University of Exeter | Centre for Energy and the Environment

Exeter's Greenhouse Gas Reporting 2023

Centre for Energy and the Environment

Internal document 1105

March 2026

University of Exeter | Centre for Energy and the Environment

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Report number: Internal document 1105

Publication date: 16th March 2026

Revision Number: 4.0

Version history:

Version number	Initials	Date	Description
1.0	EF	10/02/2026	First draft
2.0	EF	11/02/2026	Second draft following internal review
3.0	EF	18/02/2026	Edits following ECC comments
4.0	EF	16/03/2026	Final version

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Cover image: Exeter Quayside

Management Summary

Exeter City Council (ECC) declared a Climate Emergency in 2019 and pledged to work towards creating a net zero city by 2030. The target year is 20 years in advance of the 2050 national net zero target required under the Climate Change Act and reported on in the Seventh Carbon Budget. This study provides an updated greenhouse gas inventory for the city using the latest data, published in 2025 covering emissions throughout 2023, and estimates the annual emission reductions required to achieve zero emissions by 2030 and 2050.

Exeter's 2023 greenhouse gas emissions are estimated as 436.3 $ktCO_2e$. At 32% (140.7 $ktCO_2e$), buildings represent the largest share of emissions followed by transport (24%, 104.7 $ktCO_2e$), power (20%, 88.6 $ktCO_2e$), industry (8%, 36.9 $ktCO_2e$) and waste (8%, 35.6 $ktCO_2e$).

Exeter has continued its steady decline towards net zero, with a reduction of 38.0 $ktCO_2e$ (-8%) from 2022 (474.2 $ktCO_{2e}$). The power sector accounts for 43% of this where ongoing grid decarbonisation nationally has delivered emissions reductions of 16% (-16.5 $ktCO_2e$) for Exeter. Emissions from the buildings and industry sectors have reduced by 9% (14.4 $ktCO_2e$) and 11% (-4.6 $ktCO_2e$), respectively. There were minor (<5%) changes to emissions in the other sectors: transport, agriculture, land use, waste and F-gases.

Based on the last four inventories, the "current trend" shows Exeter is decarbonising steadily at a rate of 13.1 $ktCO_2eyr^{-1}$ where it would reach net zero by 2057 – seven years off the 2050 national target set out in the Climate Change Act. The current trend would see 2030 annual emissions of 344.3 $ktCO_2e$ and cumulative emissions from 2021 of 4,093 $ktCO_2e$. If Exeter is to reach net zero by 2030, it would have to decarbonise at a rate of 62.3 $ktCO_2eyr^{-1}$ from 2023, reaching cumulative emissions of 2,716 $ktCO_2e$. Alternatively, assuming Exeter has followed the current trend of decarbonisation up to the end of 2025, the required decarbonisation rate drastically increases under a shorter timescale, to 82.0 $ktCO_2eyr^{-1}$, where cumulative emissions would reach 3,060 $ktCO_2e$.

Ongoing grid decarbonisation will continue to deliver emissions savings, but a reduction from non-power sectors, especially transport and buildings, is vital to achieving net zero in a timely manner. Achieving 2030 net zero will require a concerted effort from all stakeholders in the city: business owners, residents and the public sector including the council, as acknowledged by the IPCC.

Future emissions trajectories for Exeter following the Climate Change Committee's Seventh Carbon Budget show that the emissions reduction needed to meet 2050 net zero, as established under the Climate Change Act, will also require emissions reductions in advance of the current trend.

Contents

1 Introduction

The 2008 Climate Change Act, with subsequent amendments, sets a legal obligation for net zero emissions in UK by 2050. The Act established the Climate Change Committee (CCC). The CCC sets five-year carbon budgets for the UK, the most recent of which is the Seventh Carbon Budget covering the period from 2038 to 2042* [1]. In 2019, increasing urgency to address climate change led Exeter City Council (ECC) to declare a Climate Emergency and pledge to work towards net zero by 2030 [2].

In 2020 the Council announced a series of initiatives to drive forward the city's net zero ambitions and establish a baseline greenhouse gas (GHG) inventory for the city [3]. In 2022, the Centre for Energy and the Environment (CEE) at the University of Exeter was commissioned to quantify Exeter's current inventory, based on 2019 data, and quantify the reductions and metrics required to achieve net zero in 2030 [4]. Initial projections examined the challenge of net zero by 2050 – the national timeline. The progress of Exeter towards climate neutrality was investigated in 2024 based on 2022 emissions data [5].

This study provides an updated greenhouse gas (GHG) inventory for the city using the latest data, published in 2025, and estimates the annual emission reductions required to achieve zero GHG emissions in 2030 and 2050.

Publication of most of the required data occurs two years in arrears, so this update extends the historic time series to 2023.

2 Methodology

The GHG inventory is compiled on a territorial basis. Territorial emissions are those arising from within the boundaries of Exeter (Figure 1)†. The one exception is the power sector, which is assessed based on electricity consumption in the area, assuming national average electricity supply emission factors. The publication year of territorial GHG emissions for local authority areas lags the data year by two years, so the most recent data available is for 2023 [6].

* This study makes extensive use of material from the Seventh Carbon Budget. References to the CCC refer to the Seventh Carbon Budget [1] unless stated otherwise.

† The territorial emissions method is consistent with the approach taken in UK national reporting, i.e., it considers all the emissions arising from activity within Exeter. An alternative approach is a consumption-based inventory, which would include upstream and downstream emissions arising outside an area, e.g., the manufacture, use and disposal of goods, services, and food from/to elsewhere.

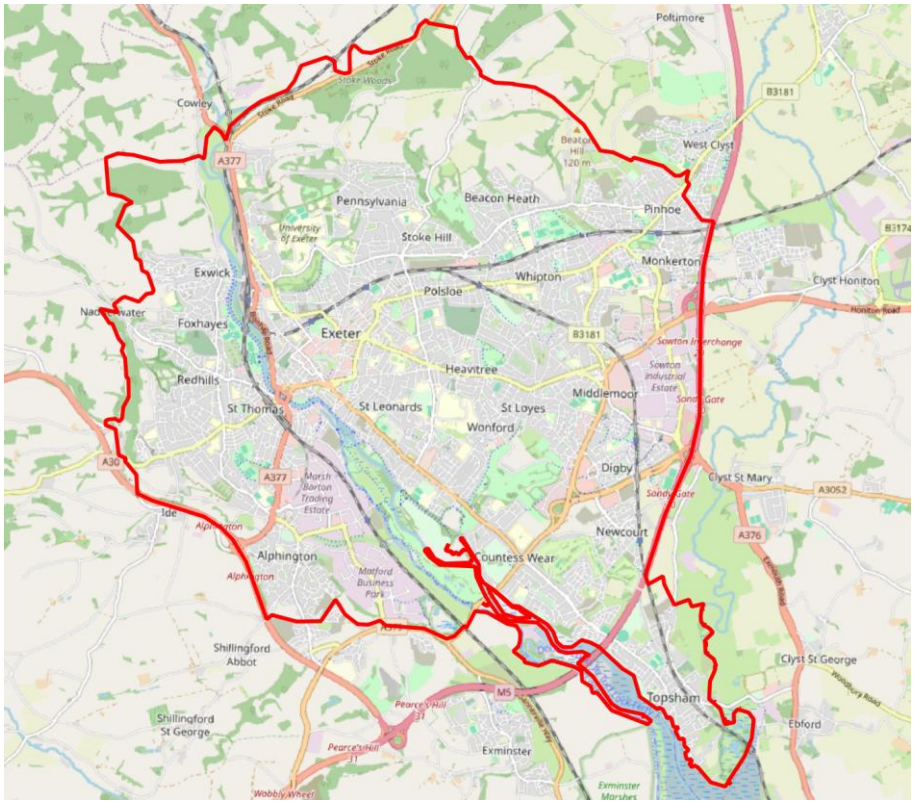

Figure 1. Exeter's territorial boundary. This inventory include all emissions generated within this boundary, as well as emissions associated with the consumption of electricity within it [7].

2.1.1 Methodology Changes

The methodology is generally the same as that followed for the 2019 inventory [8] with regular improvements made with subsequent inventories [9–11]. A summary of revisions from the initial report is given in the 2022 inventory report [5].

There have also been revisions to the source data for the Government-reported emissions. For the 2025 publication, based on 2023 data, the main methodological improvements are to the electricity consumption of non-road mobile machinery [12].

2.1.2 Reporting Categories – Sectors

The GHG inventory for Exeter reports emissions under the following categories:

- **Power:** emissions resulting from electricity consumption.
- **Buildings:** emissions resulting from fuel combustion in the domestic, commercial, and public administration sectors.
- **Industry:** emissions as categorised from industry in the government local authority CO_2 dataset [6]. This includes large industrial installations but excludes electricity use, which is reported under power.
- **Transport:** emissions from road and rail vehicles. Emissions from electric vehicles are reported under power; emissions from aviation and shipping are excluded.
- **Agriculture:** emissions from fuel use (excluding electricity), livestock and arable operations in the sector.

- **Land use*:** emissions are produced by biomass removal and are removed (sequestered) by biomass growth. Draining or wetting organic soils, soil mineralisation, and fertiliser application in the forestry industry are also included. Fertiliser use in agriculture is reported under agriculture.
- **Waste:** emissions from the disposal of solid waste and wastewater.
- **F-gases:** emissions from the leakage of fluorinated gases.

3 Current Inventory

3.1 Headline emission results for 2022

Total GHG emissions in Exeter for 2023 are estimated at 436.3 $ktCO_2e$†. This is a reduction of 38.0 $ktCO_2e$ (-8%) from 2022 and 73.6 $ktCO_2e$ (-14%) from 2019‡. Compared to 2008, the 2023 inventory has reduced by 330.0 $ktCO_2e$ (-43%)§. The breakdown of 2023 emissions is shown by sector in Table 1 and Figure 2, and by subsector in Figure 3 and Table 2.

As a predominantly urban area, Exeter's primary source of emissions is from buildings (32%, 140.7 $ktCO_2e$), with residential fuel use comprising the majority of that at 59% (82.5 $ktCO_2e$). Transport is the second most polluting sector at 24% (104.7 $ktCO_2e$), followed by power at 20% (88.6 $ktCO_2e$). Industrial and F-gas emissions contribute 8% (36.9 $ktCO_2e$) and 4% (17.8 $ktCO_2e$), respectively.

Emissions from waste comprise 8% (35.6 $ktCO_2e$) of Exeter's inventory which is dominated (81%) by waste incineration as, whilst not all the waste arises within Exeter, GHG emissions from Marsh Barton's energy from waste (EfW) facility are within Exeter's territorial boundary.

Exeter has limited agriculture and land use emissions at only 3% (11.0 $ktCO_2e$) and <1% (1.0 $ktCO_2e$) of its total inventory, respectively. The latter of which, for Exeter, is a net source of carbon where GHGs are emitted instead of sequestered through its limited area of natural carbon stores, trees, grasslands etc.

Table 1. Breakdown of emissions by sector, including land use. Values may not sum to total shown due to rounding.

Sector	Emissions, tCO_2e	% of total
Power	88,588	20%
Buildings	140,664	32%
Industry	36,926	8%
Transport	104,681	24%
Agriculture	10,995	3%
Waste	35,625	8%
F-gases	17,805	4%
Land use	985	0%
TOTAL	436,269	100%

* This sector includes emissions from land use, land use change and forestry, referred to as LULUCF.

† Multiple atmospheric compounds contribute to climate change, including carbon dioxide (CO_2) and methane (CH_4), with varying potencies. The unit, $ktCO_2e$, kilotonnes of carbon dioxide-equivalents, measures all activities relative to emissions of carbon dioxide.

‡ Compared to the latest, revised figures of 474.2 kt CO_2e and 509.9 kt CO_2e for 2022 and 2019, respectively.

§ Compared to the latest, revised figure of 766.3 $ktCO_2e$ for 2008.

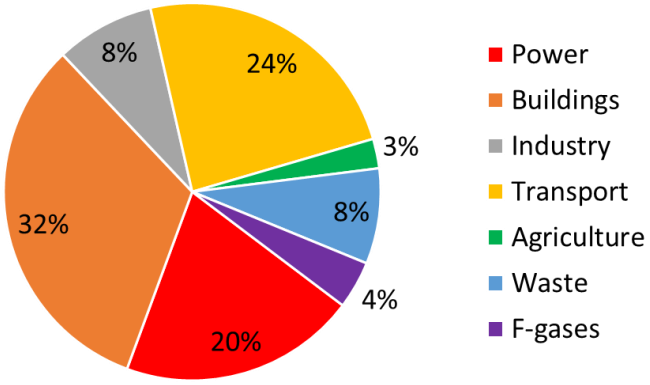

Figure 2. Exeter's 2023 GHG emissions by sector[*].*

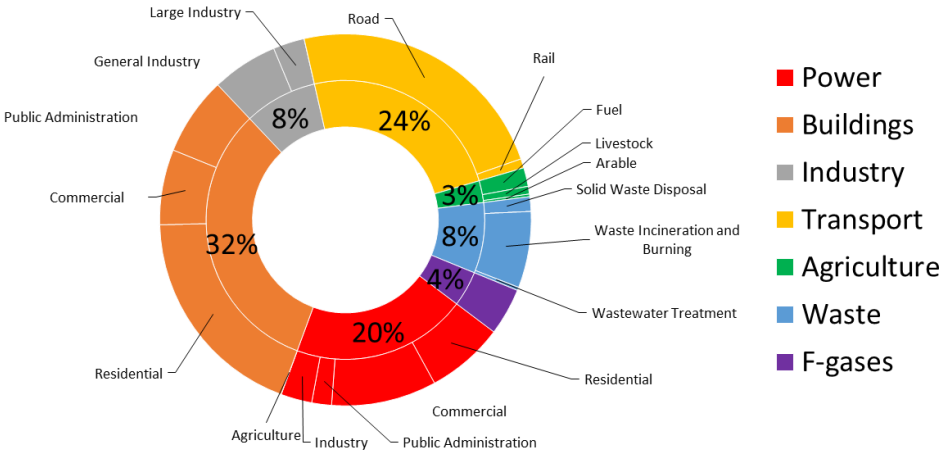

Figure 3. Exeter's 2023 GHG emissions by sector and sub-sector[*].*

Table 2. Breakdown of emissions by subsector, including land use. Values may not sum to total shown due to rounding.

Sector	Emissions, tCO_2e	% of total	Subsector	Emissions, tCO_2e	% of sector	% of total
Power	88,588	20%	Residential Electricity	29,448	33%	7%
			Commercial Electricity	39,837	45%	9%
			Public Administration Electricity	7,475	8%	2%
			Industry Electricity	11,775	13%	3%
			Agriculture Electricity	53	0%	0%
Buildings	140,664	32%	Residential Fuel	82,494	59%	19%
			Commercial Fuel	28,521	20%	7%
			Public Administration Fuel	29,649	21%	7%
Industry	36,926	8%	Industry Fuel	25,021	68%	6%
			Large Industry	11,905	32%	3%
			Industrial Processes	0	0%	0%
Transport	104,681	24%	Road Transport (exc. Electricity)	101,222	97%	23%
			Rail Transport (exc. Electricity)	3,460	3%	1%
Agriculture	10,995	3%	Agriculture Fuel	7,074	64%	2%
			Agriculture Livestock	2,933	27%	1%
			Agriculture Arable	988	9%	0%

[*] Land use emissions of 0.99 kt CO_2e are not plotted.

Sector	Emissions, tCO_2e	% of total	Subsector	Emissions, tCO_2e	% of sector	% of total
Waste	35,625	8%	Solid Waste Disposal	5,533	16%	1%
			Biological Waste Treatment	0	0%	0%
			Waste Incineration and Burning	28,864	81%	7%
			Wastewater Treatment	1,228	3%	0%
F-gases	17,805	4%	Industry Product Use	17,805	100%	4%
Land Use	985	0%	Land Use and Land Use Change	985	100%	0%
TOTAL	436,269	100%	TOTAL	436,269	-	100%

3.2 Annual Trend

Figure 4 and Table 5 (Appendix A) show the trend in annual emissions split by sector from 2005*. Figure 5 displays the annual change in emissions for each sector from 2008, which shows a general downward year-on-year trend primarily driven by reductions in the power sector from national grid decarbonisation.

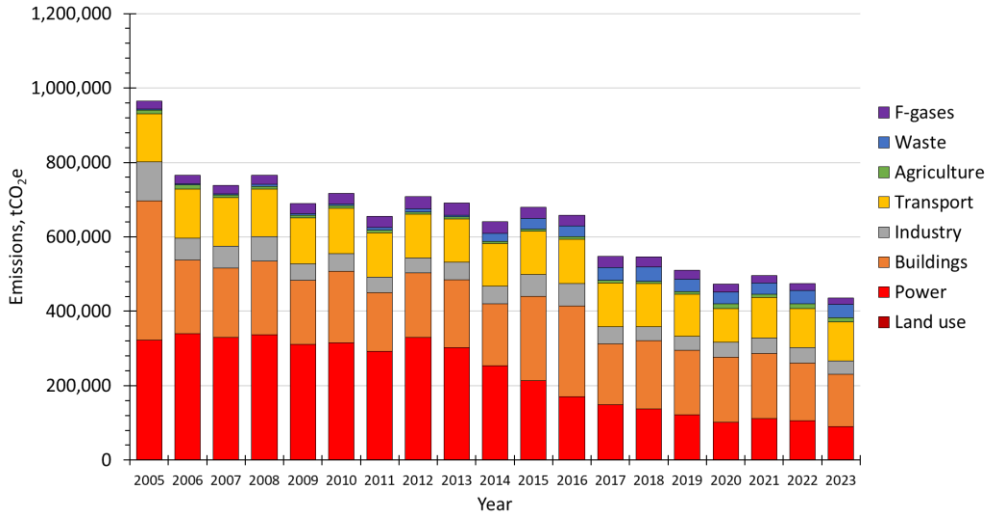

Figure 4. Change in Exeter's annual GHG emissions by sector from 2005 to 2023.

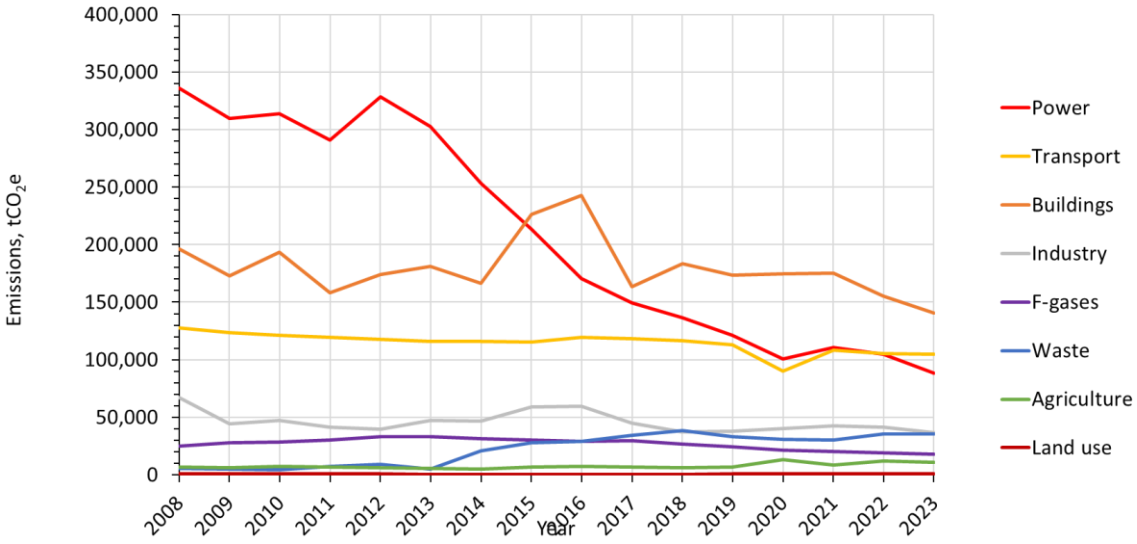

Figure 5. Change in Exeter's GHG emissions for each sector from 2008 to 2023.

* Historical data undergoes regular revisions from central government. This report uses the revised figures but a comparison between the original estimates and the revised totals is shown in Appendix B.

3.2.1 Change from Previous Inventory

Table 3 presents the absolute and relative change in emissions by sector between the revised 2022 inventory and the 2023 inventory. The final column of Table 3 also shows the share of the total 38.0 $ktCO_2e$ reduction from 2022 to 2023 attributable to each sector. At 43%, most emissions reductions come from ongoing renewable penetration into the electricity grid nationally, resulting in a 16% reduction (-16.5 $ktCO_2e$) of emissions from the power sector. Second, at 38%, emissions from buildings have decreased by 9% (-14.4 $ktCO_2e$) which follows national trends that the CCC have attributed to "warmer-than-average winters and record high energy prices" [1]. The industry sector is responsible for 12% of total emission reductions, showing a small 11% reduction (-4.6 $ktCO_2e$).

Emissions from transport show no major change (<1%, -0.4 tCO_2e). As the second most polluting sector, transport should be a key focus for decarbonisation within Exeter. There are slight decreases in other sectors: F-gases, 3% of total reduction (-1.3 $ktCO_2e$, -7%); and agriculture, 2% reduction of total reduction (-0.9 $ktCO_2e$, -8%). There are minor increases in the waste (0.07 $ktCO_2e$, <1%) and land-use (0.02 $ktCO_2e$, 2%) sectors.

Table 3. Comparison of GHG emissions by sector between the 2022 (revised) and 2023 inventories. Values may not sum to total shown due to rounding.

Sector	Emissions, tCO_2e		Change		
	2022	2023	Change, tCO_2e	Change, %	Proportion of reduction, %
Power	105,045	88,588	-16,457	-16%	43%
Buildings	155,072	140,664	-14,408	-9%	38%
Industry	41,494	36,926	-4,568	-11%	12%
Transport	105,103	104,681	-421	0%	1%
Agriculture	11,890	10,995	-895	-8%	2%
Land use	966	985	20	2%	0%
Waste	35,559	35,625	65	0%	0%
F-gases	19,121	17,805	-1,316	-7%	3%
TOTAL	474,250	436,269	-37,981	-8%	100%

4 Decarbonisation to Net Zero

4.1 Progress from 2008 towards zero emissions

Figure 5 shows the changes achieved in each sector since 2008 alongside a linear trajectory from 2008 to net zero in 2030. Only the power and land use sectors are on track to achieve zero GHG emissions by 2030. The former is primarily controlled nationally, and the latter is already near zero due to Exeter's small area. This highlights the amount of work required to reach net zero by 2030, particularly among the building and transport sectors where reductions fall well short of the required level, with the current inventory exceeding the linear pathways by 78.1 $ktCO_2e$ and 64.0 $ktCO_2$, respectively.

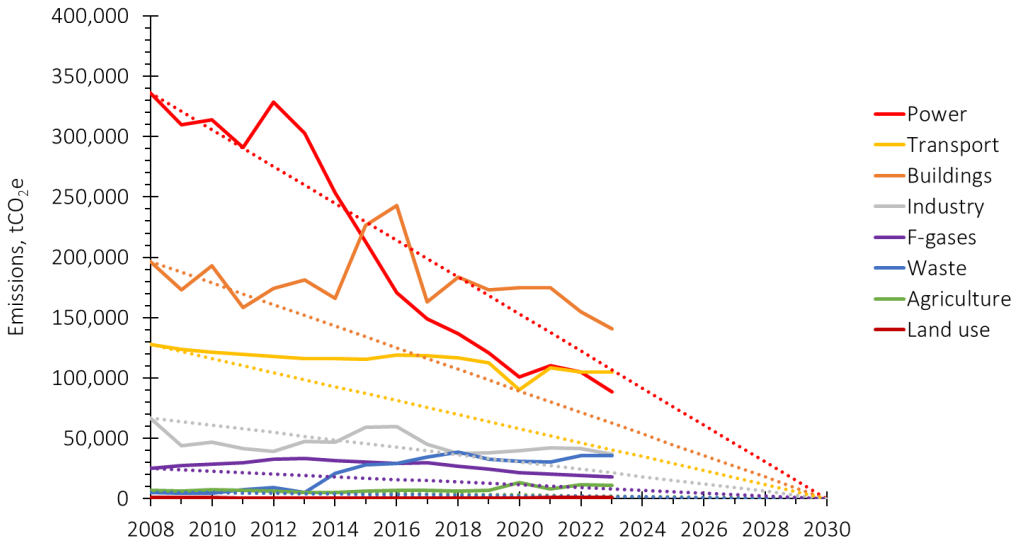

Figure 5. Historic emissions and linear decarbonisation pathway (dotted) from 2008 to net zero by 2030 by sector.

Figure 6 shows the progress in reducing GHG emissions from all sectors combined. Progress again falls short of delivering net zero by 2030. Current emissions are nearly two-fold (192.5 $ktCO_2e$, 78%) the linear projection of 243.8 $ktCO_2e$.

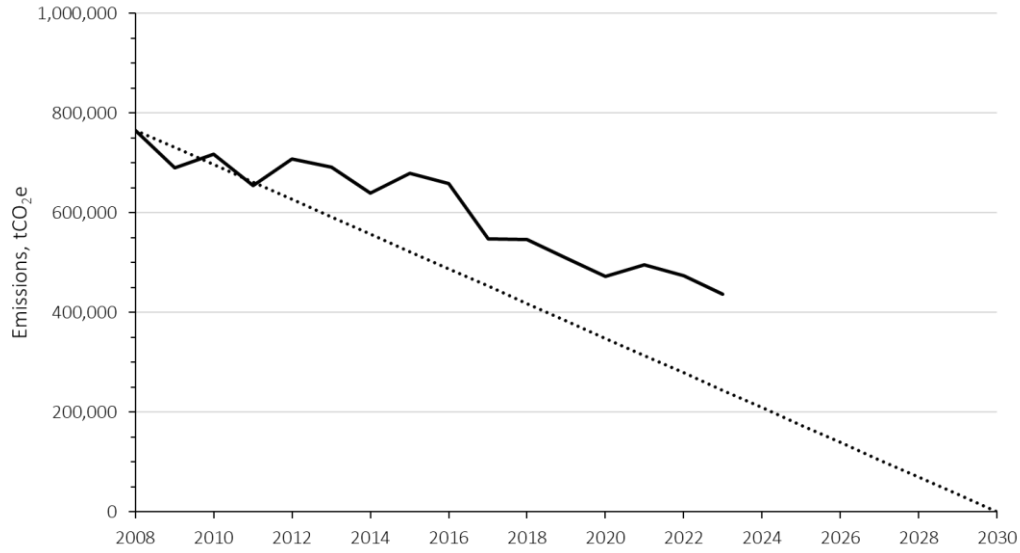

Figure 6. Emissions and linear decarbonisation pathway (dotted) from 2008 to 2030 net zero.

4.2 Future emissions trajectories

This section considers three potential trajectories of future GHG emissions reductions shown in Figure 7. The cumulative emissions from 2021 under each of the three pathways are shown in Figure 8 and the results summarised in Table 4.

The newly defined "current trend" extrapolates Exeter's total GHG emissions from 2023 based on a linear regression of Exeter's 2020-23 inventories. This suggests that emissions will continue to reduce at an average rate of 13.1 $ktCO_2eyr^{-1}$, with annual emissions in 2030 of 344.3 $ktCO_2e$ and cumulative emissions estimated at 4,093 $ktCO_2e$. Net zero would not be reached until 2057.

Two other trajectories have been created to see linear decline to net zero by 2030. The "linear decline from 2023" requires a decarbonisation such that emissions reduce by 62.3 $ktCO_2eyr^{-1}$, this would result in cumulative emissions of 2,716 $ktCO_2e$.

Historic data, which is two years in arrears, shows that radical reductions in emissions across all sectors have yet to be delivered. Assuming this is still the case, it is sensible to consider another trajectory where the current trend is followed up until 2025 followed by linear decline to net zero by 2030 – "linear decline from 2025". From 2025, emissions would have to reduce by 82.0 $ktCO_2eyr^{-1}$ to reach net zero, producing a cumulative total of 3,060 $ktCO_2e$ from 2021.

A further trajectory has been created to see linear decline from 2025 to net zero by 2050, the UK target[13]. This would require Exeter to decarbonise at a rate of 16.4 $ktCO_2eyr^{-1}$, producing cumulative emissions of 4,044 $ktCO_2e$ from 2021 to 2030.

Ongoing grid decarbonisation will continue to deliver emissions savings, with minimal intervention required from Exeter, but a reduction from non-power sectors, particularly transport and buildings, will be required to achieve net zero by 2030. Achieving this endpoint will require concerted effort from all stakeholders within the city: businesses, residents, and the public sector including the council itself, as acknowledged by the IPCC [14].

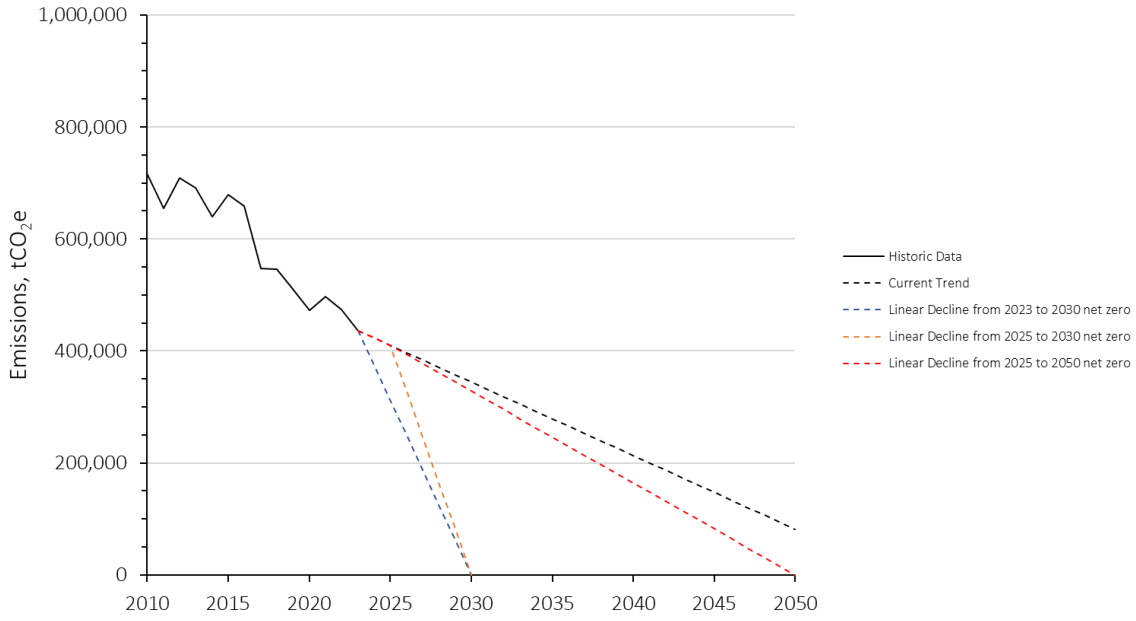

Figure 7. Four linear decarbonisation trajectories: the current trend (black), linear decline from 2023 to 2030 net zero (blue), linear decline from 2025 to 2030 net zero (orange) and linear decline from 2025 to 2050 net zero (red).

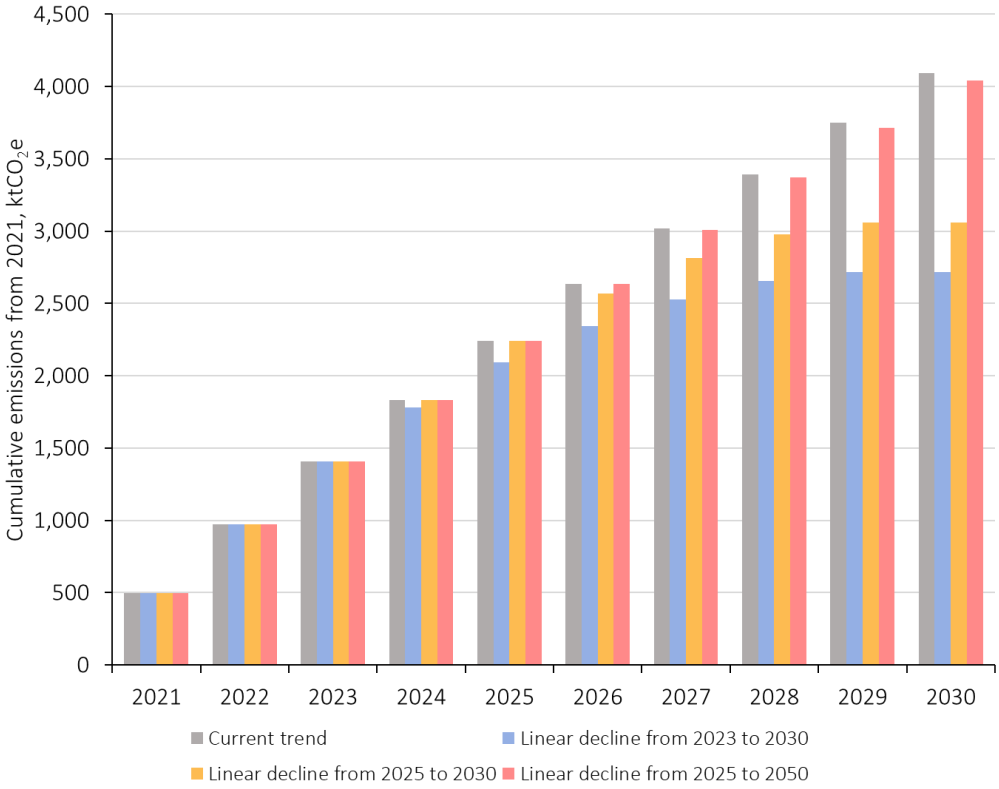

Figure 8. Cumulative emissions from 2021 under the four decarbonisation trajectories.

Table 4. Summary results of the three decarbonisation trajectories.

Parameter \ Trajectory	Current trend	Linear decline from 2023 to 2030	Linear decline from 2025 to 2030	Linear decline from 2023 to 2050
Year net zero is reached	2057	2030	2030	2050
Annual emissions reduction, $ktCO_2eyr^{-1}$	13.1	62.3	82.0*	16.4
2030 emissions, $ktCO_2e$	344.3	0	0	328.0
Cumulative emissions from 2021 to 2030, $ktCO_2e$	4,093	2,716	3,060	4,044

4.3 Future emission trajectories following the Seventh Carbon Budget

Future emissions trajectories for Exeter have been estimated based on the CCC's Balanced Pathway, which achieves net zero in 2050 in accordance with the Climate Change Act [1,13]. Any emission offsets have been excluded as Exeter, a predominantly urban authority, has few opportunities for sequestration through land use changes (planting) and GHG removals (industrial carbon capture).

The trajectories have been determined by scaling the CCC's national Balanced Pathway trajectories to Exeter's 2023 inventory. Figure 9 compares the future trajectory of total emissions in Exeter following the current trend and the Balanced Pathway, excluding offsets. The current trend estimates 2050 emissions of 81.4 $ktCO_2e$ with the Balanced Pathway

* This is the annual emissions reduction required from 2025. In this trajectory, the current trend is followed from 2023 to 2025, with an annual emissions reduction of 13.1 $ktCO_2eyr^{-1}$. Between 2023 and 2030, the average emissions reduction required would be 62.3 $ktCO_2eyr^{-1}$ – the same as the linear decline from 2023.

projecting residual emissions of 25.7 $ktCO_2e$. The 55.7 $ktCO_2e$ difference between these two pathways highlights the significant additional effort required, beyond the current trend, to meet near net-zero by 2050.

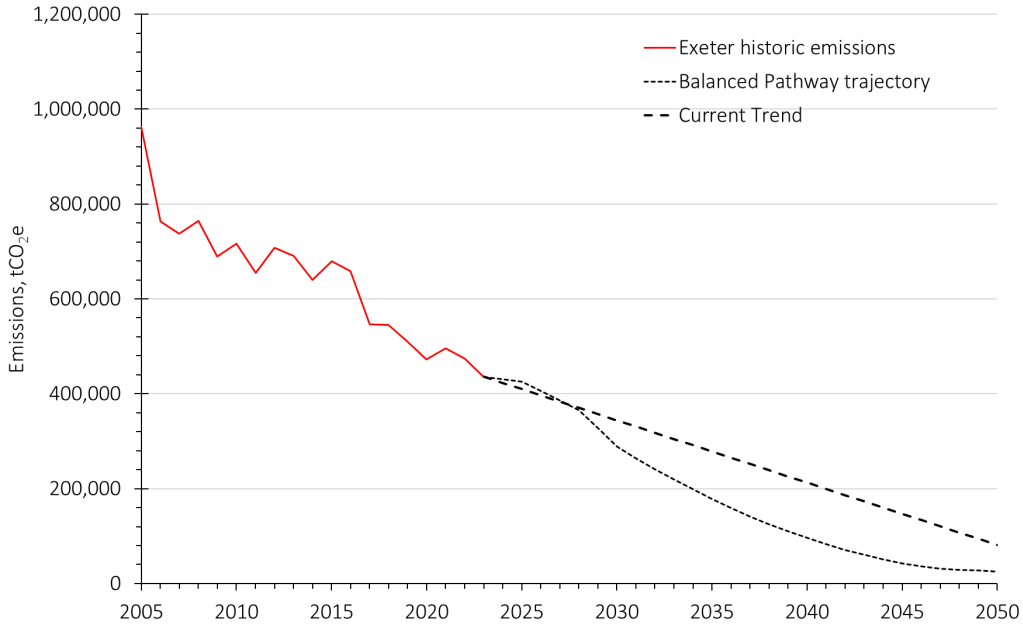

Figure 9. Exeter's current trend of future emissions compared to the CCC's Balanced Pathway.

Balanced Pathway trajectories have also been determined for each sector (Figure 10). It should be noted that the land use trajectory is shown (Figure 10 - f) for completeness but has not been included in the overall totals in Figure 9. Nationally, the CCC project land use to become a net sink of emissions. Currently, land use is a net source of carbon with most emissions arising from the conversion of land to settlement, counteracting any carbon sequestered by forests or grasslands.

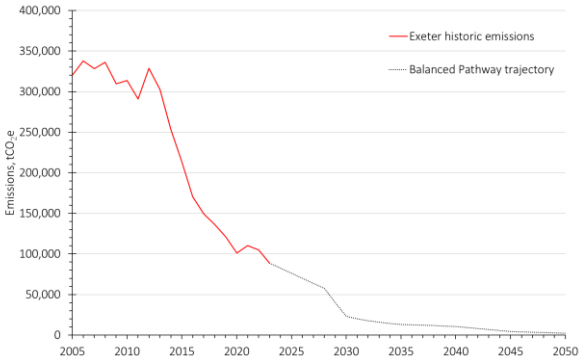

Figure 10 - a. Power

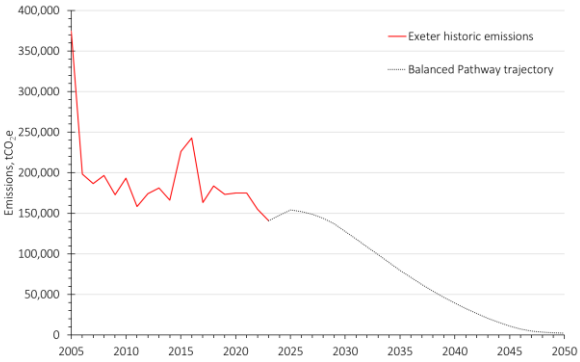

*Figure 10 - b. Buildings**

* The CCC argue that the recent reductions in building emissions are only short-term and will increase over the next few years. However, they will not return to the same pre-2022 level due to installation of energy-saving practices, in response to high energy prices [1].

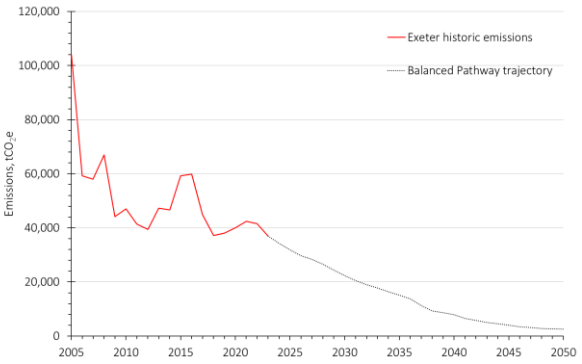

Figure 10 - c. Industry

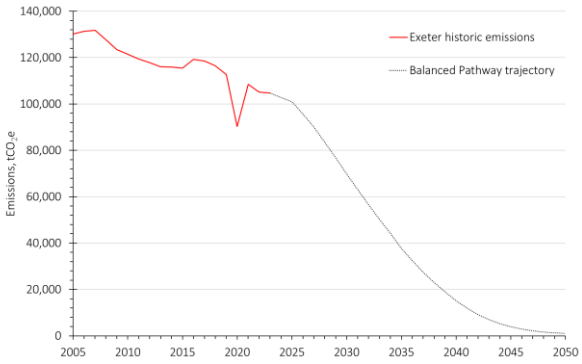

Figure 10 - d. Transport

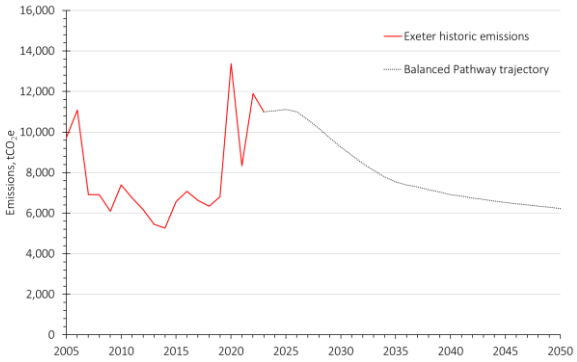

Figure 10 - e. Agriculture

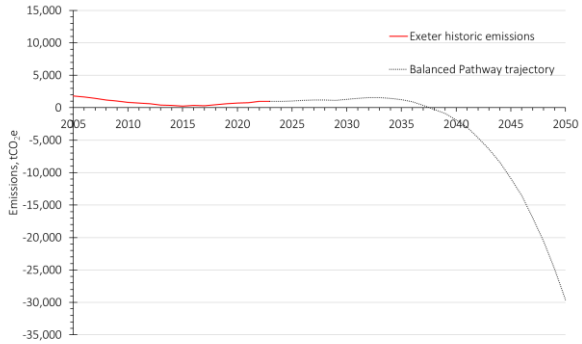

Figure 10 - f. Land Use

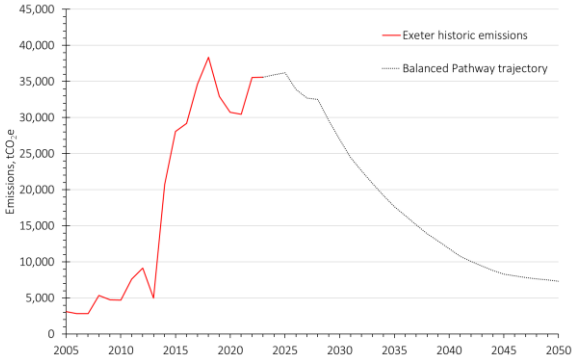

Figure 10 - g. Waste

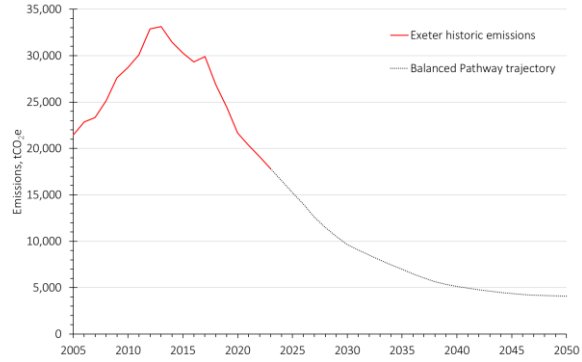

Figure 10 - h. F-gases

Figure 10. Future GHG emissions in Exeter by sector according to the Balanced Pathway with current and scaled national historic emissions.

References

[1] Climate Change Committee, The Seventh Carbon Budget - Advice for the UK Government, London, 2025. www.theccc.org.uk/publications (accessed April 15, 2025).

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Appendix A. Emissions by Sector from 2005

Table 5. Exeter's GHG emissions by sector from 2005 to 2023. Values may not sum to total shown due to rounding.

Emissions, $ktCO_2e$	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Power	320	338	328	336	310	314	291	329	303	253	213	171	149	137	121	101	110	105	89
Buildings	375	198	186	197	173	193	158	174	181	166	226	243	163	184	173	175	175	155	141
Industry	104	59	58	67	44	47	41	39	47	47	59	60	45	37	38	40	42	41	37
Transport	130	131	132	128	123	121	119	118	116	116	116	119	118	116	113	90	108	105	105
Agriculture	10	11	7	7	6	7	7	6	5	5	7	7	7	6	7	13	8	12	11
Land use	2	2	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
Waste	3	3	3	5	5	5	8	9	5	21	28	29	35	38	33	31	30	36	36
F-gases	21	23	23	25	28	29	30	33	33	31	30	29	30	27	24	22	20	19	18
TOTAL	965	765	739	766	690	717	655	709	691	640	679	659	547	546	510	473	496	474	436

Appendix B. Impact of Data Revisions

Historical data undergoes regular data adjustments from central government. As such, previously published results are adjusted in subsequent publications. Exeter's 2022 GHG emissions were initially estimated at 465.8 $ktCO_2e$[5] but are now calculated as 474.2 $ktCO_2e$, an increase of 8.4 $ktCO_2e$ (2%). Similarly, the revised 2019 value in the previous report has been revised further from 511.3 $ktCO_2e$ to 509.9 $ktCO_2e$. Figure 11 compares the previously reported and revised values for 2005 to 2022, along with the 2023 value.

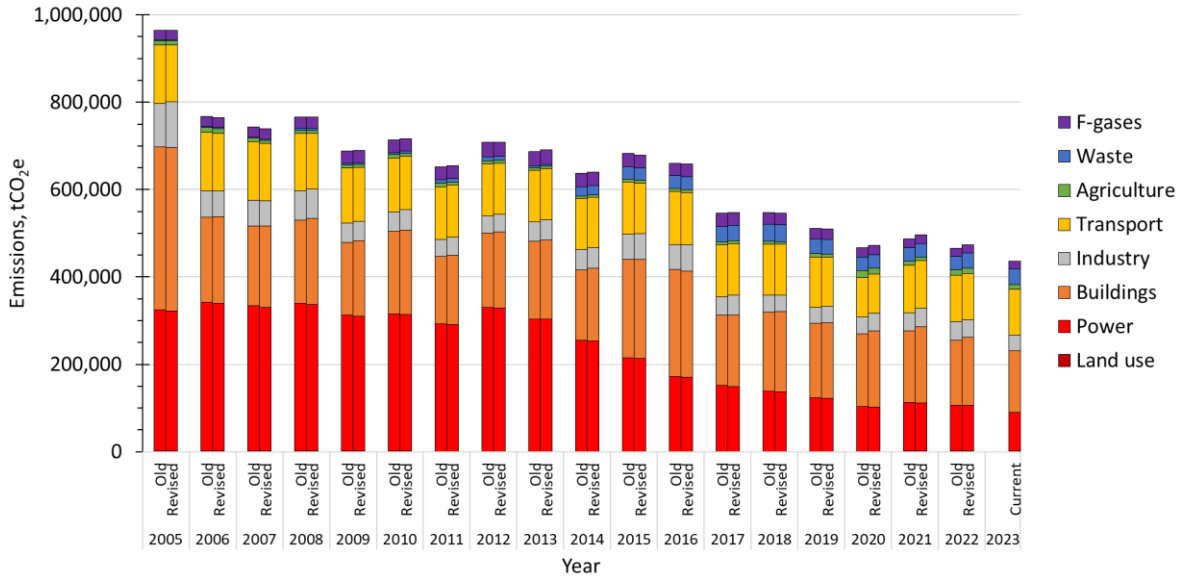

Figure 11. Comparison of previously reported and revised GHG emissions from 2005 to 2022 and the current 2023 value.