waste sent to landfill to be reduced from 20.8% (in 2001/2) to 13.1% in 2020 • Waste recycled and composted to increase from 10% (in 2001/2) to 11.4% in 2020. • Waste incinerated for energy recovery to increase from 69.2% (in 2001/2) 75.5% in 2020. Shetland Local Development Strategy 2014-2020 • Support community initiatives which investigate and/or implement innovative recycling and waste management solutions in local communities

Key challenges and the relevant major players are shown below.

Table 20. Key challenges and major players in the energy sector

Key challenges include…	Major players
Changing behaviour to reduce the amount of waste generated Continuing to increase recycling and divert biodegradable waste from landfill	DEFRA is responsible for policy and regulations on waste, while SEPA plays a role in issuing permits for waste disposal and treatment and dealing with waste crime and pollution. SIC is responsible for household waste collection, commercial waste collection, and waste disposal. Collectively they can influence recycling rates and biodegradable waste at different stages of the supply chain, and deliver awareness campaigns to change people’s behaviour, although ultimately this relies on cooperation from consumers and businesses.
Changing practices in the construction industry to minimise CD&E waste	Nationally, construction, demolition and excavation (CD&E) waste is a significant source of waste, as is industrial waste. Reducing CD&E waste requires developers, designers and contractors to work together, while reducing industrial waste falls to industry owners. SIC can play an indirect role as an LPA, by determining what types of construction projects are approved and what waste reduction standards they have to meet.
Deployment of energy recovery with carbon capture and storage (CCS) to waste facilities	The Government is leading on CCS technologies nationally, but SIC may have a role linked to their responsibilities for waste management and procurement. For example, SIC is responsible for the Lerwick ERP, which provides heat for the Lerwick District Heat Network. Any changes that would affect the Lerwick District Heat Network would need to be coordinated with Shetland Heat Energy & Power (SHEAP).

What areas can SIC influence the most?



- Engaging with residents and businesses, to promote waste reduction measures.
- Provide separate collections for different waste streams, including food and green waste (which could either be composted or sent to AD).
- SIC can showcase best practice by setting targets for reducing waste within operations that SIC directly controls. This is addressed in more detail in the NZCR. Among the actions that could be taken, note that the CCC suggests that Local Authorities ‘introduce a zero-waste procurement policy that bans single-use plastics, excess packaging, specifies recycled content, favours appliances and goods that can are repairable and recyclable.’
- SIC can encourage construction sector organisations to monitor and report on waste arisings, set waste reduction targets, and adopt circular economy principles to maximise the beneficial reuse of assets and materials.

B.5 Business and Industry

The majority of emissions from business and industry are addressed under other sections in this Appendix.

B.6 Buildings

What needs to happen to reach net zero?

- Energy demand in all buildings needs to decrease significantly – including both new and existing buildings. This will require much higher levels of insulation and airtightness and more efficient building services (e.g., heating, ventilation, hot water and cooling), along with smart controls and energy management systems. It is also likely to require changes in user behaviour, although in the case of Shetland, where rates of fuel poverty are very high, behaviour change would not be necessary for all households.
- All buildings will need to be capable of operating with 100% renewable energy, which will involve replacing all heating systems and other building services that rely on fossil fuels. Until and unless hydrogen gas is commercialised, it is likely that heat pumps and district heating will be the main options for heat decarbonisation in Shetland.
- Uptake of small-scale renewables and battery storage will also need to be radically scaled up. This does not make a big difference to GHG emissions, but helps to reduce bills and contribute to a diversified energy supply.

Table 21. Relevant policies and strategies in the buildings sector

UK-wide	National	Local
'Net Zero Strategy: Build Back Better' HM Government (2021) & Heat and Buildings Strategy • Create a market-based mechanism for low-carbon heat • Reinforce electricity networks to get ready for increase in heat pumps • Hydrogen trials and Hy4Heat research programme • Finalise a standard for low-carbon hydrogen by early 2022 • *Note: only some aspects apply to Scotland*	Climate Change (Emissions Reduction Targets) Act 2019 (Scotland) • Net zero by 2045 with the latest and interim emissions reductions targets of 75% by 2030 and 90% by 2040 (including the buildings sector). Update to the Climate Change Plan (2018-2032) • Decarbonise buildings sector in line with Climate Change Act • Retrofit buildings and achieve ultra-high levels of fabric efficiency in new builds • No more than 5% to be fuel poor by 2040 • Making Things Last: a circular economy strategy for Scotland • Plan to work with the construction sector to ensure that waste reduction in the building design of both new build and refurbishment, while	Shetland Local Housing Strategy 2011-2016 (currently being updated for 2022-2027) • Shetland's social rented housing stock (SIC and Hjaltland Housing Association housing) must address climate change and reducing overall emissions as well as meet the Scottish Housing Quality Standard. SIC's Corporate Plan "Our Ambition 2021-2026" • Continue and, where possible, accelerate current energy efficiency, energy conversion initiatives.

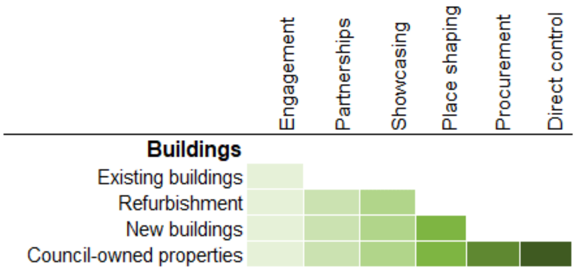
	also enabling more reuse and recycling at end of life	

Key challenges and the relevant major players are shown below.

Table 22. Key challenges and major players in the buildings sector

Key challenges include…	Major players
Reducing energy demand in the existing building stock	Owner-occupiers, landlords and (to a lesser extent) building tenants have the greatest ability to influence energy demand. The Government has introduced the Minimum Energy Efficiency Standards (MEES) to encourage uptake of energy efficiency measures in the private rented stock and Local Authorities are responsible for enforcement. The Government recently announced that it will provide £4.3 million to councils in an effort to clamp down on landlords not complying with energy efficiency regulations. There are also a variety of funding initiatives proposed in the Scottish CCPu that would target interventions at households in fuel poverty and those least able to pay.
Decarbonising heat and switching away from natural gas and other fossil fuels	As with energy demand, owner-occupiers, landlords and (to a lesser extent) building tenants can directly influence choice of heating system. However, because heat pumps and renewables are more expensive than conventional heating systems, uptake is strongly linked with the availability of funding. National, regional, and local governments can therefore play an important role by offering financial incentives to switch heating systems. (For example, the Renewable Heat Incentive is closed to new applications but there could be replacement initiatives in future). BEIS is responsible for setting energy policy for the UK as a whole, but the Scottish Government has also set out its own proposals within the CPPu and Heat in Buildings Strategy. For more information on energy, see Section B.3.
Ensuring that new buildings are net zero compatible	The Building Standards Division of the Scottish Government sets standards related to energy and carbon emissions, and Local Authorities are responsible for enforcement.
Adopt Circular Economy principles across the entire construction industry	SIC is responsible for waste management, but in practice there are few levers to achieve this type of fundamental shift in construction practice. LPAs can play a role through planning policy but most of the influence lies with industry bodies, developers, construction companies, manufacturers, and designers.

What areas can SIC influence the most?



- The Council will need to primarily rely on engagement and partnerships to reduce emissions in the existing housing stock (e.g., continuing to provide energy saving advice, or continuing to make grant funding available for energy efficiency improvements). In principle Local Authorities can also enforce minimum energy efficiency standards in existing buildings, although to date very few have done so due to lack of resources, local opposition, and other issues. This may improve in the near future as a result of additional funding.
- SIC has more influence over new buildings and major refurbishments, and direct influence over council-owned properties or developments. Some social housing in the Shetland Islands is managed by the Hjaltland Housing Association (HHA), who work closely with SIC's Housing Service. SIC may rely on continued partnerships with HHA to reduce emissions in this housing stock.
- The Council can promote heat decarbonisation through the development and implementation of LHEES (at the time of writing, this is under consideration by SIC).
- Both SIC and SHEAP would be involved in expanding the Lerwick heat network, but this should only be undertaken if there are *also* plans in place to fully decarbonise the network, either by switching to heat pumps or introducing CCS – otherwise there is a risk of 'locking in' future emissions as more buildings are connected. SIC can therefore play an important role as an LPA by developing a spatial strategy that identifies sites/developments that could be suitable for connection.
- SIC can also provide, or help households to access, advice on energy saving measures, retrofitting and renewable technologies.

B.7 Land use and agriculture

What needs to happen to reach net zero?

- According to the CCC, some reduction in greenhouse gas emissions can be achieved by adopting low carbon farming practices e.g., better soil and livestock management, less use of fertilisers, and increased diversification. However, the CCC also states that a net zero future will require a large increase in natural carbon sequestration through afforestation, peatland restoration, and similar projects. This can only be achieved if large areas of agricultural land are released for alternative uses – which, in turn, would rely on shifts in consumer behaviours and diets, reducing food waste, and new farming technologies to maintain per capita food production.
- In the Shetland Islands, emissions from land use are significant (c. 50% of Scope 1 & 2 emissions). A key driver of these emissions is peatland – land use policies will need to address peatland management, alongside agricultural land management.
- Engagement with local stakeholders has highlighted the fact that agricultural practices are strongly linked with available funding, and that existing funding schemes may incentivise activities that are not compatible with reducing emissions. The development of alternative (e.g. outcomes-based) environmental schemes will therefore be crucial.

Table 23. Relevant policies and strategies in the land use sector

UK-wide	National	Local
'Net Zero Strategy: Build Back Better' HM Government (2021) • Increase low carbon farming, peatland restoration and woodland creation • *Note: only some aspects apply to Scotland* The 25 Year Environment Plan (2018) • Improve soil health and expand tree cover • Green towns and urban areas • *Note: only some aspects apply to Scotland* The Environment Act 2021 • *Note: only some aspects apply to Scotland* Agriculture Act (2020) • *Note: only some aspects apply to Scotland*	Climate Change (Emissions Reduction Targets) Act 2019 (Scotland) • Net zero by 2045 with the latest and interim emissions reductions targets of 75% by 2030 and 90% by 2040. • Councils are required to reduce their operational GHG emissions to meet a net zero target by 2045 at the latest. The Environment Strategy for Scotland: Vision and Outcomes (2020) • Restore the natural environment and end Scotland's contribution to climate change by 2045 The Environment Strategy for Scotland: initial monitoring framework (2021) Update to the Climate Change Plan (2018-2032) • Increase woodland creation rates • Increase the use of sustainably sources wood in construction • Increase carbon storage from peatlands • Establish pilot 'Regional Land Use Partnerships' (RLUPs) Scotland's Forestry Strategy (2019-2029) • Increase the contribution of woodlands and forests to the sustainable economy • Improve the resilience of woodlands and forests • Increase the use of woodland and forest resources Scotland's National Peatland Plan (2015)	Shetland Local Development Strategy 2014-2020 • Develop programmes which investigate innovative use of land and assets in light of Common Agricultural Policy review

	• Target to restore 21,000 ha/year of degraded peatland.	

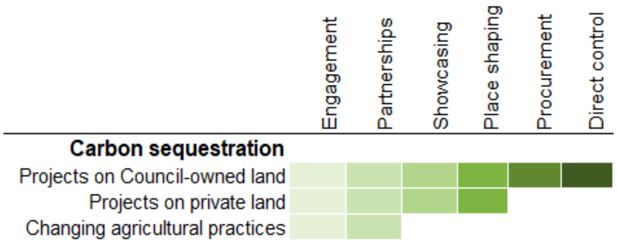
Key challenges and the relevant major players are shown below.

Table 24. Key challenges and major players in the land use sector

Key challenges	Major players
Protecting existing carbon sinks, while also protecting ecosystems, natural habitats, and biodiversity	The Scottish Environmental Protection Agency (SEPA) is Scotland's principal environmental regulator, responsible for protecting and improving Scotland's environment. DEFRA is responsible for Government policy on a range of environmental topics including but not limited to land management, conservation, biodiversity, and climate adaptation. Local Authorities play a part in their role as LPAs. Representatives from the agricultural sector, such as the National Farmer's Union, Scottish Agricultural College, and Crofting Commissoin, need to be engaged to identify suitable sustainable farming practices for Shetland. The Shetland Amenity Trust has set up a Peatland Restoration Project, which aims to help landowners improve their peatland management practices. The Shetland Peatland partnership, which has representation from all key organisations involved in peatland restoration in Shetland, has recently been set up to promote and accelerate such projects. Local community groups are also likely to play a role and should be consulted in any decision-making about significant land use changes.
Low carbon agricultural practices (livestock and land management)	Policy, regulations, and enforcement are primarily the responsibility of DEFRA and SEPA, but the decision to exceed minimum standards and adopt low carbon practices would largely fall to landowners. Farming tenants are key stakeholders but have less influence over land use. NFU (National Farmers Union) also likely to be a key stakeholder.
Increasing tree cover and ensuring it is sustainably managed in the long term	Policy is set at a national level by DEFRA, although SIC can contribute indirectly via its role as an LPA.
Releasing agricultural land for alternative uses e.g., woodland or rewilding projects	The major players include consumers (whose dietary and lifestyle habits influence production), private landowners, businesses, industry bodies, communities, and researchers/innovators in the field of agricultural production. The spatial strategy for Shetland can also have an impact, if somewhat limited due to land ownership and legal issues.

What areas can SIC influence the most?

- SIC can deliver carbon sequestration projects on council-owned land. As explained in a separate report, projects on SIC landholdings could account for roughly 10-15% of the total improvement.



- The Council can further provide business support to landowners and farmers to enable them to adopt low carbon practices, and support research initiatives or pilot projects on these topics as appropriate.
- Continue to partner with local organisations working in this area, such as the Shetland Peatland Partnership.
- SIC can promote tree cover and other green infrastructure through local plans and strategies, although in practice this would primarily impact new developments.
- Note that biodiversity should be given high importance alongside carbon emissions and energy use, although that is not the focus of this report. It is crucial that the ecological emergency is addressed alongside the climate emergency.

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