East Dunbartonshire Climate Action Plan – summary evidence and options report

CONTENTS

1. THIS DOCUMENT

This document summarises the evidence and options report that has been prepared by the consultancy Ricardo, to inform the development of East Dunbartonshire's Climate Action Plan (CAP). It looks at greenhouse gas (GHG) emissions from the Council itself, and also across the whole of East Dunbartonshire. For both, it gives information on current emissions, key measures to help deliver net zero and possible pathways to delivering net zero.

Based on the evidence and options report, the Council will prepare the CAP, which will set out the proposed net zero targets for both the Council and the whole of East Dunbartonshire, and a plan of action for how they will be delivered.

2. NET ZERO COUNCIL

Local authorities have a key role to play in helping Scotland meet its 2045 net zero target. The Climate Change (Scotland) Act 2009 states that public bodies have a duty to contribute to Scotland's national emission reduction target. And Scottish Government guidance in 2021 on Public Sector Leadership on the Global Climate Emergency proposed a number of key milestones for the public sector to achieve this, including achieving zero direct emissions from buildings by 2038 and no further purchase of petrol or diesel vehicles from 2025.

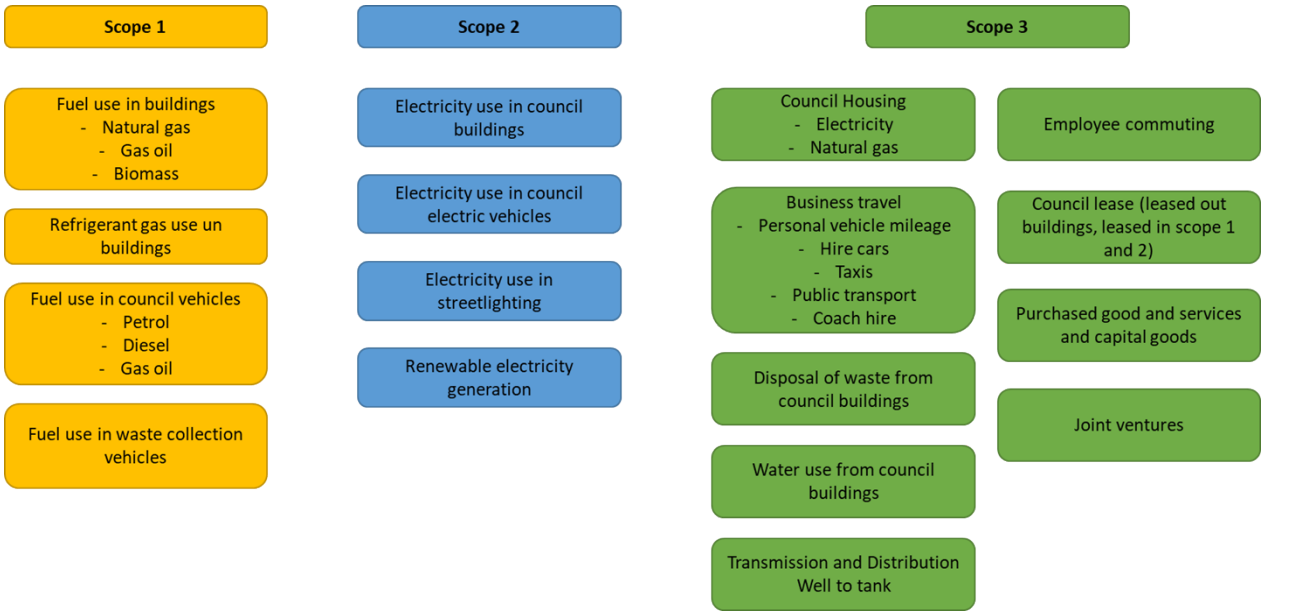
This section looks at what the Council's current GHG emissions are, analysis of the options for reducing these emissions and recommendations on how this might be achieved.

2.1 THE COUNCIL'S CURRENT GHG EMISSIONS

2.1.1 Scope of emissions

The Council's GHG emissions includes scope 1 (direct emissions from Council buildings and vehicles), scope 2 (indirect emissions from electricity use) and scope 3 (all other indirect emissions), as shown in Figure 1 below.

Figure 1: Council emission sources



2.1.2 Latest emissions

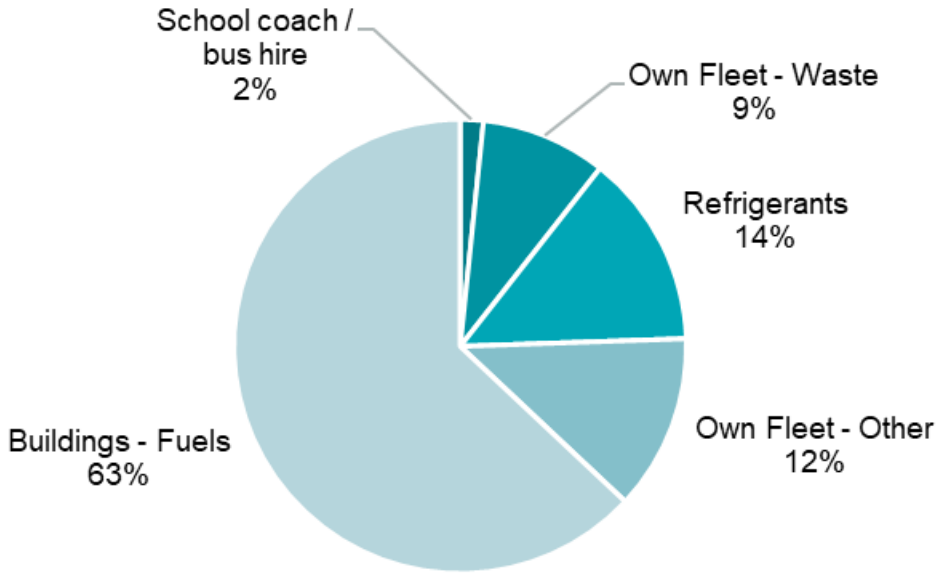
The Council's GHG emissions were estimated for the 2019/20 year, the latest year for which representative (i.e., pre-pandemic) data was available. Total GHG emissions in this base year were 95,826 $ktCO_2e$[1].

Table 1: summary of total Council GHG emissions in 2019/20, broken down by scope

Category	Emissions tCO_2e/yr	%
Scope 1	10,067	10.5
Scope 2	5,291	5.5
Scope 3	80,467	84.0
Total	**95,826**	**100**

The Council's direct GHG emissions (e.g., from its own buildings and vehicles, aka scope 1 emissions) and indirect emissions from electricity use (aka scope 2 emissions) were 15,358 tCO_2e. This is 3.2% of total GHG emissions across East Dunbartonshire[2]. The breakdown of scopes 1, 2 and 3 is shown in Figure 2, Figure 3 and Figure 4 below.

Figure 2: Breakdown of scope 1 Council emissions



[1] $ktCO_2e$ = Thousand tonnes of carbon dioxide equivalent. This takes all greenhouse gases and converts non-CO_2 gases to a carbon equivalent based on their potency (aka their global warming potential).

[2] This is as expected – typically a Council's own GHG emissions represents less than 5% of the GHG emissions across the local authority area that it covers.

Figure 3: Breakdown of scope 2 Council emissions

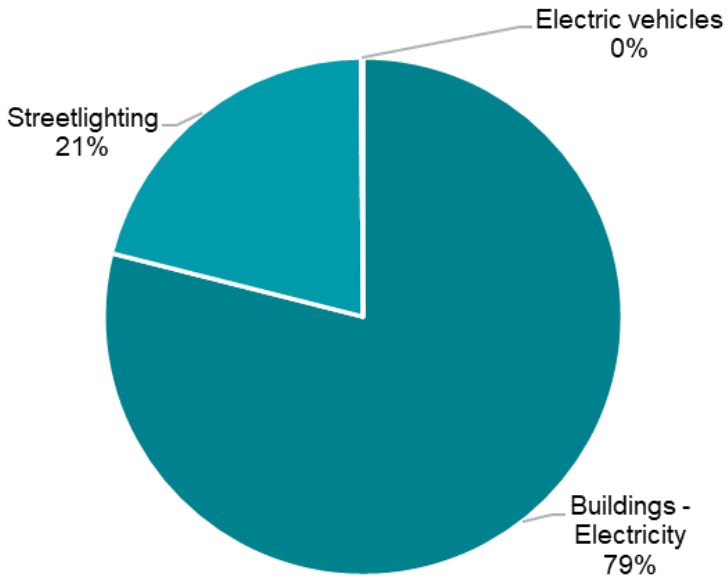
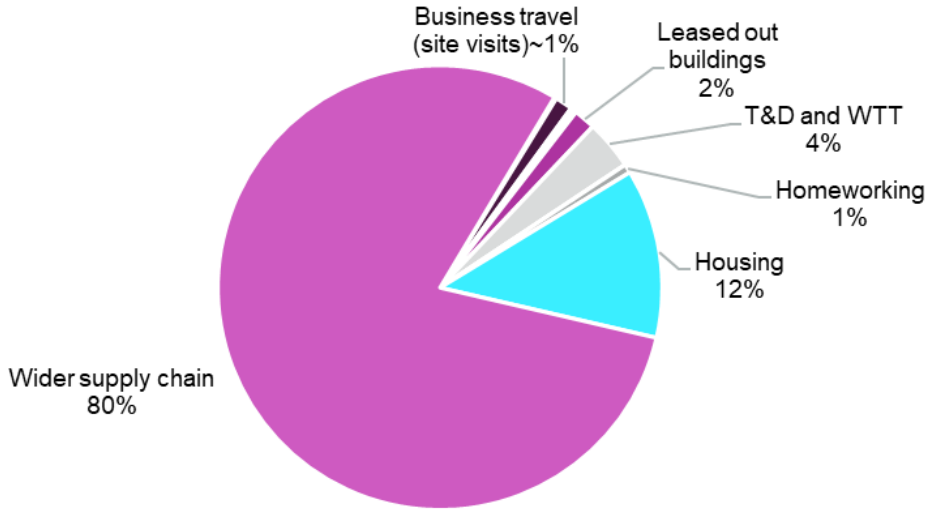


Figure 4: Breakdown of scope 3 Council emissions



2.2 THE COUNCIL'S FUTURE GHG EMISSIONS

A number of future GHG emissions scenarios were developed using Ricardo's net zero modelling tool. 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 emissions source (the same tool was also used to model the area-wide net zero scenarios).

2.2.1 Business as usual scenario

A business as usual (BAU) scenario predicts what might happen to GHG emissions in the future based on planned emissions reductions/increases due to known projects (e.g., estate changes, street lighting projects, staff number changes), organisation growth and external changes (grid decarbonisation impacts, population growth and market move to EVs). It therefore does not assume any new and additional action above what is

already planned or where the action is not 'firm and funded'. For example, it does not include the proposed milestones in the Scottish Government guidance on 'Public Sector Leadership on the Global Climate Emergency'. Detailed assumptions for the BAU scenario are shown in Table 9 of the evidence report.

The graphs below show the Council's BAU emissions by sector, both with (Figure 5) and then without (Figure 6) emissions from its supply change (as the change in other emissions sources is dwarfed by and therefore obscured by the supply chain emissions in Figure 5). The following key observations can be drawn.

- There is a small decrease in the Council's total emissions. To an extent the expected reductions will be offset by growth areas such as staff numbers and population. Scope 3, in particular the wider supply chain, accounts for such a large proportion of the emissions and are not forecast to change in the BAU.
- Therefore, the Council needs to make a proactive effort if net zero is to be achieved as the business-as-usual measures do not achieve net zero, as shown by the projections.
- Scope 2 emissions (emissions from electricity use) decrease substantially across the period as the grid decarbonises.
- Key emission areas that remain in 2044/45 that require addressing by net zero measures are supply chain, heating fuel use in buildings, housing, and employee commuting.

Figure 5: BAU emissions by sector

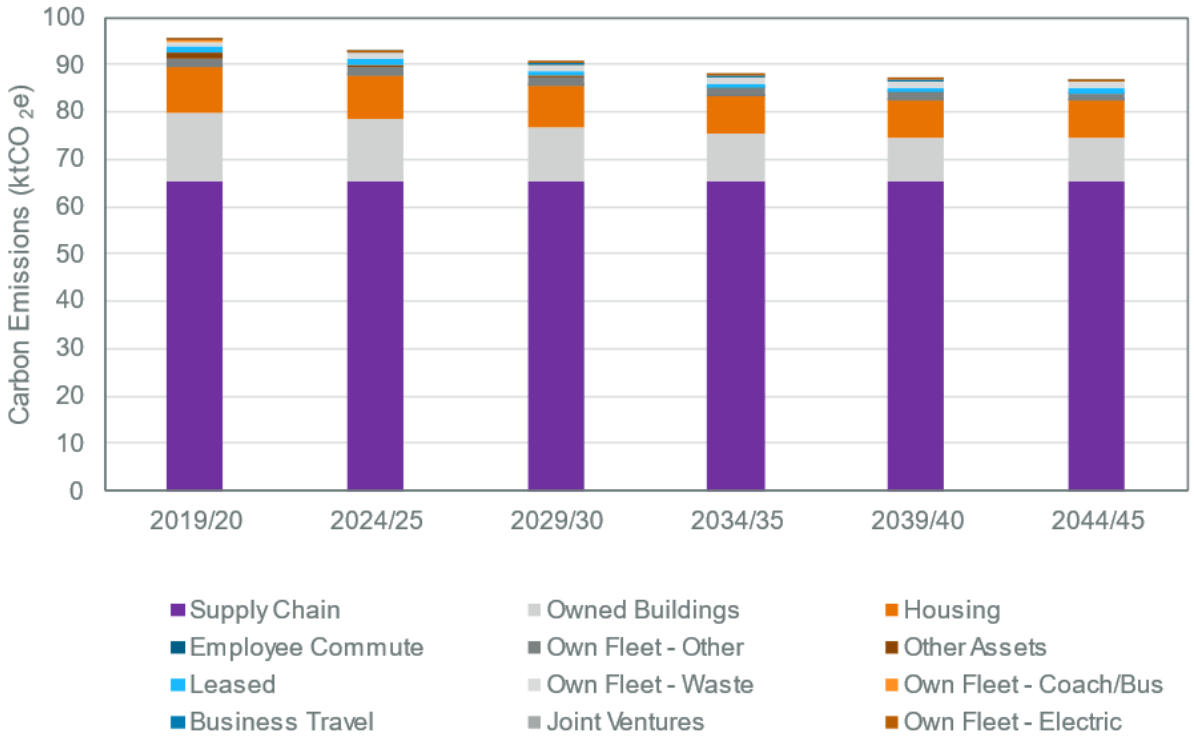
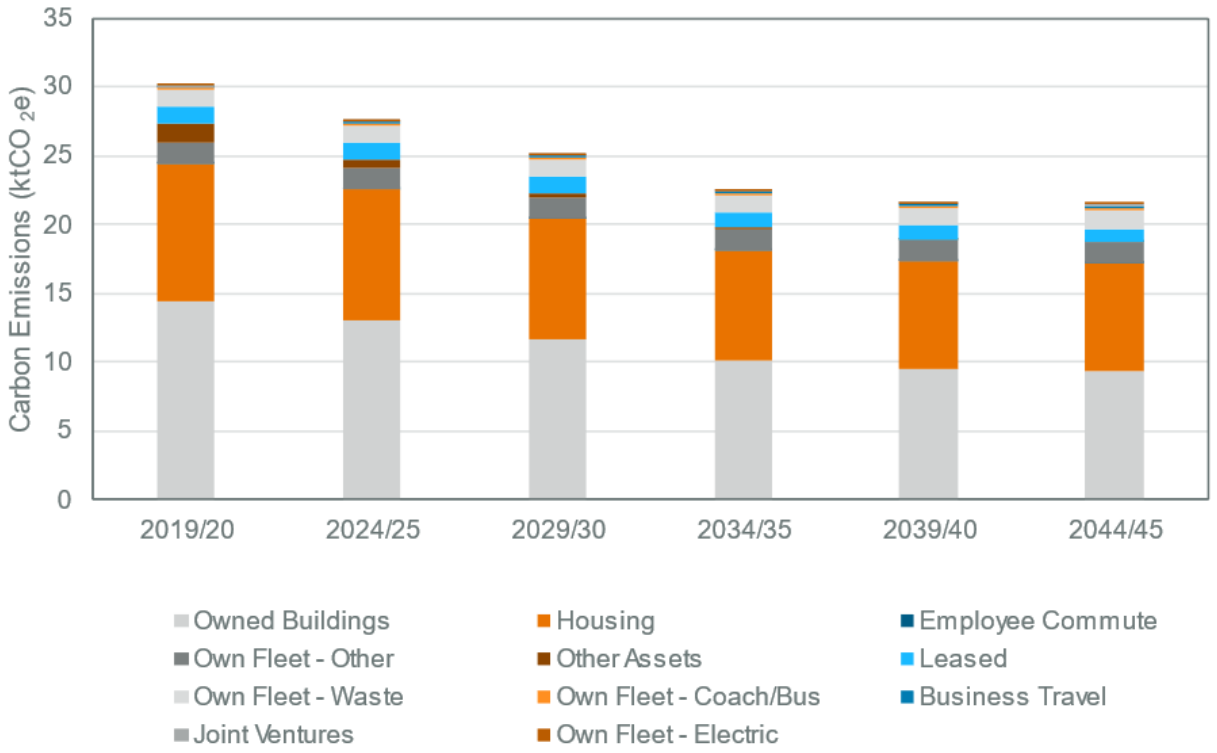


Figure 6: BAU Emissions by sector (excluding wider supply chain)



2.2.2 Net zero scenarios

Four scenarios were modelled using Ricardo's net zero modelling tool:

- 1 – balanced, with lower ambition on supply chain decarbonisation
- 1a – balanced, with greater ambition on supply chain decarbonisation
- 2 – balanced, plus additional local leadership
- 3 – conservative

All these scenarios broadly entail the same sort of measures – there are not many different ways to achieve net zero:

- Scope 1
  - Improved fabric efficiency of council-owned buildings and switching to low carbon heating (e.g., air-source heat pumps and direct electric heating).
  - Switching Council cars and vans to electric and, in the short term, more efficient fuel use.
  - Moving to electric and/or hydrogen school buses and waste vehicles and, in the short term, more efficient fuel use.
  - More efficient refrigerant use and moving to lower emission refrigerants.
- Scope 2
  - Reduced electricity consumption.
  - Greater levels of renewable energy generation (e.g., rooftop solar).
- In both Scopes 1 & 2
  - Reduction in office space due to increased council workforce homeworking,
- Scope 3
  - Reduced business travel emissions from travel policies.
  - Switching to low carbon cars and taxis for business travel.
  - Reductions in water use and waste.
  - Decarbonisation of supply chain.

The next sections explain the four scenarios in a bit more detail. Further information is in the evidence report and the assumptions for each measure in each scenario are set out in Appendix 1.

2.2.2.1 Scenario 1

Delivers net zero for scopes 1 and 2 by 2036, but scope 3 does not reach net zero so the Council would not achieve overall net zero by 2045.

Scope 1 emissions are substantially reduced by 2036 through the move to electric heating and electric or green hydrogen vehicles. A small portion of emissions remain from the use of refrigerants in air conditioning systems.

Scope 2 emissions are substantially reduced by 2035. This is attributed mainly to grid decarbonisation, although a small portion of emissions remain that could be removed through the increased use of local renewable generation or green energy procurement.

Scope 3 emissions are reduced, though a large portion (primarily wider supply chain emissions) remain. These would require addressing by offsets or more proactive measures.

The pathway does not reach net zero if scope 3 emissions are included, achieving a 47% reduction from the baseline.

The pathway reaches net zero for scopes 1 and 2 by 2036, achieving a 91% reduction from the 2019 baseline.

The total net cost of reaching net zero in this scenario (capital costs, plus the costs of offsetting any residual emissions, minus fuel savings) is up to £339m over the period to 2045 (see Section 2.4).

Figure 7: Net zero scenario 1 – emissions by sector

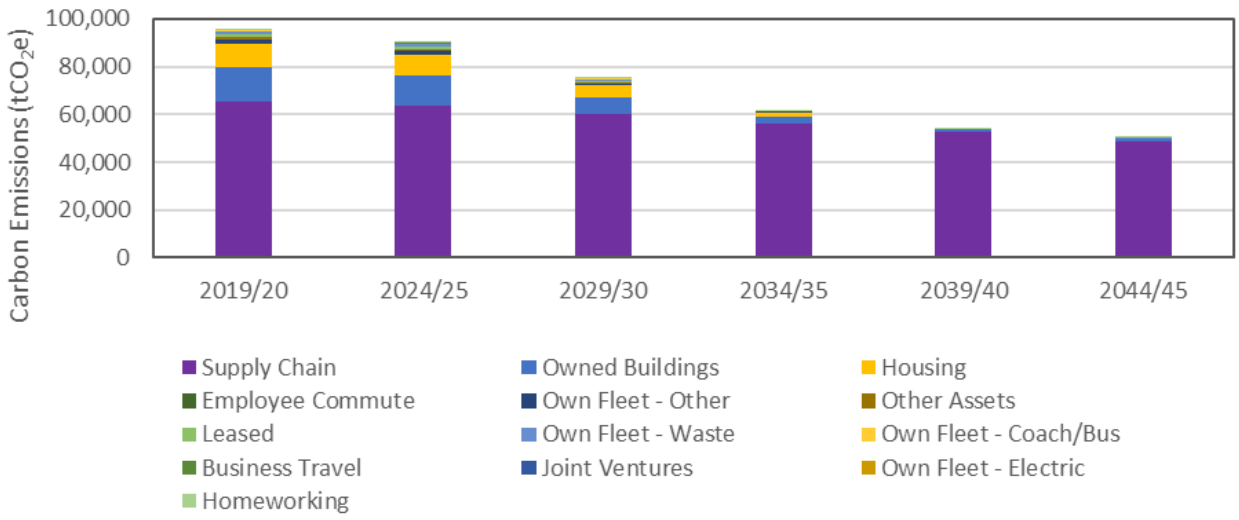
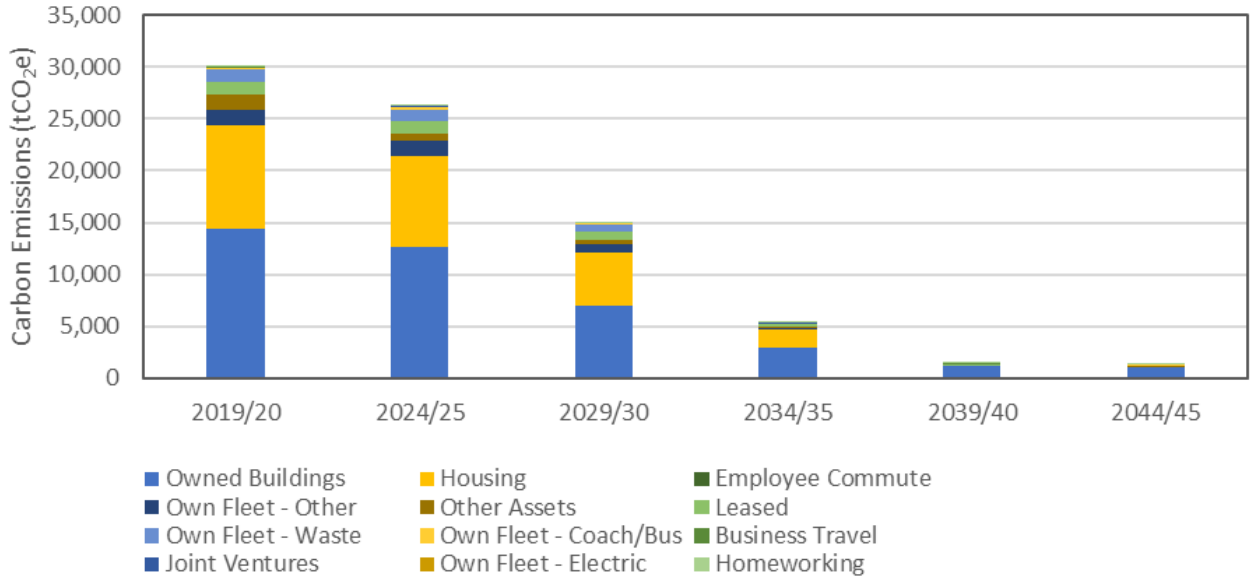


Figure 8: Net zero pathway 1 – emissions by sector (excluding supply chain)



2.2.2.2 Scenario 1a

Delivers net zero for scopes 1 and 2 by 2036, and overall net zero by 2045.

This scenario delivers net zero across all scopes by 2045, as in the case of Scenario 2 below, but contains cost at approximately the level of Scenario 1.

It is identical to Scenario 1 above in relation to Scopes 1 and 2.

It also matches Scenario 1 above in relation to scope 3, with the exception of procurement. Modelling for Scenario 1 assumed a 25% reduction in procurement emissions whereas the modelling for Scenario 2 assumes 90% of suppliers decarbonise by 2045. Adopting the Scenario 2 procurement assumption therefore enables net zero to be met by 2045 for all scopes while containing costs at the lower level set out for Scenario 1. This assumes that supply chain emission reductions are largely delivered without significant cost to the Council and with limited Council intervention. However, there is a high level of uncertainty related to this with further assessment required (see Financing Net Zero section below). The cost of this further assessment is estimated to be around £100,000.

The total net cost of reaching net zero in this scenario (capital costs, plus the costs of offsetting any residual emissions, minus fuel savings) is up to £326m over the period to 2045 (see Section 2.4).

Figure 9: Net zero scenario 1a – emissions by sector

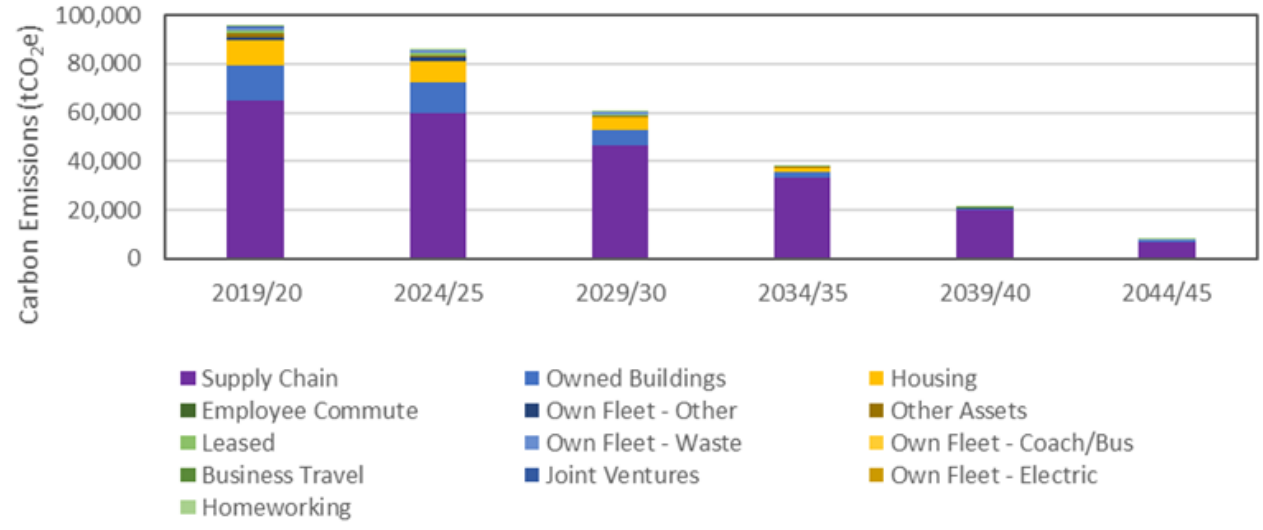
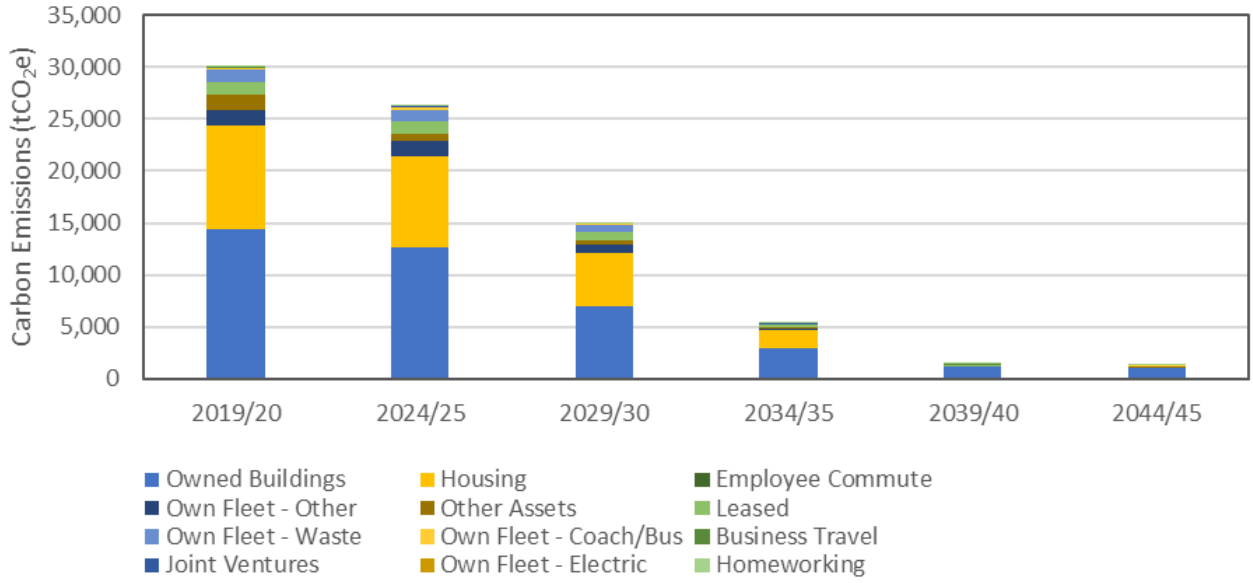


Figure 10: Net zero scenario 1a – emissions by sector (excluding supply chain)



2.2.2.3 Scenario 2

Delivers net zero for scopes 1 and 2 by 2036, and overall net zero by 2045.

This scenario prioritises local action, including greater levels of uptake of heat pumps and increased renewable energy generation (e.g., from rooftop solar). It also delivers substantial reductions in scope 2 emissions earlier than in scenario 1 and delivers greater reductions in scope 3 emissions.

Scope 1 emissions are substantially reduced by 2036 through the move to heat pump heating and electric or green hydrogen vehicles. A small portion of emissions remain from the use of refrigerants in air conditioning systems. But the additional local action does not result in net zero being achieved sooner than in scenario 1.

Scope 2 emissions are substantially reduced by 2033, this is attributed to grid decarbonisation and the installation of solar PV renewable technology to meet 75% of EDC's demand.

Scope 3 emissions are significantly reduced, with an assumption that 90% of Council suppliers will decarbonise in line with 2050 commitments.

The pathway reaches net zero including scope 3 by 2045, achieving a 92% reduction from the 2019 baseline.

The pathway reaches net zero for scopes 1 and 2 by 2036, equally achieving a 92% reduction with residual emissions of 1,204 tCO2e.

The total net cost of reaching net zero in this scenario (capital costs, plus the costs of offsetting any residual emissions, minus fuel savings) is up to £1.2bn over the period to 2045 (see Section 2.4).

Figure 11: Net zero scenario 2 – emissions by sector

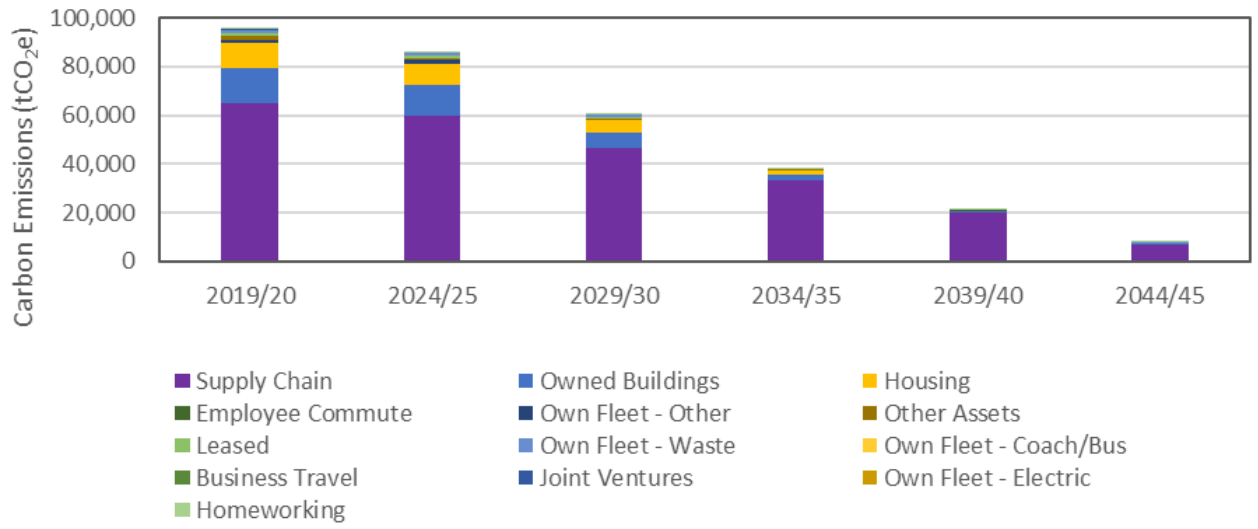
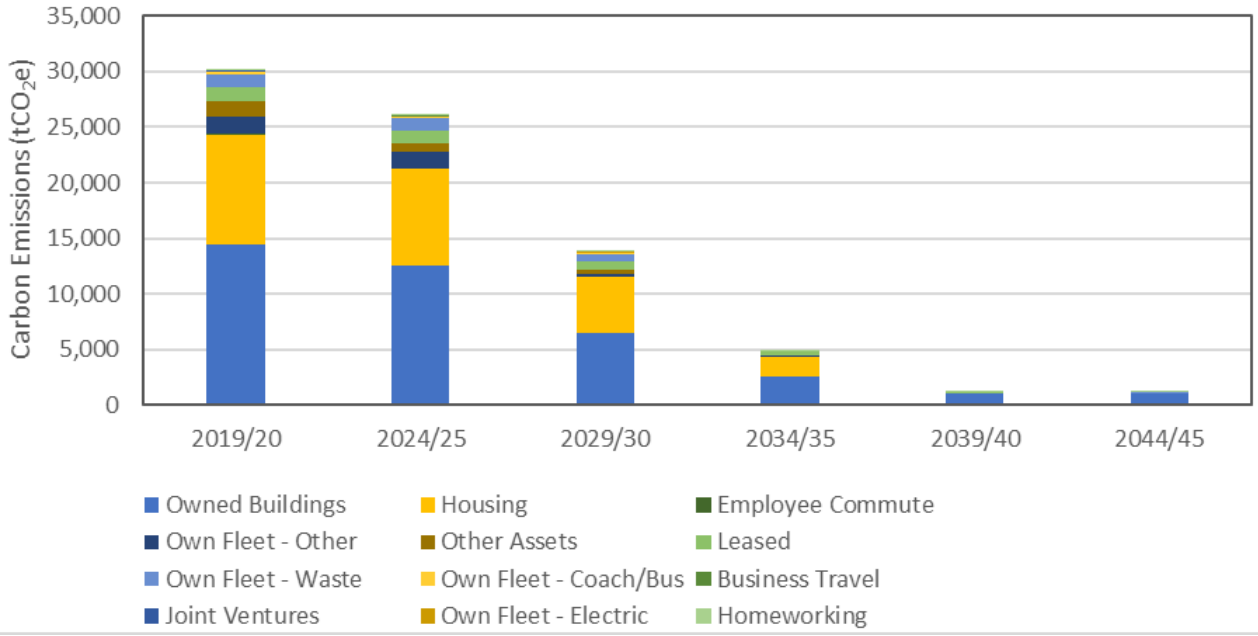


Figure 12: Net zero scenario 2 – emissions by sector (excluding supply chain)



2.2.2.4 Scenario 3

Net zero by 2041 with 91% emissions reduction for scopes 1 and 2, but scope 3 does not reach net zero.

Scope 1 emissions are reduced more slowly, reaching a 90% reduction by 2041, with reduced impact from building decarbonisation and a decelerated implementation timeline for conversion to a low carbon fleet.

Scope 2 emissions are reduced significantly by 2039, mainly through grid decarbonisation, although some residual emissions remain.

Scope 3 emissions are not significantly reduced, with only a 26% reduction from the baseline.

The pathway does not reach net zero if scope 3 emissions are included, achieving a 47% reduction from the baseline.

The pathway reaches net zero for scopes 1 and 2 by 2041, achieving a 91% reduction from the 2019 baseline.

The total net cost of reaching net zero in this scenario (capital costs, plus the costs of offsetting any residual emissions, minus fuel savings) is up to £270m over the period to 2040 (see Section 2.4).

Figure 13: Net zero scenario 3 – emissions by sector

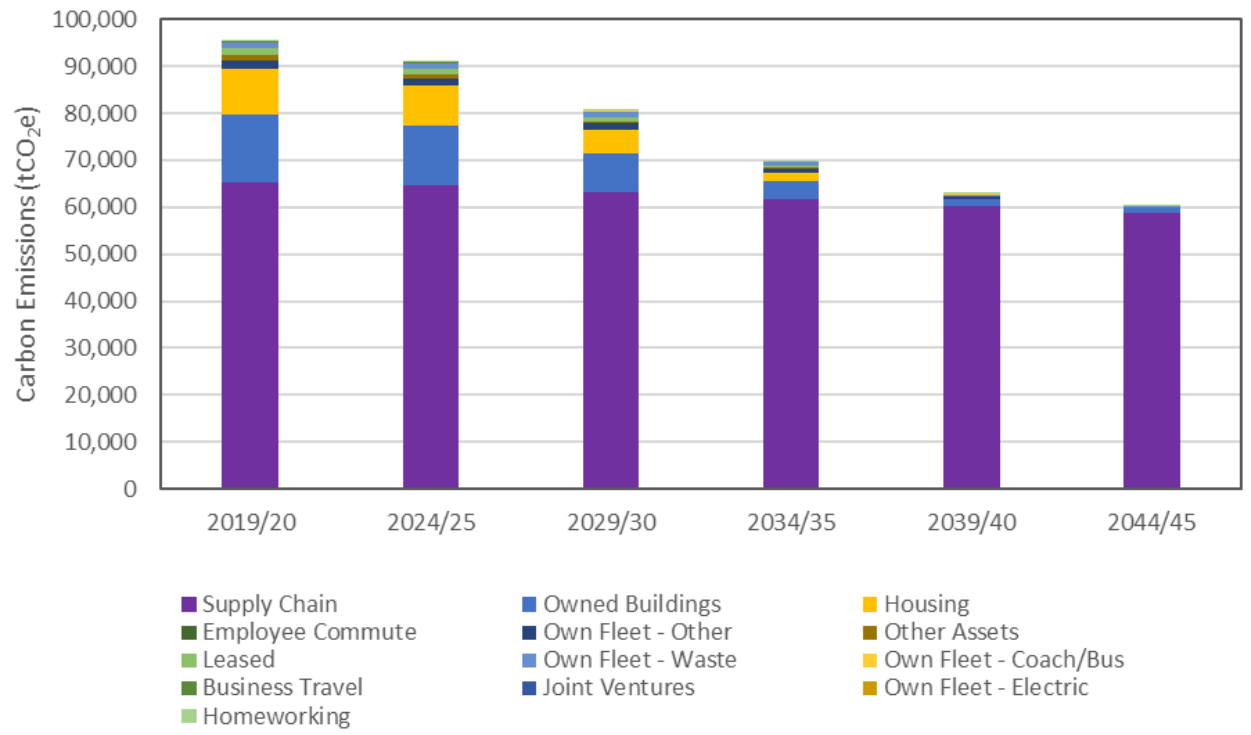
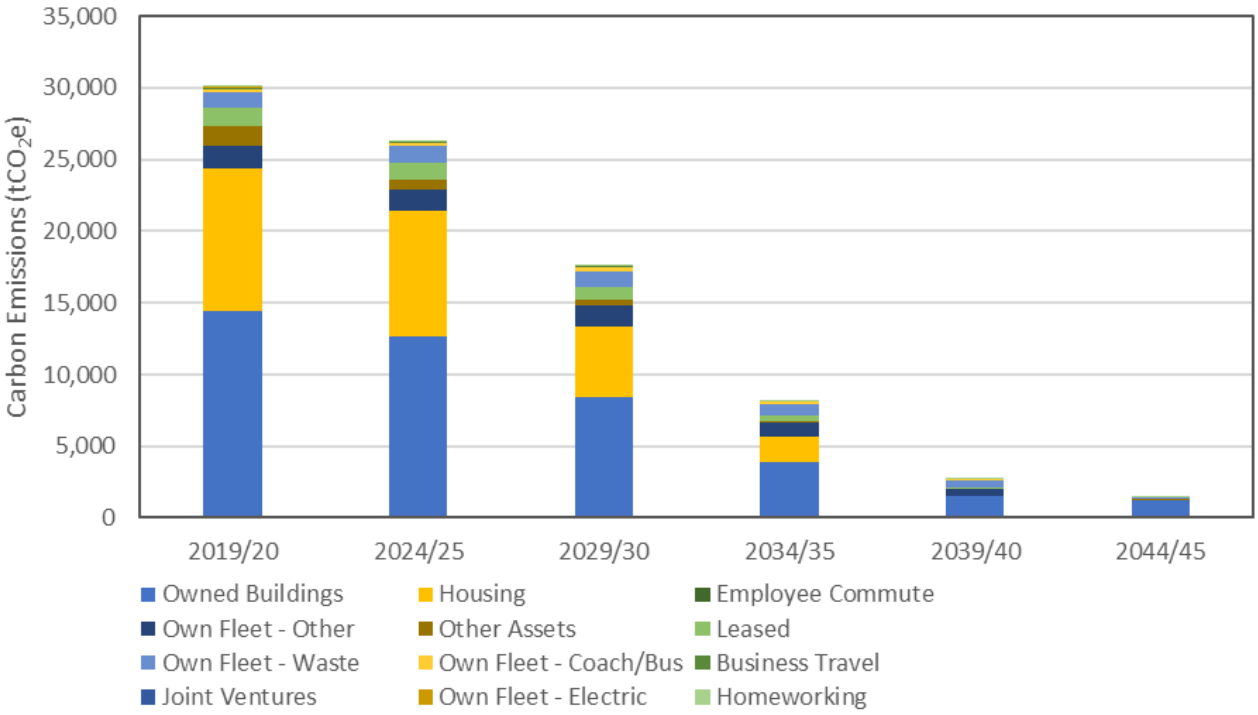


Figure 14: Net zero scenario 3 – emissions by sector (excluding supply chain)



2.2.3 Summary

- Only scenarios 1a and 2 meet net zero for all GHG emissions by 2045. This is due to deep cuts in emissions from procurement. Without this, net zero by 2045 for all GHG emissions is not possible. However, the cost associated with scenario 2 is substantially higher than the other scenarios.
- Scenario 1 cannot meet net zero for all emissions scopes by 2045 **and is therefore not recommended.**
- We therefore recommend scenario 1a. This follows the ambition set out in scenario 1 for all emissions except those from procurement (supply chain). Emissions from procurement follow the ambition set out in scenario 2, with these emissions being reduced sufficiently to reach net zero for all emissions by 2045. This would deliver net zero for Scopes 1 and 2 by 2036, thus demonstrating Council leadership on net zero, while achieving net zero for Scope 3 by 2045 but at a cost similar to that attached to Scenario 1 and much lower than scenario 2.

2.3 DELIVERING CORPORATE NET ZERO

2.3.1 Summary of recommended actions

The evidence report sets out in detail the actions that the Council will need to take to deliver net zero. The recommended actions are listed in Appendix 2. Some of the key recommendations that were set out in the evidence report include:

- Heat decarbonisation strategy for the council estate (including council housing, joint ventures, and leased buildings). This should include actions such as the development of a BEMS upgrade programme, a HVAC optimisation programme, and lighting upgrade programme.
- Completion of the draft fleet decarbonisation plan, ensuring the document addresses all vehicle types and the supporting infrastructure needed, including a review of the Broomhill depot design.
- Energy plan focusing on meeting the gap between demand and generation through various options, including PV roll out, private wire/sleeving opportunities (see below for explanation), community ownership schemes, and green electricity procurement for any residual demand.
- A travel policy establishing guidance on elements such as flights, business travel, and public transport prioritisation.
- Sustainable procurement action plan including mapping of priority suppliers and engagement plans to reduce emissions from key suppliers. The Council has already committed to furthering sustainability within the Annual Procurement Strategy in line with the adopted Circular Economy Strategy.
- A water management plan to formalise existing monitoring arrangements and improvement roll outs.
- A waste strategy aligning with the Circular Economy Strategy.

2.3.2 Homeworking

Evidence shows that overall, the emissions impacts of homeworking are small, and that the reduction in emissions (e.g., reduced commuting) broadly balance out the increase in emissions (e.g. heating homes more), where office spaces remain open. But if increased homeworking is combined with efforts to reduce office sizes, then a 2% reduction in overall buildings and transport emissions can arise.

An increase in homeworking will increase the Council's scope 3 emissions associated with homeworking. However, it will reduce the emissions associated with employee commuting and scope 1, 2 and 3 emissions associated with office use where a reduction in offices accompanies the increase in homeworking. The Council is considering closing 1,500m2 of offices (30%) as part of the workforce for the future programme. Analysis suggests that there would likely be emissions reductions from working from home under most home heating circumstances for lone car and long-distance lone car drivers, which make up the majority of EDC commuting patterns. In addition, reducing office space would also make it easier to meet the 2038 milestone proposed by the Scottish Government for public sector bodies to reach zero direct emissions from their buildings, thus also reducing costs.

2.3.3 Green energy procurement

There are a range of options for the Council in procuring green energy, including selecting a green tariff, installing renewables on the Council's own sites (or on partner sites) or private wire/sleeving. Private wire systems are localised electricity grids connected to the local distribution networks but linked to privately-owned central plant which produces electricity, whereas sleeving is where the electricity from the generation plant travels through the grid (and network chargers are paid) to the Council. The Council may also wish to consider community ownership (where local residents can buy shares in the renewable installation to raise the capital).

2.4 FINANCING CORPORATE NET ZERO

The total cost of doing this will depend on how the emissions reductions are delivered, but as a minimum is likely to cost around £320m over the period (£430m of costs and £115m of cost savings, e.g., lower fuel bills). **If greater levels of local renewable electricity generation (e.g., rooftop solar) and building fabric efficiency improvements are assumed (as in scenario 2), it would increase the capital costs to nearer to £1.4bn (it would result in lower ongoing operational costs, but these reductions would be much lower than the increase in capital spend). But doing this would not deliver net zero more rapidly.** Costs are set out in Table 2 table below and broken down by measure in Appendix 4.

Table 2: Estimated costs per pathway

Costs/savings	Pathway 1	Pathway 1a	Pathway 2	Pathway 3
Total CAPEX to 2045	£429-439m	£429-439m	£1.37bn	£293-304m
Fuel cost savings to 2045	£115m	£115m	£137m	£52m
Residual GHG emissions (tCO_2e)	**50,142**	**7,700**	**7,688**	**60,068**
Offsetting cost range for residual emissions (indicative)	**£1.5m - £15m**	**£231k - £2.3m**	**£230k - £2.3m**	**£1.8m - £18m**
Total expenditure by 2045	**£316-339m**	**£314-326m**	**£1.265bn**	**£243-270m**

The biggest costs come from decarbonising buildings (both Council offices – scope 1 – and leased out buildings and Council housing – scope 3) **and from switching the vehicle, school bus and waste collection fleets to electric and hydrogen**.

The costs to the Council of decarbonising its supply chain such that net zero is delivered by all emissions by 2045 (scenarios 1b and 2) **are very uncertain** and **need further analysis**[3]. They have therefore not been included in these figures other than a small amount for consultancy to carry out the further analysis. **The actual costs of decarbonising the supply chain will be borne by suppliers, but there could in theory be a cost to the Council if it results in more expensive bids being favoured over most cost competitive ones.** However even this is highly uncertain and may not be the case in a future where we expect all businesses to be decarbonising their operations.

There would also be a cost to offset residual emissions. Under the recommended approach outlined above (i.e., scenario 1a), there would still be residual GHG emissions in 2045 of about 7700 tCO_2e (8% of 2019 emissions). If these were to be offset, it would entail an additional cost. There is significant uncertainty over the future cost of carbon credits. Assuming a range of £30-300 per tCO_2e would result in a total cost of £230,000 to £2.3m in 2045. See 2.5 below for more details on offsetting.

[3] £100,000 has been included in the cost data, to support consultancy work on decarbonising EDC's supply chain.

Funding streams are available to support action by Council's to reduce their own emissions, for example the Scottish Central Government Energy Efficiency Grant scheme[4]. More information on funding sources and options are set out in the accompanying note on financing net zero.

2.5 OFFSETTING

As seen, residual emissions will remain across all pathways in 2045 that will need to be offset. Offsetting will be required annually to meet net zero as the Council and area continue to emit emissions. These will need to be included within annual operational costs.

There is a wide range of possible offsetting costs. For example, the Woodland Carbon Code is selling carbon credits for £10-30/tCO2e. The GLA currently sets it at £95/tCO2e for development projects. The Treasury Green Book indicates that carbon values could go up closer to £600/tCO2e in the future and research from PwC suggests prices could go up by almost a factor of 10. Hence, in the analysis that was carried out, a range of £30-£300/tCO_2e was used.

An alternative to purchasing carbon credits from an already certified carbon offset project is to invest in the creation of carbon offsets within East Dunbartonshire. This would offer more local benefits and would give EDC greater control over the schemes and certainty over the outcomes of the projects. However, doing so would require additional effort to establish and run and would not be certified.

The following factors should be considered as the Council reviews its options for additional offset projects:

- What would council stakeholders prefer?
- Does the Council wish to use sequestration / offsetting projects as 'good news' stories?
- Do the Council have additional available land or can use third party land?
- Would the benefits of the natural sequestration options be of use? Are there any other co-benefits for council operations? (Such as air quality, flood prevention and recreational space development).
- Short term vs long term strategies and reliance on future markets

The next steps for the Council would be to:

- Quantify the sequestration potential of current and planned projects as identified in council strategies.
- Review potential land (both council and suitable third party) for additional projects.
- If needed review the option of purchased offsets for any remaining emissions.

3. NET ZERO EAST DUNBARTONSHIRE

East Dunbartonshire Council has a legal duty to support the national target of net zero GHG emissions by 2045 under the Climate Change (Scotland) Act of 2009. This is not limited to council operations; therefore, it is expected that local authorities use their powers and influence to contribute to emissions reductions in the local authority area beyond their own operations. This requires ambitious mitigation actions in all key sectors, namely buildings, transport, energy system, agriculture, industry, and waste. If carried out in a well-thought-out manner, these mitigation actions can result in a wide range of co-benefits, such as enhanced biodiversity, improved well-being, increased social connectivity, and climate adaptation.

3.1 EAST DUNBARTONSHIRE'S CURRENT GHG EMISSIONS

3.1.1 Scope of emissions

Scope 1, 2 and 3 emissions at an area level are set out in Table 3 below.

Table 3. Explanation of scope 1, 2, and 3 emissions at an area level

Type	Definition	Examples

[4] Scottish Central Government Energy Efficiency Grant scheme: form and guidance - gov.scot (www.gov.scot)

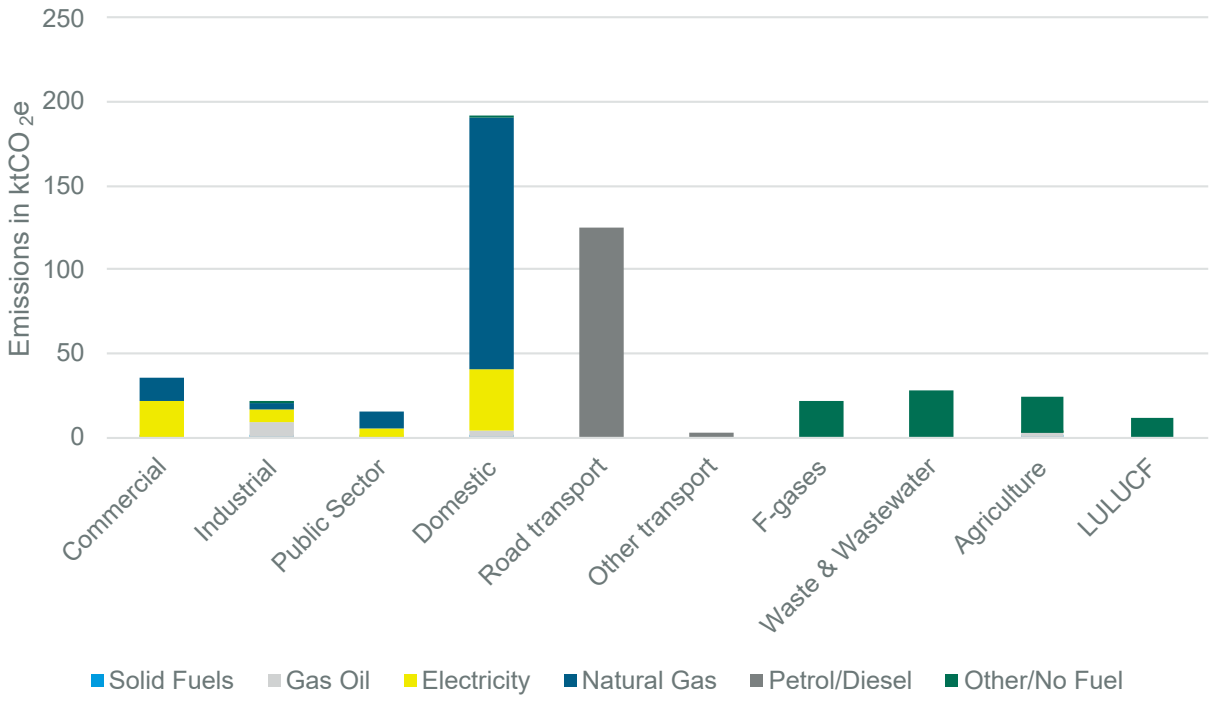
Scope 1	Direct emissions from fuel combustion and fugitive emissions within the local authority boundary	• Fuel combustion in buildings and road vehicles • Emissions from agriculture, waste and wastewater treatment, or landfill activities taking place within East Dunbartonshire
Scope 2	Indirect emissions from purchased electricity, heat, steam or cooling that is generated elsewhere	• Use of grid electricity within East Dunbartonshire homes and businesses
Scope 3	Other indirect emissions	All other indirect emissions, such as: • Waste or wastewater treatment *outside* of East Dunbartonshire (of waste arisen within East Dunbartonshire) • Transport of fuels that are used within the city • Supply chains for food, products, and materials • Journeys to/from the city that are outside the local authority boundary • Shipping and aviation

At the area-level the aspiration has been to ensure that the emissions baseline conforms to the reporting standard of the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC), specifically the BASIC+ framework, as far as is reasonably possible. This would mean covering all scope 1 and 2 emissions, as well as scope 3 emissions for energy (transmission and distribution losses), transport (trans-boundary transportation) and waste (emissions from the disposal and treatment of waste outside of East Dunbartonshire that was generated within East Dunbartonshire). However, it was not entirely feasible to conform to the BASIC+ reporting standard as the official, national datasets have not been set up to conform with this framework. The GHG baseline developed thus far conforms with all BASIC and BASIC+ requirements other than transboundary transport.

3.1.2 Latest emissions

GHG emissions across East Dunbartonshire in 2019 (the latest year for which data was available when the project started) were 476 $ktCO_2e$. The breakdown of these emissions by sector and by fuel type is shown in Figure 15 below.

Figure 15: Estimated GHG Emissions in East Dunbartonshire by sector and fuel type

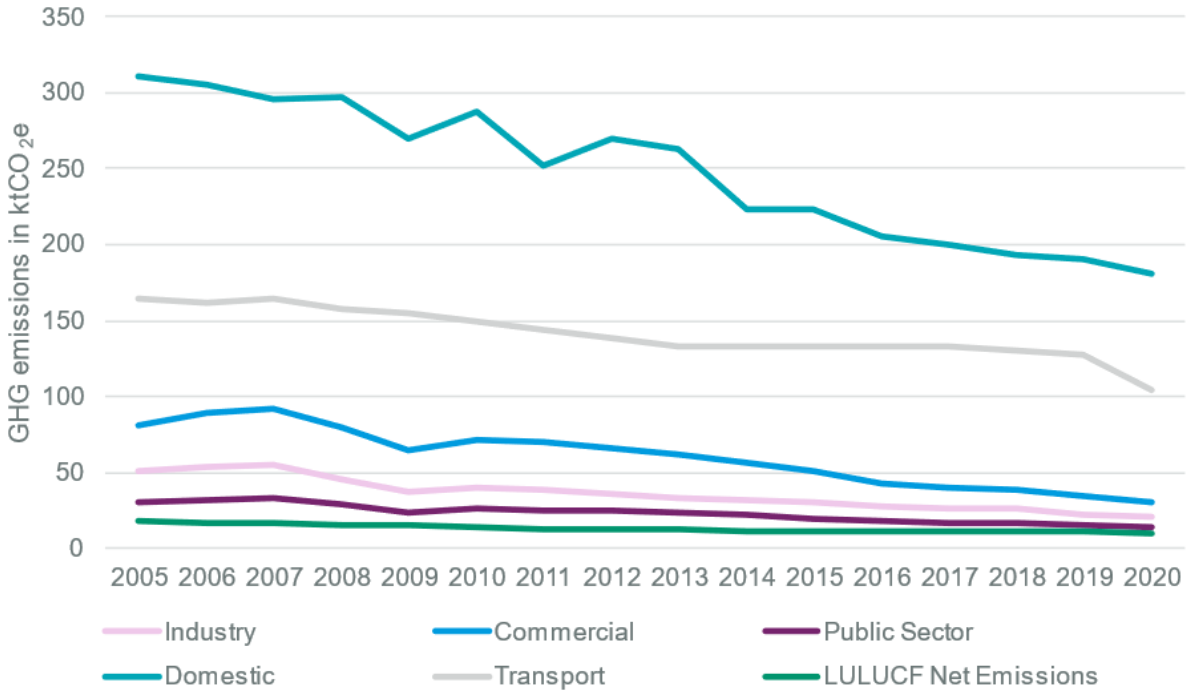


Energy use in domestic buildings accounts for the largest portion of the total, at around 40%, followed by road transport (26%). Emissions from commercial buildings and industry are estimated to account for roughly 10% of GHG emissions respectively while public sector buildings account for around 3%. Emissions from fluorinated gases account for roughly 4% of emissions.

The land use and forestry (known as land use, land use change and forestry, or LULUCF) sector is not a large contributor to overall emissions (c. 2%) but bears the potential to be turned into a net sink (i.e., absorbing more GHG emissions than it emits). The majority of agricultural emissions stem from livestock. Overall, agriculture makes up around 5% of emissions. Emissions from waste and wastewater treatment associated with East Dunbartonshire are estimated to be roughly 28 $ktCO_2e$ (almost 6%). These are Scope 3 emissions meaning that the waste is generated in East Dunbartonshire but disposed of elsewhere (for example at the Dunbar waste treatment facility in East Lothian).

The majority of the GHG emissions across East Dunbartonshire are CO_2 from combustion activities. Figure 16 below shows how the CO2 emissions have changed over time since 2005. This shows emissions in 2020 dropped significantly, as we would expect as a result of lockdowns. However, we know from more recent data that there has since also been a considerable uplift in emissions between 2020 and 2021 as the economy bounced back.

Figure 16: Trends in CO_2 emissions in East Dunbartonshire, 2005-2020



3.2 EAST DUNBARTONSHIRE'S FUTURE GHG EMISSIONS

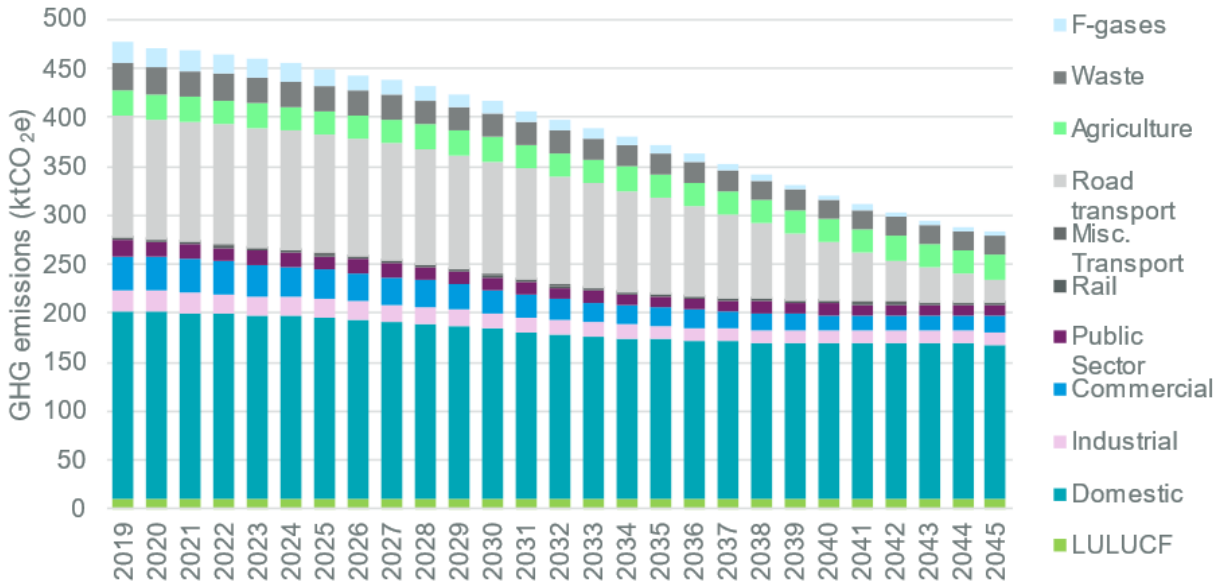
A number of future GHG emissions scenarios were developed using Ricardo's net zero modelling tool.

3.2.1 Business-as-usual scenario

The BAU scenario is intended to show the changes that could occur if no additional action, either locally, regionally, or nationally, was taken to mitigate GHG emissions in East Dunbartonshire, beyond those that are already planned and committed. It includes national-level economic and demographic trends, along with projected energy prices and likely technological improvements (e.g., better vehicle efficiency). The scenario essentially answers the question "what would happen to emissions if we continued doing what we are doing now".

In the BAU scenario, GHG emissions in East Dunbartonshire would fall by roughly 13% by 2030, 33% by 2040, and 43% by 2045.

Figure 17: Changes in GHG emissions by sector in the BAU scenario



This simply reflects the fact that the policy landscape does not yet exist, either locally or nationally, to deliver net zero. Similar BAU trends can be seen in other local authorities, as well as at the Scottish and UK levels. The major factor driving these changes is the decarbonisation of the electricity grid. Overall, the BAU results highlight the fact that additional GHG mitigation efforts will be necessary to ensure that the net zero target in East Dunbartonshire can be met.

3.2.2 Net zero scenarios

Three scenarios were modelled using Ricardo's net zero modelling tool:

- 1 – balanced
- 2 – balanced, plus local ambition
- 3 – accelerated

All these scenarios broadly entail the same sort of measures – there are not many different ways to achieve net zero:

- Energy use in buildings
    - Improving thermal efficiency of buildings.
    - Connecting a proportion of domestic buildings that are currently on the gas network to heat networks, and then converting these to use renewable heat (such as large-scale electric heat pumps).
    - Almost all domestic buildings that aren't suitable for heat networks are assumed to switch to individual heat pumps.
    - A small proportion of buildings (around 4%) was identified as not suitable for heat pumps. These were assumed to be switched to (or remain on) direct electric heating.
    - Hydrogen was not considered as a suitable heating option for East Dunbartonshire due to both the technical issues and high costs associated with this fuel. This is in line with recent policy developments.
- Energy system
    - Electricity grid decarbonisation taking place in line with national modelling and targets.
    - Massive increase in local deployment of roof-mounted solar technologies on suitable buildings.
- Transport

    - Avoiding car journeys via behavioural and technological change, e.g., working from home.
    - Replacing a proportion of remaining car journeys with walking, cycling and public transport.
    - Reducing demand for LGV and HGV movements through trip consolidation and changes in logistics.
    - Improving HGV efficiency through technology improvements and driver training initiatives.
    - Uptake of electric vehicles (cars, vans, buses, motorcycles and possibly HGVs, which could also run on hydrogen).
- Industry
    - Decarbonisation of heat through fabric efficiency measures and switch to low-carbon heat such as heat pumps.
    - Decarbonisation of industrial processes through a switch to low-carbon fuels such as grid electricity and hydrogen.
- Waste
    - Reduce emissions from landfill through waste reduction measures, namely: reduced waste arisings, increased recycling rates.
    - Reduce emissions from landfill through landfill gas (methane) capture.
    - Improved wastewater management.
    - Improved composting management.
- Agriculture and land use
    - Diet change to reduce meat and dairy consumption.
    - Halving food waste by 2030.
    - Measures to release land such as productivity improvements and moving 10% of horticulture indoors.
    - Reducing emissions from agricultural machinery through a switch to electricity, green hydrogen, and biofuel.
    - Mitigation actions for the land use and forestry sector require further, site-specific research (the CCC suggests a range of measures, such as afforestation, peatland restoration, agro-forestry, broadleaf management, and energy crops & short rotation forestry.

The next sections explain the three scenarios in a bit more detail. Further information is in the evidence report and the assumptions for each measure in each scenario are set out in Appendix 3.

3.2.2.1 Scenario 1 - balanced

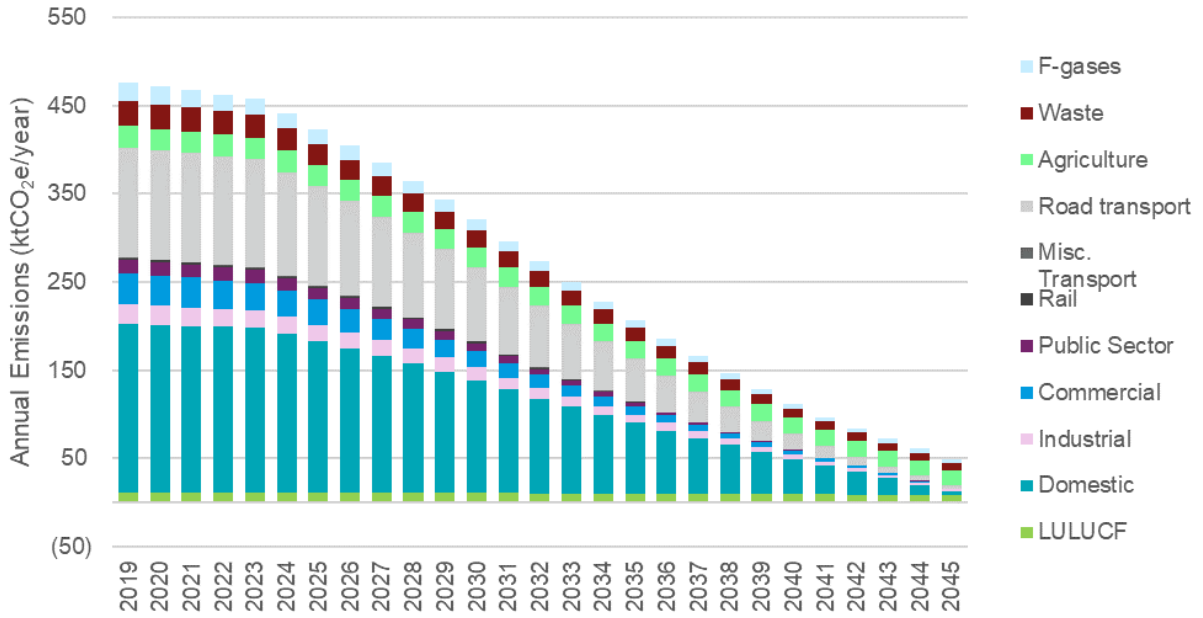
Achieves net zero by 2045 but would still require some offsetting.

This is based on the CCC's 6th carbon budget's "Balanced Pathway", with all possible actions brought forward from 2050 to 2045 in line with the Scottish Net Zero target, and with some changes made to reflect Scottish climate policy (e.g., the 20% reduction in car km travelled).

It illustrates a pathway to net zero that is very ambitious (e.g., full switch to low-carbon heating such as heat pumps, near complete electrification of the transport sector, partial decarbonisation of industrial processes).

It gets East Dunbartonshire relatively close to net zero (90% reduction from 2019 levels) but still results in substantial residual emissions (49.4 $ktCO_2e$ annual emissions in 2045).

Figure 18: GHG emissions by sector in scenario 1



3.2.2.2 Scenario 2 – balanced plus local ambition

Achieves slightly greater emissions reductions by 2045.

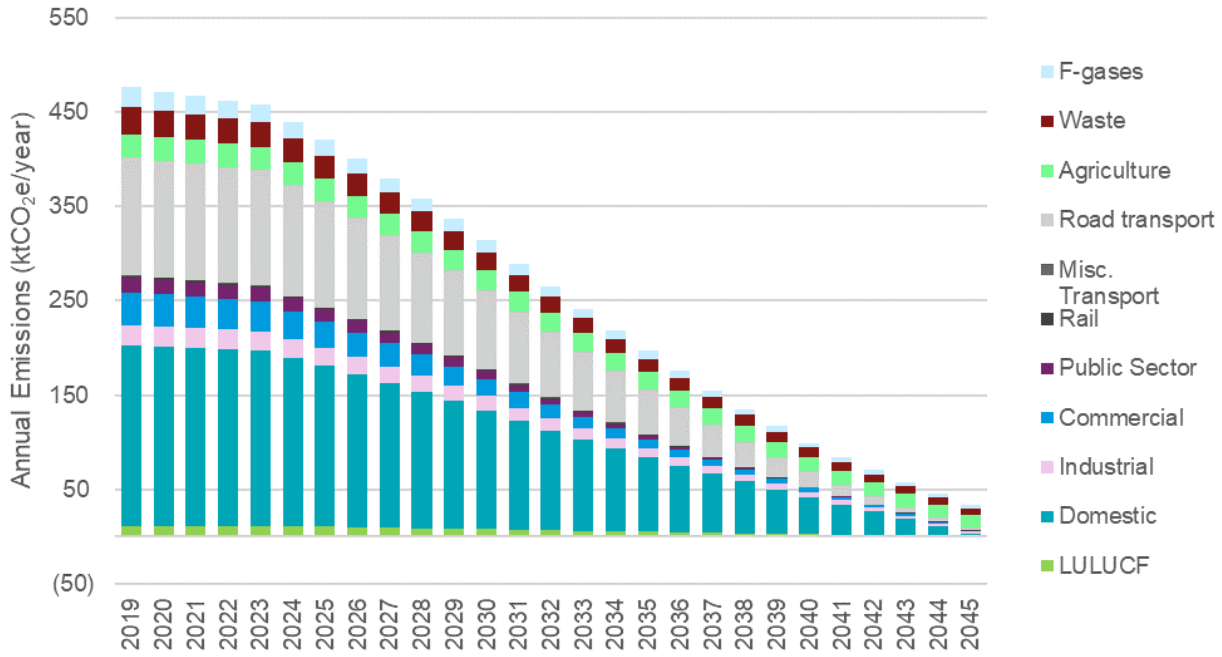
Scenario 2 builds on Scenario 1 but assumes that the target was met more through local ambition where this was deemed feasible.

Specifically, it is assumed that more vehicle kilometres (i.e., the distance covered by cars) are avoided through behavioural and societal changes and shifted to sustainable alternatives. It was further assumed that higher levels of retrofitting are realised, resulting in a decrease in energy consumption in buildings. Actions in both these sectors have impacts on energy consumption as well as – albeit to a lesser degree – GHG emissions.

In addition to the energy-related measures, it was assumed that more ambitious measures can be realised in the land use sector, assuming a 100% reduction in LULUCF emissions (up from 25% in scenario 1).

Under this scenario East Dunbartonshire would see an emissions reduction of 93% by 2045 – with residual annual emissions of 34.3 ktCO2e in 2045.

Figure 19: GHG emissions by sector in scenario 2



3.2.2.3 Scenario 3 – accelerated

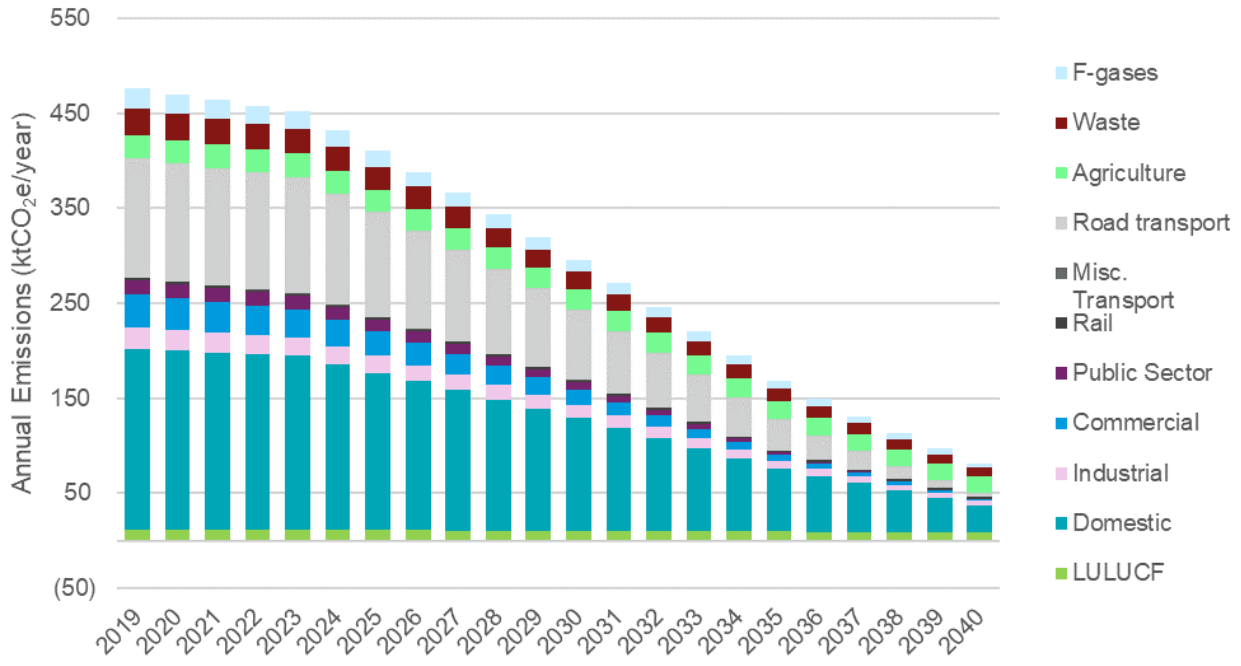
Net zero is not reached by 2040 without significant levels of offsetting.

This illustrates an accelerated pathway to net zero with a target year of 2040. The aim with this scenario was to test the scope for meeting net zero before 2045. It assumes the UK Government's target to decarbonise the grid by 2035 is met (unlike the other scenarios). This is far from certain and is outside of the Council's control.

Many of the measures are brought forward to 2040 where this was deemed feasible. However, in some cases it was judged that this would not be feasible for certain measures, for example bringing forward by five years the full decarbonisation of all buildings in East Dunbartonshire, or the transition of HGVs from diesel to electric or hydrogen.

The scenario results in an 83% reduction in GHG emissions from 2019 levels. Hence, even accelerating many of the measures, net zero would not be attainable without significant quantities of offsetting.

Figure 20: GHG emissions by sector in scenario 3



3.2.3 Summary

- **The analysis shows that a net zero target for East Dunbartonshire in advance of the 2045 Scotland date would be challenging, and setting such a target would entail considerable risk.**
- **Scenario 2 delivers slightly deeper emissions cuts than scenario 1, although both achieve the technical definition of net zero by 2045 (a 90% or more cut in emissions).**
- **Scenario 2 delivers the emissions reductions through greater ambition at the local level, for example higher rates of uptake of solar PV, and of modal shift away from private car use. But it also entails higher costs, primarily from assumed greater levels of fabric efficiency in buildings.**
- **The recommendation is therefore scenario 1, and to commit to a net zero target for the whole of East Dunbartonshire of 2045, in line with the Scottish target.**

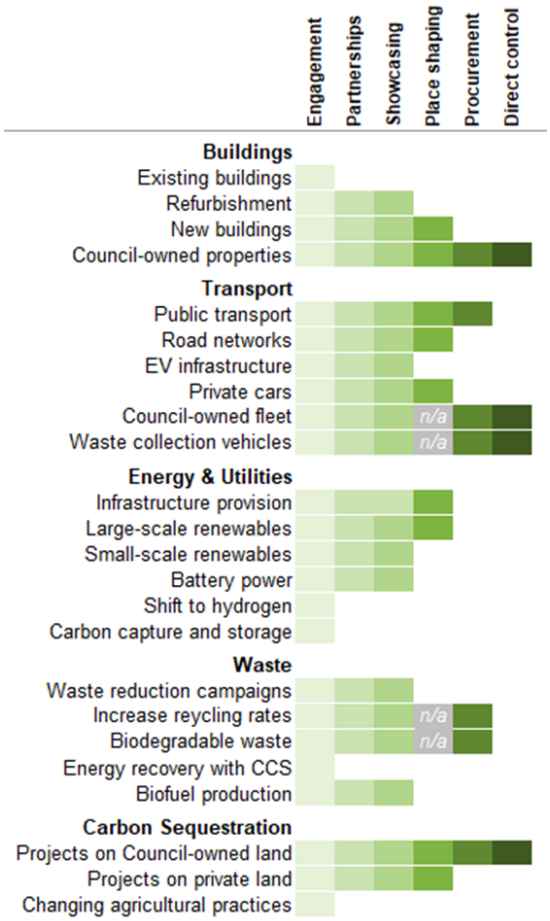
3.3 DELIVERING NET ZERO ACROSS EAST DUNBARTONSHIRE

Whilst the Council's own (scope 1 and 2) emissions only account for 3% of all GHG emissions across East Dunbartonshire, local authorities have a wide range of options for exerting indirect influence over emissions that they do not directly control.

Figure 21: Ways in which local authorities can influence GHG emissions across the area

Figure 22 summarises how East Dunbartonshire Council (EDC) can influence decarbonisation across key policy areas. The colour coding is used to indicate the ways that EDC can play a role. Indirect methods of influence are shown in lighter green and direct methods in darker green. Grey shading with ‘n/a’ means that a method is not applicable or not likely to be used.

Figure 22: EDC influence over emissions in different sectors



Overall, much of the Council's influence will be reliant on engagement with stakeholders to promote carbon reduction projects, showcasing best practice, raising awareness, partnerships and lobbying for change. Some examples of key actions are as follows:

- Buildings:
    - The Council will need to primarily rely on engagement and partnerships to reduce emissions in existing buildings (e.g., continuing to provide energy saving advice, or continuing to make grant funding available for energy efficiency improvements).
    - EDC has more influence over new buildings and major refurbishments, and direct influence over council-owned properties or developments. There are a number of registered social landlords that provide social housing provision throughout East Dunbartonshire – working closely with them will be key.
- Transport:
    - While EDC can procure public access EV charging points, they will need to rely on showcasing, partnerships, and engagement to successfully encourage uptake of private EVs.
    - Additionally, the Council needs to ensure that all new developments are located and designed to reduce demand for travel and encourage active/sustainable transport options. This could involve, for example, identifying sites for consolidation centres to reduce the number of commercial goods vehicles operating in town centres. This would have co-benefits for air quality, public health, etc.
    - For assets directly controlled by EDC, 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.

  - EDC has been in communications with other local authorities from the Glasgow City Region and carried out a public consultation at the end of 2022 with the goal to develop an EV strategy.
  - The Council has significant influence on the area's spatial design via the planning system which, in turn, impacts future transport emissions. Specifically, the NPF 4 includes 'local living' as one of the key spatial principles. As part of this, LPAs should help create "connected and compact neighbourhoods where people can meet the majority of their daily needs within a reasonable distance of their home, preferably by walking, wheeling or cycling or using sustainable transport options". This could specifically include the creation of 20-minute neighbourhoods, where possible.
- Energy:
  - EDC will be able to play an indirect role through engagement, partnerships and in its capacity as an LPA. For example:
    - Demonstrating and showcasing the feasibility and benefits of projects, particularly small-scale renewable energy and battery power projects on council-owned land or properties, or innovative pilot projects
    - Playing a coordinating role (e.g., through community energy projects).
  - While EDC is not in charge of grid upgrades and expansion, local authorities can encourage the development of the required infrastructure by bringing local partners together and steering implementation through planning policy.
  - There are limited opportunities for EDC to influence the use of some technologies such as hydrogen gas and carbon capture usage and storage, initiatives which will be driven predominantly at the national/UK level. EDC's role in this regard will primarily be to keep abreast of new developments. There could potentially be opportunities to engage in pilot schemes in the future.
- Land use and agriculture:
  - EDC can deliver carbon sequestration projects on council-owned land. It needs to be ensured these projects also consider biodiversity requirements, tackling the ecological emergency alongside the climate emergency.
  - 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. The Council should maximise existing partnerships such as the green network partnership and utilise their service agreement with the Green Action Trust. EDC may also partner with local organisations working in this area, such as 'Friends of…' organisations which focus on specific nature reserves such as Lenzie Moss.
  - EDC 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 in planning policy, although that is not the focus of this report.
  - As per NPF 4, EDC should "protect, restore and enhance natural assets making best use of nature-based solutions." and "protect and expand forests, woodland and trees." This not only ensures that the ecological emergency is tackled alongside the climate crisis, but also that emissions from the LULUCF sector are reduced as far as possible through increasing carbon sequestration.
- Waste:
  - The Council should continue to provide separate collections for different waste streams, including food and green waste, and consider options for additional carbon emissions reduction when renewing waste contracts in future.
  - Engaging with residents, businesses, waste contractors and Government can promote waste reduction measures and showcasing best practice by setting targets for reducing waste within operations that EDC directly controls. 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.'

- EDC 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.

3.4 FINANCING NET ZERO ACROSS EAST DUNBARTONSHIRE

The most significant costs are associated with upgrading the building stock and replacing the vehicle fleet.

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 £970-1,650 million for domestic buildings and around £280-350 million for non-domestic buildings.

The cost to replace existing cars and vans with zero-emission alternatives is in the region of £1,500 million; however, this is based on current vehicle ownership rates whereas many of the mitigation measures related to transport would promote lower reliance on private vehicles.

Using the same cost of carbon credits as above, the costs of offsetting residual emissions in each scenario are as follows. It is not necessarily the case that these costs should be borne by the Council.

Table 4: Estimated cost for offsetting

	Scenario 1	Scenario 2	Scenario 3
Residual emissions (tCO_2e)	49,400	34,300	82,000
Cost of offsetting residual emissions[5]	£1.5m - £14.8m	£1m - £10.3m	£2.5m - £24.6m

It is important to understand the context of these cost figures:

- **These are not costs that need to be fully met by the Council**. Funding is also available from national government (both Scotland and UK). Furthermore, it is widely recognised that public finance will only be able to meet part of the costs of delivering net zero. Significant private sector and other investment will also be needed. A key challenge for all local authorities will be how to unlock and encourage this private sector investment.
- The cost figures quoted above are total investment costs, for example the cost of an electric vehicle or a heat pump. It **does not deduct the cost of what someone would be purchasing anyway**, for example a petrol/diesel vehicle or a condensing gas boiler.
- **The transition to net zero will generate significant benefits, many of which are hard to quantity**. These include reducing costs of congestion (through measures to increase use of public transport and active travel), tackling fuel poverty (through improved thermal efficiency of homes), improved air quality (through a shift to cleaner vehicles) and improved health outcomes (through cleaner air, more green spaces and more active travel).
- That said, it will be **necessary to ensure a just transition**, so that specific social groups and businesses are not unduly adversely affected by the transition to net zero.

There are a range of funding streams available to support the transition to net zero, with Scotland-specific ones including the Social Housing Net Zero Heat Fund, the SME Loan Fund and the Heat Network Fund. There are also other options for funding local net zero action that local authorities are starting to explore more and more, such as local climate bonds, local insetting schemes, revenue raising schemes such as parking levies and as-a-service models (e.g., energy-as-a-service).

3.5 OFFSETTING

It is widely recognised that getting GHG emissions in an area down to zero will not be possible and there are always likely to be some residual emissions in hard-to-tackle sectors. To achieve true net zero, these emissions would therefore need to be offset. Section 2.5 above explains the uncertainty in the future cost of carbon credits and this wide range was used to calculate the costs of offsetting in Section 3.4. However, there is no

[5] Assuming a carbon cost of between £30 and £300 per tCO_2e.

clarity on who would be responsible for paying this cost. As outlined above, whilst the Council has considerable influence over delivering net zero, it does not hold all the levers needed to achieve it and arguably should not be solely responsible for meeting the costs of any offsets.

APPENDICES

APPENDIX 1 – ASSUMPTIONS FOR CORPORATE NET ZERO SCENARIOS

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
Scope 1								
School coach / bus hire vehicle switch	Assumes a move to green hydrogen with refuelling facility costs shared between neighbouring LAs/commercial re-fuelling becomes available(whole fleet, 21 vehicles conversion by 2035)	2027 - 2035	Same as pathway 1	Assumes a move to green hydrogen with Council funded refuelling facility at Broomhill depot(whole fleet, conversion by 2035)	2027 - 2035	Assumes a move to electric vehicles (whole fleet conversion by 2045)	2030 - 2045	Larger vehicles have a less developed market of low carbon solutions than small vehicles. As such the two most likely options available to the council (electrification and hydrogen) have both been considered and included in relevant different pathways. Third party providers will potentially require support in transitioning to low carbon vehicles. Therefore, this is likely to be possible later in the timeframe.
Own fleet – waste vehicles – improved efficiency	5% fuel saving	2023 - 2028	Same as pathway 1	10% fuel saving	2023-2028	Same as pathway 1	Same as pathway 1	Typically, efficiency measures can achieve a fuel saving of greater than 10%. In the balanced and conservative pathways, 5% has been assumed to reflect that telematics has already been rolled out by the council, though there is opportunity for further efficiency improvements. For example, the council could target driver training and more fuel efficient tyres. There are few barriers to the implementation of these actions therefore, it is recommended that they are targeted early in the pathway.

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
Own fleet – waste vehicles – vehicle switch	Assumes a move to green hydrogen with refuelling facility costs shared between neighbouring LAs/commercial re-fuelling becomes available (whole fleet, 72 vehicles conversion by 2035)	2027 - 2035	Same as pathway 1	Assumes a move to green hydrogen with Council funded refuelling facility at Broomhill depot (whole fleet conversion by 2035)	2027 - 2035	Assumes a move to electric vehicles (whole fleet conversion by 2045)	2030 - 2045	Larger vehicles have a less developed market of low carbon solutions than small vehicles. As such the two most likely options available to the council (electrification and hydrogen) have both been considered and included in relevant different pathways. Fuel switching should align with vehicle end of life, understood to be post 2030 for some of the fleet.
Refrigerant leakage	10% saving of refrigerant leakage	2023 - 2025	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Up to 50% leakage reduction is achievab temperatures[1]. A 10% reduction has been assumed to reflect current refrigerant maintenance practices.
Refrigerants replacement	60%[1] saving on emissions associated with refrigerants	2025 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Replace refrigerants with drop in alternatives with a lower global warming potential, thus retaining existing air conditioning, heat pump and chiller equipment whilst minimising the emissions associated with any refrigerant leakage.
Own fleet – other vehicle – efficient use	5% saving of current fuel	2023 - 2026	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Typically, efficiency measures can achieve a fuel saving of greater than 10%. 5% has been assumed here to reflect that the Council has rolled out telematics, but has additional scope for other areas such as driver training and fuel efficient tyres, These are

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
								relatively ready to implement so have been given an earlier timeframe.
Own fleet – other vehicle – vehicle switch	Assumes a transition to an electrified vehicles fleet (all 500 by 2030). Electric vehicles assumed to be 60% more energy efficient.	2025 - 2035	Same as pathway 1	Same as pathway 1 with accelerated timeframe	2025-2030	Same as pathway 1 with decelerated timeframe	2030 – 2045	Assumes these are the smaller vehicles (cars and vans) for which there are suitable electric alternatives. The timeframe allows for vehicles being replaced as they reach end of life. This is highly dependent on the installation of the new Broomhill depot (understood to be imminent) with charging facilities, and suitable charging infrastructure being installed at other key council sites. Timeframes may be impacted by the need for infrastructure upgrades.
Buildings – Building fabric	16% savings of heating consumption	2024 – 2038	Same as pathway 1	27% saving of heating consumption	2024 – 2038	12% saving of heating consumption	2024 – 2038	Energy intensity (kWh/m^2) limits applied to determine whether specific building fabric upgrades to be applied – these limits vary per pathway. Threshold hierarchy: Conservative>balanced>ambitious Thus less buildings meet criteria in conservative pathway compared to balanced and from balanced to ambitious. Various packages of measures applied across building stock -requires building level assessment to justify cost and savings. Savings of between 12-27% estimated through calculations on building level. There is a knock-on impact to heating decarbonisation – higher building fabric upgrade levels allow HPs with better sCOPs to be installed, increasing energy savings.20% is a

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
								typical saving that can be achieved from building fabric improvements. These are ready to implement but have been given a longer implementation timeframe due to the large number of buildings, but with the programme completed in advance of the 2038 zero direct emissions target.
Buildings – efficient heating	10% saving on building heating use	2023 - 2033	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	10% is a typical saving in heating demand that can be achieved from efficiency measures for heating systems, such as pump and fan replacement works. These are ready to implement but have been given a longer implementation timeframe due to the large number of buildings
Buildings – heating switch	Move to electrificati %[1] reduction in use	2025 - 2038	Same as pathway 1	Move to electrification via ASHP or direct electric with a 50% reduction in fuel use. Higher b/fab upgrade resulting in better HP performance	2025 - 2038	Move to electrification via direct electric or ASHP with a 12% reduction in fuel use	2025 - 2038	Estimates for existing boiler /heat generation technology efficiency against new heat pump seasonal Coefficient Of Performance (sCOP) to reduce fuel for heat generation. Higher sCOP in ambitious pathway due to higher building fabric upgrades – higher sCOP leads to lower energy requirements for the buildings. These are ready to implement but have been given a longer implementation timeframe due to the large number of buildings, but with the programme completed in advance of the 2038 zero direct emissions target.

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
								For pathway 1 there is a mix of moderate levels of building fabric and a mix of direct electric and HPs. For pathway 2 there is high building fabric and high HP installation. For pathway 3 there is reduced levels of building fabric and high direct electric installation.
Scope 1 & 2								
Building space usage rationalisation	30% reduction in office space utilised	2025 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	30% reduction in office space in order to reflect increased council workforce homeworking.
Scope 2								
Buildings – electricity energy management	2% saving of electricity consumption	2025	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	10% is a typical saving that can be achieved from efficiency measures. These could include review and upkeep of energy data, and adjustment of pump and fan set points through BEMS. As the Council's has already undertaken considerable work in this area 2% is assumed based on information provided by EDC. These are ready to implement so have been given an earlier timeframe.
Buildings – electricity efficiency improvements	2% saving on electricity consumption	2024	Same as pathway 1	Same as pathway 1. Assumed this could be implemented	Same as pathway 1. Assumed this could be implemented	Same as pathway 1. Assumed this could be implemented in	Same as pathway 1. Assumed this could be implemented	15% is a typical saving that can be achieved from moving to more efficient appliances. As the Council's has already undertaken considerable work in this area 2% is assumed based on

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
				in procurement specification in a single year	in procurement specification in a single year	procurement specification in a single year	in procurement specification in a single year	information provided by EDC. These are ready to implement so have been given an earlier timeframe.
Buildings – electricity renewable generation	20% of electricity demand (Typical figure for moderate level of installations)	2025 - 2035	Same as pathway 1	75% of electricity demand (Would likely require most available roof space and potentially additional land)	2025 - 2035	10% of electricity demand (lower level of installations)	2025 - 2045	The pathways assume varying rates of renewable generation to meet electricity demand. For pathway 1, this is a typical figure which could be achieved with a moderate level of installation. Pathway 2 is ambitious and would likely require most available roof space and possibly additional land and storage. Pathway 3 is a conservative view of deploying renewables on site. These technologies are ready to be deployed but have been given a longer timeframe to reflect the scale of systems that would need deployed. A detailed study would need to be conducted to confirm feasible percentages on the Council's estate or additional land.
Buildings – electricity green procurement	Not included in pathway 1	Not included in pathway 1	Same as pathway 1	Purchase green electricity for all grid supplied electricity	2035 - 2045	Not included in pathway 3	Not included in pathway 3	Only pathway 2 includes green electricity These would also require emissions to be reported on a market basis rather than a location basis as they currently are. This is because market based emissions are required to be reported when electricity is purchased through green tariffs. As the Council do not

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
								currently procure green energy this would result in them having to use the residual emission factor rather than average grid for their current emissions, which would increase their current emissions.[1]
Streetlighting - LED	No accelerated programme compared to BAU	No accelerated programme compared to BAU	No accelerated programme compared to BAU	No accelerated programme compared to BAU	No accelerated programme compared to BAU	No accelerated programme compared to BAU	No accelerated programme compared to BAU	Remaining LEDs to be converted over the next 15 years as part of the current programme.
Scope 3								
Joint ventures (same as buildings)	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Same as pathway 1	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Assumptions as per council owned buildings	
Leased out buildings, (same as buildings)	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Same as pathway 1	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Assumptions as per council owned buildings	Assumptions as per council owned buildings	
Business Travel – Other Travel policy	20% reduction in travel emissions	2024 - 2030	Same as pathway 1	40% reduction in travel emissions	2024 - 2030	10% reduction in travel emissions	2024 - 2032	Travel policies are readily implementable, and it is recommended the Council undertake one. Timeframe reflects that ongoing engagement will be required to sustain savings. Typical savings are from Ricardo project experience.
Business Travel – Taxi Switch to low carbon vehicles	Assumes 36 taxis switch to EVs by 2030	2027- 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Assumes 36 taxis switch to EVs by 2045	2030 - 2045	Assumes these are the smaller vehicles (cars and minivans) for which there are suitable electric alternatives. The timeframe allows for vehicles being replaced as they come up for renew. Assumes all taxi travel is electrified. Third party providers will potentially require support in moving to low carbon vehicles. As such, costs will be

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
								attributed to the Council for these upgrades across the pathways.
Business Travel - Car mileage Travel policy	Assumes switch to electric vehicles	2024 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Assumes switch to electric vehicles	2028 - 2035	Assumes that policy can encourage an earlier switch to electric vehicles and council staff could be encouraged to switch faster than third parties such as taxis. Council should implement a travel policy to prevent unnecessary journeys where public transport is available and results in similar travel time.
Waste, waste strategy	25% reduction in waste	2025 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	The Council should begin collecting actual waste data from its operations to assess where these can be reduced, drawing from draft policies such as the circular economy strategy. Savings are typical from Ricardo project experience).
Water, water management programme	10%[1] reduction in water	2024 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	The Council should resolve the issues with its water data to allow better management of water consumption and to continue the roll out of efficient appliances.
T&D and WTT, Reduced as fuel consumption decreases	Reduced as fuel consumption decreases		Same as pathway 1					
Employee commuting, Travel policy and facilities	50% reduction in travel emissions	2024 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	25% reduction in travel emissions	2024 - 2030	Measures have the potential to be developed rapidly once funding becomes available. It is recommended a Travel Plan be put in place as quickly as possible. Timeframe reflects that

Measure	Pathway 1 - Balanced		Pathway 1a - Balanced + greater supply chain ambition	Pathway 2 - Balanced plus additional local leadership		Pathway 3 - Conservative		Rationale
	Assumptions	Implementation timeframe		Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
for low carbon travel								ongoing engagement will be required to sustain savings. Respective percentages would require staff modal shift to low carbon transport solutions including electric vehicles, zero carbon public transport, or increased homeworking in the timeframe.
Employee commuting, homeworking	51% reduction in staff travelling to offices	2025 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	New work patterns proposed suggest a 51% reduction in staff travelling to the office compared with the baseline year.
Homeworking – additional homeworking	Staff hours of homeworking as per proposed new working patterns	2025 - 2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Staff hours will be as per the workforce for the future assumptions, and staff numbers as per the increasing trend discussed in the BAU. Assumed domestic heating would remain gas **Note this increases emissions**
Housing, Element energy	Aligned to Element Energy work and projections. 100% removal of fossil fuels	2024 to 2038	Same as pathway 1					
Wider supply chain, Sustainable procurement strategy	25% reduction in emissions	2024 - 2045	Same as pathway 2	Assumes 90% suppliers decarbonise with legally binding 2050 net zero target	2024 - 2045	10% reduction in emissions	2024 - 2045	Pathway 1 - Assumptions reflective of a conservative and slower transition to sustainable procurement. Pathway 2 assumes 90% is based upon 90% of suppliers being large enough to have net zero commitments. These are typical percentages from Ricardo experience. Pathway 3 assumes only a small % of suppliers decarbonise.

APPENDIX 2 – RECOMMENDED ACTIONS FOR CORPORATE NET ZERO

Sector/Area

Buildings

- Develop decarbonisation strategy and programme for council buildings
- Review buildings without BEMS and assess whether BEMS should be installed aligning with decarbonisation of heat in buildings strategy
- Review buildings with BEMS and investigate possible improvements to systems
- Develop HVAC improvement plan detailing maintenance and upgrade of current system
- Utilise thermal camera to assess heat loss from council estate and develop building upgrade plan, in conjunction with decarbonisation strategy
- Establish lighting upgrade programme for council estate

Homeworking

- Conduct a staff survey to establish confirm the assumptions associated with the workstyle time allocations
- Complete an office rationalisation assessment to decide if offices can be further consolidated or closed (an initial reduction of 1,500 m2 has been estimated)
- Conduct a staff home energy use survey in order to more accurately establish the emissions associated with homeworking

Transport

- Assessment of needs
    - Undertake vehicle rationalisation across fleet / other council vehicles
    - Undertake assessment of HGV zero/low emission options for future looking at:
        a) Use case assessment of each vehicle type
        b) Lead times/availability
        c) Cost-benefits
        d) Funding availability
        e) Duty and strategic factors as per table 15
    - Undertake EV fleet review including:
        a) Engaging with third parties on availability of all types of vehicles, esp. coaches/taxis, lead times
        b) Assessment of energy demand / grid upgrades

c) Assessment of charging infrastructure need at sites / across district
d) Charging software platforms
e) Charge time requirements and how this will be supported
f) Comparison of lease models vs owned outright
g) Cost-benefit analysis
h) Funding availability
i) Duty and strategic factors as per table 15

- Policy development
  - Complete Roads Service Climate Action Plan and ensure alignment with overall CAP
  - Develop and implement business travel policy (flights, public transport prioritisation, guidance on travel for meetings) and capture data on all forms of travel
- Feasibility studies
  - Undertake feasibility study into power/hydrogen demand of EV fleet
  - Ensure Broomhill depot design is net zero aligned – accounts for future need/use
- Surveys
  - Run staff commuting survey (annually/biannually) to ascertain commuting patterns to calculate emissions accurately
- Actions
  - Deploy suitable charging network across council sites based on review
  - Undertake measures to change staff commuting behaviour including:
    a) Investigate car share schemes
    b) Review number of parking spaces at council offices
    c) Investigate parking policy options
    d) Ensure active travel approaches encouraged
    e) Promote public transport use
    f) Promote switch to EVs
    g) Investigate salary sacrifice
    h) Ensure suitable charging facilities
  - Establish sustainable travel employee forum
  - Deploy suitable charging network across council sites based on review
  - Undertake measures to change staff commuting behaviour including:
    a) Investigate car share schemes

b) Review number of parking spaces at council offices
c) Investigate parking policy options
d) Ensure active travel approaches encouraged
e) Promote public transport use
f) Promote switch to EVs
g) Investigate salary sacrifice
h) Ensure suitable charging facilities

- Establish sustainable travel employee forum
- Add additional improvements to efficiencies such as telematics on all vehicles, eco driver training for all drivers, efficient tyres

Water

- Establish water management plan looking at:
    a) Improving metering and monitoring (e.g., installing meters on remaining 14 sites - where viable, monitoring programme, investigating zero readings from meters)
    b) Efficiency upgrade programme across the estate
    c) Investigation into grey water/rainwater use
    d) Actions to drive behaviour change

Waste

- Utilise additionally captured data on purchased goods to identify key areas for improvement (CES Action 1B)
- Develop and implement waste strategy focusing on:
    a) Priority areas as determined by accurate data
    b) Reducing waste across Council operations
    c) Increasing recycling rate of purchased goods/materials
    d) Increasing low carbon waste disposal
- Utilise additionally captured data on purchased goods to identify key areas for improvement (CES Action 1B)
- Develop and implement waste strategy focusing on:
    a) Priority areas as determined by accurate data
    b) Reducing waste across Council operations
    c) Increasing recycling rate of purchased goods/materials

d) Increasing low carbon waste disposal

Procurement

- Update annual procurement strategy to embed sustainability further
- Include action plan for reducing supply chain emissions in updated procurement strategy
- Plan and agree data collection mechanisms for all purchased goods and services
- Develop supplier engagement prioritisation plan
- Develop sustainable procurement capacity building training programme for all staff
- Update CES and procurement strategy with any additional steps outlined in this evidence report
- Review council process in line with refinements detailed in this evidence report

Green procurement of energy

- Conduct a review of their own land, roof space and carpark to assess the generation potential and develop an action plan to develop the roll out of these schemes
- Assess the gap between electricity demand and electricity generation to identify sites that may benefit from a private wire arrangement (noting that the electrification of heat and transport will increase electricity demand considerably) and review surrounding land for potential private wire sites
- Seek suitable sites where larger and potential multiple technology (wind and solar) installations could be installed to meet the Council's power needs via sleeving
- Consider which of these sites would be suitable for community ownership
- Fill any gap between electricity demand and supply with green tariff electricity

APPENDIX 3 – ASSUMPTIONS FOR AREA-WIDE NET ZERO SCENARIOS

Measure	Pathway 1 – Balanced (2045)		Pathway 2 – Balanced plus local ambition (2045)		Pathway 3 – Accelerated (2040)		Rationale
	Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	Assumptions	Implementation timeframe	
Energy in Buildings							
Retrofitting measures: Domestic	Demand reduction: 12%	2024-2045	Demand reduction: 20%	2024-2045	Demand reduction: 12%	2024-2040	Sources: CCC Sixth Carbon Budget Report and expert judgement based on modelling undertaken for the Scottish Government. *Note: These figures are to be interpreted as the average across the whole building stock. Individual buildings will achieve different levels of heat demand reduction.*
Retrofitting measures: Commercial	Demand reduction: 20%	2024-2045	Demand reduction: 25%	2024-2045	Demand reduction: 20%	2024-2040	Source: CCC Sixth Carbon Budget Report.
Retrofitting measures: Public	Demand reduction: 20%	2024-2038	Demand reduction: 25%	2024-2038	Demand reduction: 20%	2024-2038	Source: CCC Sixth Carbon Budget Report. Primarily based on the CCC figures, although for the public sector additional work was undertaken to align these figures with the council pathways.
Use of smart heating controls – domestic	Demand reduction: 2-3% - applicable to 50% of properties (which did not have a smart meter as of Q1 2023).	2021-2029	Demand reduction: 2-3% - applicable to 50% of properties (which didn't have a smart meter as of Q1 2023).	2021-2025	Same as Scenario 2	Same as Scenario 2	Sources include: • Demand reduction potential taken from BEIS' 2019 smart meter roll-out cos-benefit analysis[6] • Proportion of properties with smart metres taken from the DESNZ Smart meter statistics[7] • ElectraLink database used to calculated average monthly roll-out since after the COVID-19 lockdowns[8]

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831716/smart-meter-roll-out-cost-benefit-analysis-2019.pdf

[7] https://www.gov.uk/government/collections/smart-meters-statistics

[8] https://www.electralink.co.uk/smartinsight/

							Pathway 1 assumes roll out in line with past roll-out speed. Pathways 2 and 3 assume that the 2025 target can be achieved (full roll out by the end of 2025).The implementation time frame commences in 2021 as the ElectraLink data suggests consistent roll-out in Scotland following the Covid-19 lockdowns.
Use of smart heating controls – commercial	Demand reduction: 3-5% - applicable to 50% of properties (which didn't have a smart meter as of Q1 2023 – estimated as only domestic figure available for East Dunbartonshire)	2021-2029	Demand reduction: 3-5% - applicable to 50% of properties (which did not have a smart meter as of Q1 2023 – estimated as only domestic figure available for East Dunbartonshire)	2021-2025	Same as pathway 2	Same as pathway 2	As domestic rationale
Energy savings from water efficiency measures - domestic	Uptake: 60%Saving: 24%	2024-2045	Uptake: 90%Saving: 33%	2024-2045	Uptake: 80%Saving: 33%	2024-2040	Source: HM Government / Defra[9]
Energy savings from water efficiency measures – non-domestic	Uptake: 70%Saving: 24%	2024-2045	Uptake: 95% commercial/ 100% public Saving: 33%	2024-2045	Uptake: 95%Saving: 33%	2024-2040	Source: HM Government / Defra[10]
Energy savings from LED lighting	Uptake: 60%Saving: 70%	2024-2045	Uptake: 86%Saving: 70%	2024-2045	Uptake: 86%Saving: 70%	2024-2040	Sources: BEIS[11] and Tech Advisor[12] *Note: Based on the assumption that 14% of households have LED lighting, therefore 86% marks full uptake.*
Energy savings from energy	Uptake: 60% Saving: 15%	2024-2045	Uptake: 90% Saving: 15%	2024-2045	Uptake: 80% Saving: 15%	2024-2040	Source: IEA[13]

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf

[10] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf

[11] BEIS (2020). Lighting Guide: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/874898/Lighting_Technology_Information_Leaflet_April_2020.pdf

[12] https://www.techadvisor.com/article/740371/14-of-the-uks-household-lights-are-now-leds.html

[13] https://www.iea.org/articles/a-call-to-action-on-efficient-and-smart-appliances

efficient appliances							
Upgrades to non-domestic ventilation, and air conditioning systems	Demand reduction: 30%	2024-2045	Demand reduction: 43%	2024-2045	Demand reduction: 40%	2024-2040	Sources: Swegon[14] and IEA[15]
Switching from natural gas to heat pumps: Domestic	Fuel switching: 90% of buildings on gas grid switched to electricity at high efficiency (ASHP).	2024-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Sources: CCC Sixth Carbon Budget, LHEES, and expert judgement. Air source heat pumps (ASHPs) were chosen as the main alternative to fossil fuels for heat in buildings. This is due to their use of renewable electricity as well as their high efficiency (around 300% efficiency, with the CCC's widespread innovation pathway even suggesting over 400%) compared to alternatives such as direct electric heating. While we only modelled ASHPs, this is merely a simplification for the scenarios, it will likely be a mixture of different heat pumps depending on the site (as efficiencies and emissions are similar this was not broken down further). *Note: as identified in the Stage 3 LHEES report, 75% of properties are currently suitable for heat pumps. However, as we are modelling a longer time frame than the LHEES, we have assumed a higher uptake as suitability can be increased with the necessary fabric improvements. We assume that if suitability can't be increased sufficiently, the remaining properties will need to switch to direct electric instead. While this will be less efficient and thereby have slightly higher emissions while we have not reached the grid electricity net zero target, this does not impact the modelling substantially. However, it should be noted that direct electric would incur significantly higher*

[14] https://blog.swegon.com/en/the-energy-saving-from-an-hvac-solution-is-the-most-sustainable-and-cost-efficient-source-of-energy

[15] IEA (2018). The future of cooling. Technical Report. Available at: https://www.iea.org/reports/the-future-of-cooling

							running costs, thereby making it a less effective option than heat pumps.
Buildings remaining on direct electric heating	4% of all domestic buildings not suitable for heat pumps remaining on direct electric. This translates to 73% of direct electric heating systems (1,900 properties) not switching.	N/A	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: LHEES analysis and expert judgement *Note: While it is assumed from the LHEES baseline that 25% of buildings are presently not suitable for heat pumps, this figure is expected to increase with an uptake of the necessary fabric improvement measures.*
Switching from direct electric to ASHPs	27% of domestic buildings with direct electric heating (i.e., 100% - 73%, see row above) to switch to ASHPs.	2024-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	See "Buildings remaining on direct electric heating" above. *Note: In reality, future direct electric heating properties will be a mix of those staying on direct electric heating and those switching to direct electric from fossil fuel heating systems. This modelling approach is a simplification which results in the same future heating system composition.*
Switching from natural gas to district heating	Fuel switching: 10% of domestic buildings on gas grid switched to district heating.	2025-2045	Same as pathway 1	Same as pathway 1	Same as Scenario 1 but accelerated	2025-2040	Source: LHEES analysis and expert judgement. *Note: Based on analysis undertaken for the LHEES, it was estimated that district heating potential is between 5-10% in East Dunbartonshire due to the low density of the local authority area.*
Commercial fossil fuel heating systems – switch to electrified heat sources	95% of fossil fuel systems switch to electrified heat sources This will be a split between direct electric and heat pumps	2024-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC and expert judgement based on LHEES inputs. *Note: The CCC suggests up to 5% of hydrogen uptake between 2037 and 2050 – however, recent evidence has been firmly against use of hydrogen in buildings.[16,17,18] The CCC further suggests significant district heating uptake; however, this was determined to*

[16] Rosenow, J. (2022). Is heating homes with hydrogen all but a pipe dream? An evidence review. Available at: https://www.cell.com/joule/fulltext/S2542-4351%2822%2900416-0

[17] https://www.cornwall-insight.com/press/new-report-shows-fuel-bills-could-rise-90-under-governments-hydrogen-plans

[18] https://www.theguardian.com/environment/2022/sep/20/world-first-hydrogen-project-raises-questions-about-its-role-in-fuelling-future-homes

							be limited to 10% of domestic buildings in East Dunbartonshire following LHEES analysis.
Commercial fossil fuel heating systems – switch to district heating	5% of fossil fuel heat systems switch to heat networks	2025-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	2025-2040	Source: Expert judgement based on LHEES inputs. (see domestic district heating)
Public sector fossil fuel heating systems	95% of fossil fuel systems switch to electrified heat sources This will be a split between direct electric and heat pumps	2025-2038	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC and expert judgement. *Note: The CCC suggests up to 5% of hydrogen uptake between 2037 and 2050 – however, given the 2038 backstop date, this would be too late to implement. The CCC further suggests significant district heating update, however, this was determined to be limited to 10% of domestic buildings in East Dunbartonshire following LHEES analysis.*
Public sector fossil fuel heating systems – switch to district heating	5% of fossil fuel heat systems switch to heat networks	2025-2038	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: Expert judgement based on LHEES inputs. (see domestic district heating)
Energy Systems							
Grid decarbonisation	In line with BEIS modelling (0.0066kgCO_2e/kWh by 2045)	2020-2045	Same as pathway 1	Same as pathway 1	In line with 2035 decarbonisation target	2020-2035	Sources: BEIS Green Book[19] and UK target. We have used the BEIS grid modelling for Scenarios 1 & 2 because it was deemed ambitious, yet more likely to be implemented than the UK target. The accelerated pathway (Scenario 3) assumes that the UK is able to achieve the 2035 target.[20] The CCC has assessed this as "Generally good plans with some risks" and noted the following: "However, it is not clear whether the combination of these policies and proposals will be sufficient to meet the

[19] Grid decarbonisation trends taken from BEIS greenbook:
https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[20] https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035

							overall objective of fully decarbonising electricity generation by 2035."[21] Concerns around the achievement of the 2035 target were reiterated in a recent CCC press release.[22]
Solar PV - domestic	c. 40 GWh – assumes 60% uptake	2024-2045	c. 67 GWh – assumes 100% uptake	2024-2045	c. 53 GWh – assumes 80% uptake	2024-2040	Source: Calculations based on Home Analytics Data. *Note: 100% uptake refers to full uptake of all suitable roof space. This is an approximate calculation.* *We assumed lower uptake for the domestic sector in Scenario 3 as it is (a) more roof-space to cover, therefore more materials and workforce required and (b) it was deemed more difficult to engage 100% of individuals.*
Solar PV – commercial / public	c. 2 GWh – assumes 30% uptake	2024-2045	c. 3 GWh – assumes 40% uptake	2024-2045	c. 2 GWh – assumes 30% uptake	2024-2040	Source: DECC (2010) Renewable and Low-carbon Energy Capacity Methodology *Note: As the calculation for non-domestic solar PV differs from the domestic one, 40% refers to full uptake (as it is estimated that 40% of roof space is suitable).*
Solar PV – industrial	c. 2 GWh – assumes 60% uptake	2024-2045	c. 3 GWh – assumes 80% uptake	2024-2045	c. 2GWh – assumes 60% uptake	2024-2040	Source: DECC (2010) Renewable and Low-carbon Energy Capacity Methodology *Note: As the calculation for non-domestic solar PV differs from the domestic one, 80% refers to full uptake (as it is estimated* In addition to these figures, 4.45 GWh were modelled for the recently implemented solar PV Scottish Water Horizons Project.[23]

[21] https://www.theccc.org.uk/publication/independent-assessment-the-uks-net-zero-strategy

[22] https://www.theccc.org.uk/2023/03/09/a-reliable-secure-and-decarbonised-power-system-by-2035-is-possible-but-not-at-this-pace-of-delivery/

[23] https://www.scottishwater.co.uk/About-Us/News-and-Views/2023/04/260423-Solar-Giant-Switched-on-in-East-Dunbartonshire

Transport							
Avoiding car journeys behavioural changes, switching to active travel and public transport as well as increasing vehicle occupancy.	22% of vkm avoided	2024-2045	30% of vkm avoided	2024-2045	22% of vkm avoided	2024-2040	Sources: CCC Sixth Carbon Budget Report and Scottish Household Survey 2018.[24] The result of the overall reduction (individual figures taken from CCC) is in line with the national "20% reduction in car km by 2030 target". This total reduction was calculated as a mixture of avoiding the need for car journeys in the first place (e.g., through working from home), switching to active travel and public transport, as well as increasing vehicle occupancy from 1.5 to 1.7 (cenario 1 and 3) and 1.8 (scenario 2).
Reducing demand for LGV and HGV movements through trip consolidation and changes in logistics	11% reduction in trips	2024-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report.
Improving HGV efficiency through technology improvements and driver training initiatives	Assuming 80% uptake and 15% energy savings	2024-2045	Assuming 100% uptake and 15% energy savings	2024-2045	Assuming 100% uptake and 15% energy savings	2024-2040	Source: CCC Sixth Carbon Budget Report.
Uptake of electric vehicles (cars, vans, motorcycles)	Near full uptake of EVs by target year	2024-2045	Same as pathway 1	Same as pathway 1	95% uptake of EVs by target year	2024-2040	Source: CCC Sixth Carbon Budget Report and FES.[25]
Uptake of electric buses	55% switched to electric	2024-2045	Same as pathway 1	Same as pathway 1	55% switched to electric	2024-2040	Source: CCC Sixth Carbon Budget Report.
Uptake of hydrogen buses	45% switched to hydrogen	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report. *Note: This measure was not accelerated as it is assumed that full uptake is possible before 2045.*

[24] https://www.transport.gov.scot/publication/transport-and-travel-in-scotland-results-from-the-scottish-household-survey-1/table-td9-car-occupancy-percentage-of-car-stages-1-by-car-occupancy-2008-2018-2-3/

[25] https://www.nationalgrideso.com/future-energy/future-energy-scenarios

Uptake of electric HGVs	55% switched to hydrogen	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report. *Note: This measure was not accelerated as it is assumed that full uptake is possible before 2045.*
Uptake of hydrogen HGVs	45% switched to electric	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report. *Note: This measure was not accelerated as it is assumed that full uptake is possible before 2045.*
Rail electrification & hydrogen trains	99.4% electrification, 0.6% hydrogen	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: Calculations based on data provided by Ricardo Rail team. Already almost entirely electrified, only small number of diesel trains passing through which will require hydrogen solution. *Note: As network is already electrified, no increased local ambition modelled. As hydrogen uptake is not market-ready yet, no accelerated implementation modelled.*
Industry							
Fabric efficiency measures	As commercial						Source: expert judgement
Fuel switching measures	As commercial						Source: expert judgement
Decarbonisation of industrial processes through a switch to low-carbon fuels such as grid electricity and hydrogen	50% reduction via a switch to low-carbon fuels and BECCS/ CCUS	2024-2040	100% reduction via a switch to low-carbon fuels and BECCS/ CCUS	2024-2045	Same as Scenario 2	*Note: This is an illustrative measure which is reliant on ambitious actions in the industrial sector and government funding.*	50% reduction via a switch to low-carbon fuels and BECCS/ CCUS
Waste							
Landfill: reduce, recycle, bans, methane capture	2025 ban on biodegradable wastes, 2040 full ban 80% CH4 capture & 10% oxidation	2024-2045	2025 ban on biodegradable wastes, 2035 full ban 80% CH4 capture & 30% oxidation	2024-2045	2025 ban on biodegradable wastes, 2040 full ban 80% CH4 capture & 30% oxidation	2024-2040	Source: CCC Sixth Carbon Budget Report & Charts and Data in the Report *Note: Landfill emissions do not decrease by the full 100% in any scenario due to the residual emissions.*

Composting	23% reduction of current composting emissions	2024-2030	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report & Charts and Data in the Report
Wastewater	21% reduction of current wastewater emissions	2024-2045	43% reduction of current wastewater emissions	2024-2045	36% reduction of current wastewater emissions	2024-2040	Source: CCC Sixth Carbon Budget Report & Charts and Data in the Report
Agriculture							
Diet change	20% reduction in meat consumption by 2030, further 15% meat reduction by 2045.	2024-2045	50% reduction in all meat and dairy by 2045	2024-2045	Same as Scenario 1 but accelerated	2024-2040	Source: CCC Sixth Carbon Budget Report
Land release measures	Halving food waste, increasing crop yield etc.	2024-2045	Same as pathway 1	Same as pathway 1	Same as Scenario 1 but accelerated	2024-2040	Source: CCC Sixth Carbon Budget Report
Agricultural machinery	c. 60% of gas oil and similar fossil fuels switched to less carbon-intensive alternatives	2024-2045	Same as pathway 1	Same as pathway 1	Same as pathway 1	Same as pathway 1	Source: CCC Sixth Carbon Budget Report
LULUCF							
Emissions reduction from actions in cropland & peatland.	25% emissions reduction	2024-2045	100% emissions reduction	2024-2045	20% emissions reduction	2024-2040	*Note: This is an illustrative measure – emissions estimates in the LULUCF sector are subject to large uncertainties even when local data is used. As no local studies are available to estimate LULUCF reduction potential, illustrative values were used.*

APPENDIX 4 – CORPORATE NET ZERO COSTS FOR INDIVIDUAL MEASURES

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
Scope 1					
School coach / bus hire vehicle switch	Typical cost per vehicle x fleet numbers Assume costs to be borne by Council	Assumes 21 coaches and vehicle replacement cost of FCEV bus £500,000 Assumes 21 coaches and vehicle replacement cost of BEV bus at £350,000	£10,500,000	£10,500,000	£7,350,000
Own fleet – waste improved efficiency	Typical cost per vehicle x fleet numbers	Assumes 72 vehicles and a cost of £300 per vehicle for driver training and vehicle adjustments (such as fuel efficient tyres). Route planning is assumed to be implementable by the transport team (cost associated with council staff time not included.)	£21,600	£21,600	£21,600
Own fleet – waste vehicle switch	Typical cost per vehicle x fleet numbers	Assumes a vehicle replacement cost of £480,000 x 72 vehicles. Does not include refuelling infrastructure Assumes a vehicle replacement cost of £380,000 x 72 vehicles.	£34,560,000	£34,560,000	£27,360,000
Refrigerants efficient use	Typical cost of audit x number of sites	TM44 air inspection cost at £250 per site (46 sites). Note this applies to systems over 12kW (most split systems would be less) so will be upper costs. Additional costs associated are operational costs so have not been included in the capital costs.	£11,500	£11,500	£11,500
Refrigerants replacement	Typical costs x number of buildings with air conditioning	Assumed 46 sites with air conditioning as provided by EDC and a cost of £7,000 per site (note this is an emerging solution so there is considerable uncertainty in this figure.	£322,000	£322,000	£322,000

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
Buildings –Building fabric	Building level approach with packages of measures selected based on the type of building and the energy consumption	Assumes a package of measures has been applied to reduce the heat demand such that a modern heating system can be installed. Has been applied across a selection of buildings that have energy demands over a minimum threshold. Below this threshold, the buildings are deemed as low energy users (pavilions/toilets/some storage facilities etc and building fabric upgrades are not recommended). Measures include: • Draught proofing • Loft insulation/pitched roof insulation • Triple glazing • Cavity wall and/or external wall insulation Measures are based off the floor area, which is largely known, building perimeter and wall area is based on wall-to-floor assumptions based on assumed number of stories. Glazing upgrades are based on a % of the floor area. Significant proportion of costs (>70%) come from external wall insulation measures, which has been assumed required across much of the building stock	£80,000,000	£567,000,000	£41,000,000
Buildings –efficient heating	Typical cost per building x no of buildings, based on floor areas of the buildings	Based on current buildings that are currently heated by fossil fuels. Improvements to distribution system.	£700,000	£700,000	£700,000
Buildings –heating decarbonisation	Building level approach with packages of measures selected based on the type of building and the energy consumption	An assumed cost of switching to an electrified heating source (either an ASHP system or direct electric radiant heating (electric radiant panels or overhead heaters)). Includes emitter upgrades. where required. Includes buildings currently heated by gas or biomass, buildings that are currently electrically heated are not included in the analysis.	£69,000,000	£70,000,000	£43,000,000
Scope 1 & 2					

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
Building space usage rationalisation	There would likely be savings and costs associated with this which are difficult to estimate. Costs are likely to be associated with relocation or setting up hot desking spaces.				
Scope 2					
Buildings – electricity energy management	Typical cost per building x no of buildings (63 with significant energy use that are to remain open)	Based on an average cost of £2,000 per site for building energy management systems control review and improvements in line with technology developments.	£126,000	£126,000	£126,000
Buildings – electricity efficiency improvements	Typical cost per building x no of buildings (63 with significant energy use that are to remain open)	Costs based upon lighting as move to efficient appliances assumed to be done from ongoing asset replacement budget. Assumes an average cost of £6,000per building (based upon lamp replacement rather than full lighting refurbishment) . Noting that 1/3 of council properties have LEDs.	£252,000	£252,000	£252,000
Buildings – electricity renewable generation	Size of system needed to meet % demand x typical costs (to be based on solar)	Assuming 850kWh per annum from 1kW of PV installed and a cost £750,000 per MW. Providing 20% of EDC electricity demand requires generating 3,272,551kWh per annum = 3.85MW PV is required.	£2,887,500	£10,830,000	£1,447,500

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
		Providing 75% of EDC electricity demand: 12,272,066kWh = 14.44MW PV is required Providing 10% of EDC electricity demand: 1,636,275kWh = 1.93MW PV is required			
Buildings – electricity green procurement	Not included in pathway 1 and 3 (and is an operational cost rather than capital)				
Streetlighting - LED	No accelerated programme compared to BAU				
Scope 3					
Joint ventures (same as buildings)[26]	Same as buildings	One joint venture site (costs apportioned according to site share - 27%).	£495,588	£2,045,990	£281,805
Leased out buildings, (same as buildings)[27]	Same as buildings	Assumptions based on 74 energy using leased out sites.	£135,827,703	£560,752,892	£77,208,095
Business Travel – Other Travel policy	Typical travel policy cost	Could be implemented by the Council's Land Planning & Development Service (cost associated with council staff time not included). If consultant support were required for a full strategy, then it would be £10 to £15k	£15,000	£15,000	£15,000
Business Travel – Taxi Switch to low carbon vehicles	Typical cost per vehicle x fleet numbers	Assumes an average of 3 vehicles per each of the 12 taxi contractors and a vehicle replacement cost of £28,000.	£1,008,000	£1,008,000	£1,008,000

[26] Joint ventures costs calculated as total of building measures (fabric, efficient heating, heating switch, electricity management) per building x joint venture ownership (27%)

[27] Leased assets costs calculated as total of building measures (as above) per building x total no. of leased assets (74)

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
Business Travel - Car mileage Travel policy	Typical travel policy cost	Could be implemented by the Council's travel team (cost associated with council staff time not included). If consultant support required £10 to £15k.	Covered by main travel policy costs	Covered by main travel policy costs	Covered by main travel policy costs
Waste, waste strategy	Typical waste strategy cost	Could be implemented by the Council's waste team (cost associated with council staff time not included). If consultant support required £10 to £15k.	£15,000	£15,000	£15,000
Water, water management programme	Typical water management programme costs	Assumes 63 sites and £500 per site to review metering and continue fitting of water efficient appliances.	£31,500	£31,500	£31,500
T&D and WTT, Reduced as fuel consumption decreases	No capital cost				
Employee commuting, Travel policy and facilities for low carbon travel	Typical travel policy cost and one EV charger per 10 employees	Could be implemented by the Council's travel team (cost associated with council staff time not included). If consultant support required £10 to £15k.Assuming council provided an EV charger (estimated cost £1000) per 10 employees.	£340,000	£340,000	£340,000
Housing, Element energy	Element energy	Costs provided by element energy as part of their study.	£78,220,373 to £88,664,142	£78,220,373 to £88,664,142	£78,220,373 to £88,664,142
Wider supply chain, Sustainable procurement strategy	Typical sustainable procurement action plan development costs	Consultant costs of £30k for developing an action plan. Additional costs are likely to arise from implementing the action plan recommendations and maintaining an improved sustainable procurement system. These costs would likely be defined within the action plan.	£100,000	£100,000	£100,000
Joint ventures (same as buildings) [1]	Same as buildings	One joint venture site (costs apportioned according to site share - 27%).	£495,588	£2,045,990	£281,805

Measure	Costing method	Assumptions	Pathway 1 Cost	Pathway 2 Cost	Pathway 3 Cost
Leased out buildings, (same as buildings)[2]	Same as buildings	Assumptions based on 74 energy using leased out sites.	£135,827,703	£560,752,892	£77,208,095
		Total	**Up to £439.5 million**	**Up to £1,362 million**	**Up to £304 million**

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