University of Strathclyde Glasgow

Fraser of Allander Institute

Quantifying Glasgow's Emissions Reductions: A Data-Driven Analysis from 2005 to 2022

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The Fraser of Allander Institute

Disclaimer

The analysis in this report has been conducted by the Fraser of Allander Institute (FAI) at the University of Strathclyde. The FAI is a leading academic research centre focused on the Scottish economy.

The report was produced in 2024 as part of the Glasgow Enivromental Monitoring of Indoor and Outdoor Air (GEMINOA) project which is funded by ICLEI.

The analysis was undertaken independently by the FAI. The FAI is committed to informing and encouraging public debate through the provision of the highest quality analytical advice and analysis. We are therefore happy to respond to requests for technical advice and analysis. Any technical errors or omissions are those of the FAI.

Executive Summary

This report focuses on analysing trends in territorial carbon dioxide (CO_2) emissions within Glasgow City. In 2019, Glasgow City Council declared a climate and ecological emergency and set a target to achieve net zero carbon emissions by 2030.

Progress towards this goal is tracked using local authority territorial CO_2 emissions data.

Emissions in Glasgow City provide a valuable case study for examining how territorial emissions are disaggregated to the local authority level and how this process may influence the evaluation of climate policies.

The spatial disaggregation of the UK Greenhouse Gas Inventory estimates to the local authority level is complex.

Methodological choices, such as the end-user allocation of electricity emissions and the use of devolved administration-level vehicle fleet data for all local authorities, can obscure the primary drivers of emissions reductions and the extent to which local policymakers can influence these factors.

Key findings:

- The largest single factor driving emissions reductions in Glasgow City, and more broadly in the Glasgow City Region, is the decarbonisation of the UK electricity grid, which lies outside the direct control of local policymakers. UK-wide reductions in the emissions intensity of electricity consumption are reflected in local emissions estimates through the end-user allocation of electricity emissions and account for 45% of the overall CO_2 reduction in Glasgow between 2005 and 2022.

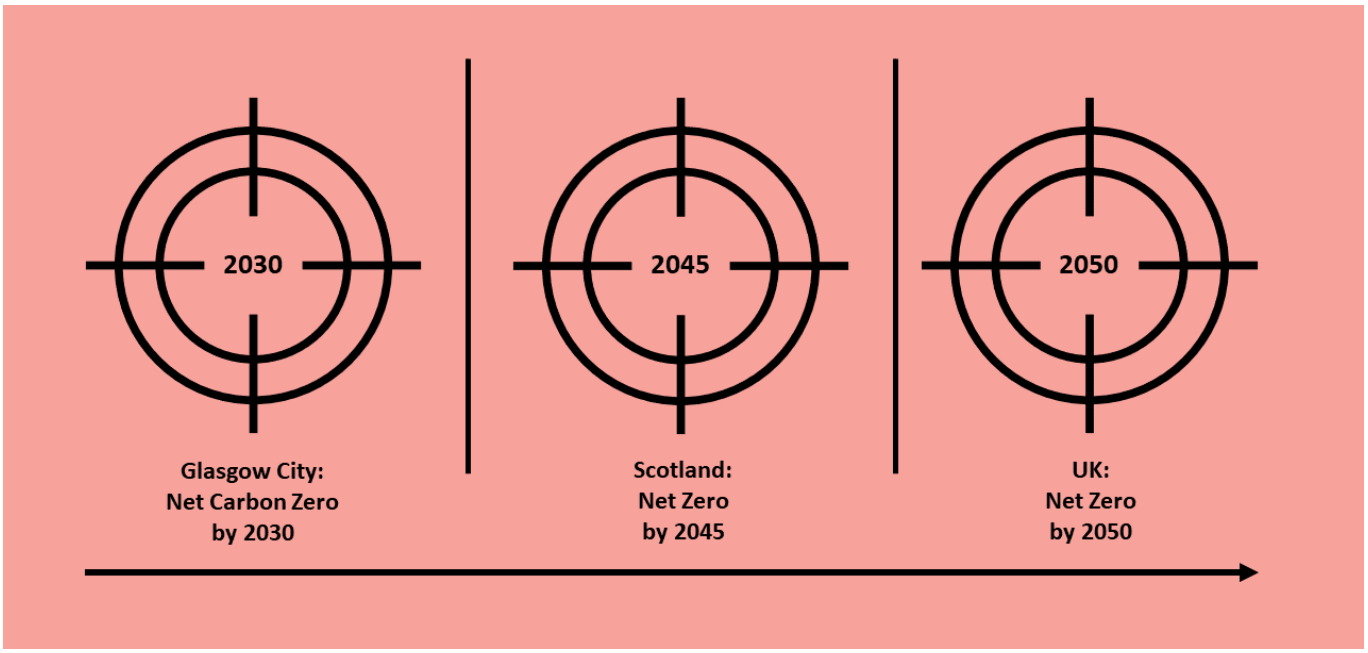
- Emissions from domestic and non-domestic gas consumption have been a leading source of CO_2 emissions in Glasgow since 2016, despite an overall 31% decrease between 2005 and 2022. Territorial emissions estimates are highly sensitive to changes in gas consumption, making household decarbonisation policies a key area for future emissions reductions.

- Transport policy has been a focal point of decarbonisation efforts in Glasgow and Glasgow City Region. Our research finds that key policies, such as the electrification of Glasgow's bus fleet, are likely to be poorly reflected in reported emissions estimates due to the methodological choices around the detail of data within the allocation of UK emissions to local authorities. This is concerning, as local policy actions that could lower CO_2 concentrations and improve air quality may be undermined if emissions reductions cannot be adequately demonstrated within the existing territorial estimates.

Introduction

This report is part of the Glasgow Environmental Monitoring of Indoor and Outdoor Air (GEMINOA) series – a multidisciplinary project funded by ICLEI – Local Governments for Sustainability. This project brings together insights from the University of Strathclyde's Engineering, Architecture, and Economics departments alongside partners in Glasgow City Council and Glasgow Science Centre to support public engagement and aid the evaluation of environmental and economic policies.

Complementing the ongoing indoor and outdoor air quality monitoring conducted by our partners, this report has focused on understanding changes in reported emissions—an increasingly important topic as emissions targets approach.



The Climate Change (Scotland) Act 2009, followed by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, positioned Scotland as one of the world's most progressive nations in setting ambitious net zero targets.

While national targets are widely publicised, local targets are often less well known and understood. The Climate Change (Duties of Public Bodies: Reporting Requirements) (Scotland) Order 2015 mandates that public sector bodies publish annual climate change reports. A 2022 Audit Scotland review on councils' climate action found that 81% of local authorities have set targets for their own direct emissions, while 53% have area-wide emissions targets (i.e., targets for emissions produced within a local authority's geographical area).

In 2019, Glasgow City Council (GCC) declared a climate and ecological emergency. Following the creation of a working group, a report was published established outlining 61 recommendations and set a target for carbon neutrality for the city by 2030. Progress towards this target is measured annually using local authority territorial CO2 emissions data.

Glasgow is the largest local authority in Scotland by population and in 2022 had the second highest absolute territorial CO2 emissions after Fife. While CO2 emissions in Glasgow have been falling since 2005 – understanding whether this trend continues, or continues at similar rate, depends entirely on the factors underpinning the decline.

This report explores Glasgow City's reported CO2 emissions over the period between 2005 to 2022, the period covered by the latest data, to identify the key drivers behind emissions reductions during this time. In doing so, we hope to shed light on the impact of methodological choices and data limitations in the measure. Our analysis helps to clarify the main drivers of emissions reductions and assesses the extent to which the impact of local policies may be obscured within the current emissions data.

The report's structure is as follows:

- Section 1 provides an overview of UK local authority GHG statistics and the emissions categories used throughout this analysis;
- Section 2 outlines the overall trend in Glasgow's territorial emissions from 2005 to 2022 and places it within the broader context of the Glasgow City Region;
- Section 3 analyses the main drivers of Glasgow's emissions reductions, with a focus on electricity, gas, and road transport;
- Section 4 discusses several policy areas where territorial emissions estimates may fall short of fully capturing the intended impacts;
- Section 5 concludes the report.

1. Data

UK Local Authority Greenhouse Gas Statisitics

The UK local authority and regional greenhouse gas emissions statistics are published annually by the Department for Energy Security and Net Zero (DESNZ, formerly BEIS). These statistics, released around 18 months after the end of the year to which they relate, provide spatially disaggregated estimates from the UK Greenhouse Gas Inventory for all 374 UK local authorities, including the 32 in Scotland.

The most recent data, published in July 2024, covering the years between 2005 and 2022, includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and total greenhouse gas (GHG) emissions in kilotonnes of carbon dioxide equivalent ($ktCO_2e$) across various sectors, produced on an "end-user" basis. Energy-use emissions are allocated to the point of consumption, while non-energy emissions, except for waste management, are allocated to the point of production.

Some of the sectors within the dataset cover groupings of Standard Industrial Classification (SIC) codes – used throughout the UK's National Accounts.

Sectors covered include:

- Industry (SIC 02-32, 35-39, 42)
- Commercial (All other SIC codes)
- Public Sector (SIC 84-87)
- Domestic
- Transport
- Land Use, Land-Use Change, and Forestry
- Agriculture (SIC 01)
- Waste Management

Emissions categories and analytical framework

This report focuses on CO_2 emissions as they relate to the net zero territorial CO_2 emissions target set by Glasgow City Council.

In the data, emissions from Industry, Commercial, Public Sector, and Domestic sectors (as shown in **Table 1**) are comprised of emissions from various sources, such as electricity, gas, and other fuels.

While the sectors provided within the dataset are useful, our analysis regroups CO_2 emissions to highlight the source i.e., fuel burned, rather than which sector emisisons came from e.g., public sector or commerical. Where possible we retained the sectoral information while highlighting the source.

Table 1: Example layout of Local Authority Greenhouse Gas Statisitcs

Industry Electricity	Industry Gas	Large Industrial Installations	Industry 'Other'	Industry Total
Commercial Electricity	Commercial Gas		Commercial 'Other'	Commercial Total
Public Sector Electricity	Public Sector Gas		Public Sector 'Other'	Public Sector Total
Domestic Electricity	Domestic Gas		Domestic 'Other'	Domestic Total

Source: *DESNZ*

Our analysis condenses the 32 sub-sectors from the full dataset into nine initial categories. An example of this is process can be seen by comparing **Tables 1 and 2**. Sectors covered include:

- Domestic Gas
- Non-domestic Gas
- Domestic Electricity
- Non-domestic Electricity
- Other Fuels
- Large Industrial Installations, Agriculture, and Waste Management
- Road Transport
- Other Transport
- Land Use, Land-Use Change, and Forestry

Table 2: Example of regrouping categories to highlight source

Industry Electricity	Industry Gas	Large Industrial Installations	Industry 'Other'
Commercial Electricity	Commercial Gas		Commercial 'Other'
Public Sector Electricity	Public Sector Gas		Public Sector 'Other'
Domestic Electricity	Domestic Gas		Domestic 'Other'
Electricity Total	Gas Total	large Industrial installations toal	'Other' Total

Source: *DESNZ*

In addition to these nine initial categories, we include three new categories – E, G, and T.

- Emissions from electricity consumption in Glasgow were divided by total electricity consumption in Glasgow from sub-national electricity consumption statistics (DESNZ) to calculate an implied emissions factor, E (ktCO2 per GWh of electricity consumption). This factor, E, was then used to separate changes in emissions resulting from changes in electricity consumption from those due to other sources.

- G: Emissions from gas consumption were divided by total gas consumption from sub-national gas consumption statistics (DESNZ) to calculate an implied emissions factor (ktCO2/GWh). This factor, G, was then used to separate changes in emissions resulting from changes in gas consumption from those due to other factors.

- T: Road traffic statistics covering the period between 2005 to 2022 and emissions from road transport in Glasgow were used to calculate an implied emissions factor T (ktCO2 per million miles driven). This factor, T, was then used to separate changes in emissions due to changes in the total number of miles driven and the change from alternative sources.

In total, our analysis includes 12 categories (nine initial measures and three derived measures described above) to help understand the cumulative change in Glasgow's emissions by source and sector over this period of time. The full list of categories includes:

- Domestic Gas
- Non-domestic Gas
- G (Implied Emissions Intensity of Total Gas Consumption)
- Domestic Electricity
- Non-domestic Electricity
- E (Implied Emissions Intensity of Total Electricity Consumption)
- Other Fuels
- Large Industrial Installations, Agriculture, and Waste Management
- Road Transport
- Other Transport
- T (Implied Emissions Intensity of Road Transport)
- Land Use, Land-Use Change, and Forestry

2. Glasgow Emissions Overview

Overall change in emissions (Glasgow, 2005-2022)

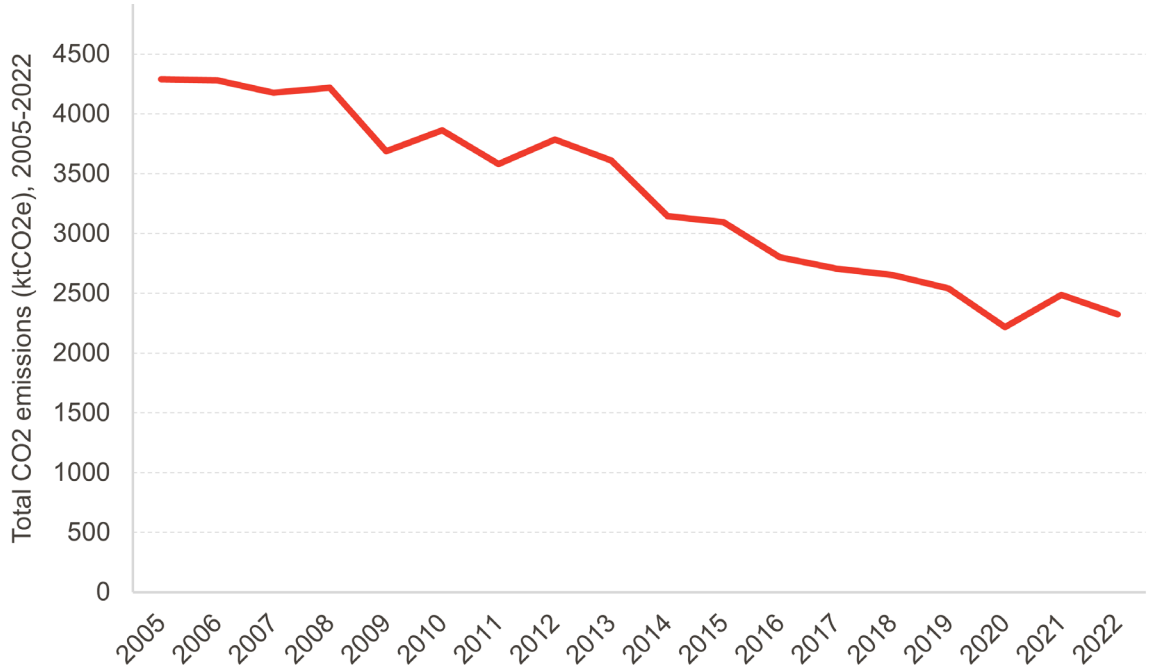
The latest estimates covering 2005-2022 show that Glasgow has seen a 46% reduction in territorial emissions. From **Chart 1** we can see a reasonably steady decline in emissions from 4290 ktCO2e in 2005 with occasional fluctuations around a broadly linear reduction across the series.

CO2 emissions declined to their lowest level on record during 2020 where Covid-19 related lockdowns had a significant impact on sources of emissions such as transport (down 20% from 2019).

In 2021 we see the post-Covid 'bounce back' as several sources of emissions increased and in 2022, we then see the 'bounce back' falling away to a (non-Covid-19 inclusive) low of 2324 ktCO2e.

The headline trend shows that significant progress has been made in the last two decades in moving towards a net carbon zero Glasgow with an average 3.51% year-on-year reduction in CO2 emissions (**see Table 3**).

Chart 1: Glasgow grand total CO2 emissions (ktCO2e), 2005-2022



Source: *DESNZ and FAI Calculations*

Table 3: Glasgow grand total CO2 emissions (ktCO2e), 2005-2022

Year	Grand total (ktCO2e)	Year-on-year reduction (ktCO2e)	Year-on-year reduction (%)	Cumulative reduction (%)
2005	4290.07	-	-	-
2006	4281.22	8.85	0%	0%
2007	4178.15	103.07	2%	-3%
2008	4219.34	-41.19	-1%	-2%
2009	3688.20	531.14	13%	-14%
2010	3863.24	-175.04	-5%	-10%
2011	3581.51	281.73	7%	-17%
2012	3785.79	-204.28	-6%	-12%
2013	3611.63	174.16	5%	-16%
2014	3145.37	466.25	13%	-27%
2015	3094.97	50.41	2%	-28%
2016	2800.36	294.61	10%	-35%
2017	2705.83	94.52	3%	-37%
2018	2653.01	52.82	2%	-38%
2019	2540.29	112.72	4%	-41%
2020	2217.74	322.55	13%	-48%
2021	2487.00	-269.26	-12%	-42%
2022	2323.51	163.49	7%	-46%

Source: *DESNZ and FAI Calculations*

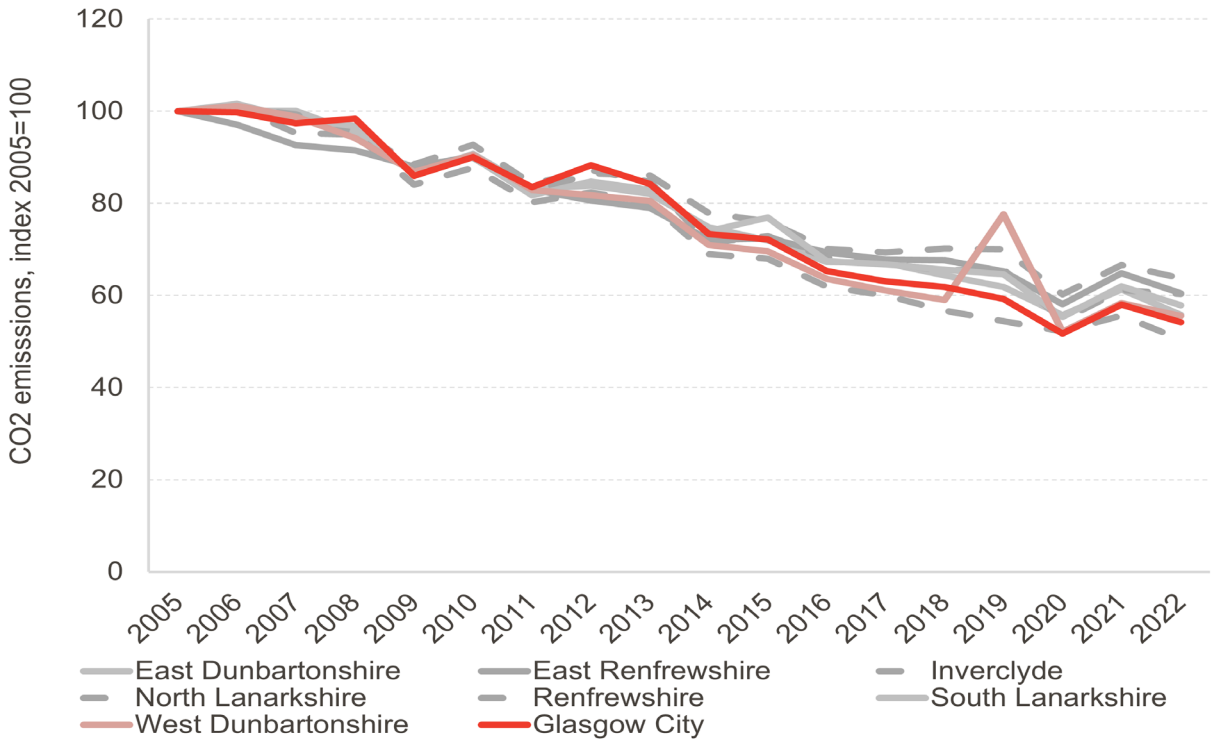
Comparison with Glasgow City Region

A natural follow-on point would be to see if the experience seen in Glasgow is mirrored in other local authorities in Scotland. **Chart 2** shows the change in CO2 emissions across the eight constituent local authorities within Glasgow City Region. Due to differences in the level of emissions, and our interest in changes since 2005, we rebase emissions in 2005 to an index value of 100.

We see from the chart that all local authorities experience a decline in CO2 emissions over this period. Glasgow (dark red line) follows a relatively similar path to the other local authorities – steady decline with minor fluctuations. Glasgow's 46% reduction between 2005 and 2022 sits between the upper and lower levels of Inverclyde (50%) and North Lanarkshire (36%).

From the data we can see a notable outlier around 2019. This significant spike comes from a large increase in Land Use, Land Use Change, and forestry (LULUCF) emissions due to a forest fire that year in West Dunbartonshire (light red line).

Chart 2: Glasgow City Region grand total CO2 emissions (ktCO2e), Index 2005 = 100, 2005-2022



Source: *DESNZ and FAI Calculations*

The similar emission trends observed across all local authorities suggest that regional and national factors might be major drivers behind the reductions.

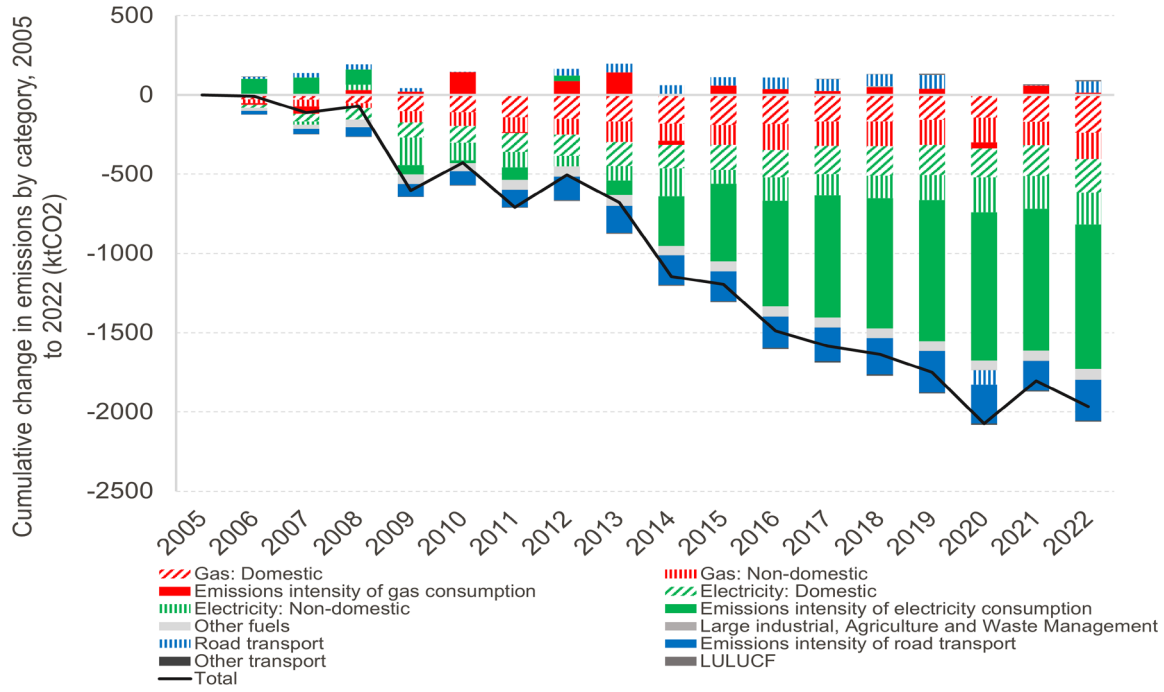
3. Drivers of Emissions Reductions

Overview

Chart 3 illustrates the cumulative change in CO2 emissions in Glasgow from 2005 to 2022, categorised by source and sector where data allow. This section focusses on analysing the three largest categories of change, electricity (green bars), gas (red bars), and road transport (blue bars).

Throughout the series most categories of emissions have decreased, however, as can be seen from **Chart 3** some have increased since 2005.

Chart 3: Glasgow CO2 emissions reduction by source (ktCO2e), 2005-2022



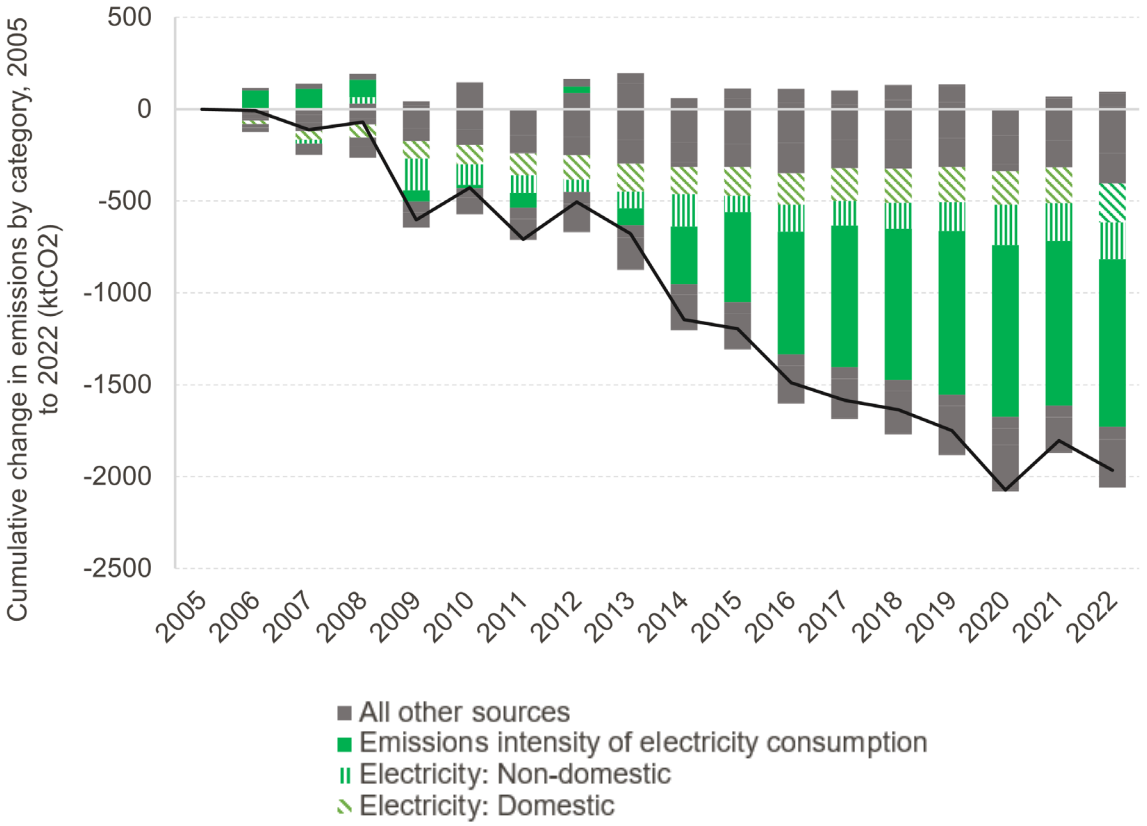
Source: *DESNZ and FAI Calculations*

The following sections will discuss the three major categories:Electricity, Gas and Road Transport.

Emissions from Electricity Consumption in Glasgow

Chart 4 presents a simplified version of **Chart 3**, highlighting the cumulative CO2 reductions from electricity in Glasgow between 2005 and 2022. The chart emphasises that reductions in electricity emissions have been the primary contributor to the overall decrease in emissions.

Chart 4: Glasgow (Electricity highlighted) CO2 emissions reduction by source (ktCO2e), 2005-2022



Source: *DESNZ and FAI Calculations*

In 2005, emissions from electricity consumption in Glasgow City totalled 1,816 ktCO2e. By 2022, this had fallen by 73% to 491 ktCO2e. This decline in electricity emissions represents about 67% of the total reduction in Glasgow's emissions during this period.

Electricity emissions are allocated to each local authority using electricity consumption data, combined with a UK average emissions intensity factor (ktCO2e/GWh) for each year, based on the 2021 UK inventory (Brown et al., 2023).

Subnational electricity consumption data, published by DESNZ, provides estimates for electricity consumption in gigawatt hours (GWh) across all Scottish Local Authorities, divided into domestic and non-domestic consumption categories. Using data for Glasgow City (as shown in **Table 4**), we calculated the implied emissions intensity factor for each year. This lets us separate the change in emissions from electricity consumption in Glasgow into a part due to the reduction in electricity consumption (as seen in the consumption data) and a reduction (i.e. improvement) in ktCO2e per GWh of electricity consumption.

Table 4: Glasgow electricity consumption and emissions data, 2005-2022

Year	Domestic electricity consumption (GWh)	Non-domestic electricity consumption (GWh)	Total electricity consumption (GWh)	Electricity emissions (ktCO2)	Implied emissions intensity factor (ktCO2/ (total) GWh)
2005	1333	2109	3442	1816	0.53
2006	1293	2112	3405	1899	0.56
2007	1245	2073	3319	1860	0.56
2008	1201	2168	3369	1873	0.56
2009	1157	1799	2956	1486	0.50
2010	1141	1922	3062	1581	0.52
2011	1114	1950	3063	1523	0.50
2012	1084	2013	3097	1651	0.53
2013	1051	1961	3013	1480	0.49
2014	1059	1788	2847	1178	0.41
2015	1034	2006	3040	1079	0.35
2016	994	1834	2828	830	0.29
2017	974	1882	2856	735	0.26
2018	937	1852	2789	664	0.24
2019	924	1780	2704	577	0.21
2020	957	1499	2456	478	0.19
2021	899	1567	2467	520	0.21
2022	824	1578	2402	491	0.20
Change 05-22	-509	-531	-1040	-1325	-0.33
Change 05-22%	-38%	-25%	-30%	-73%	-61%

Source: *DESNZ and FAI calculations*

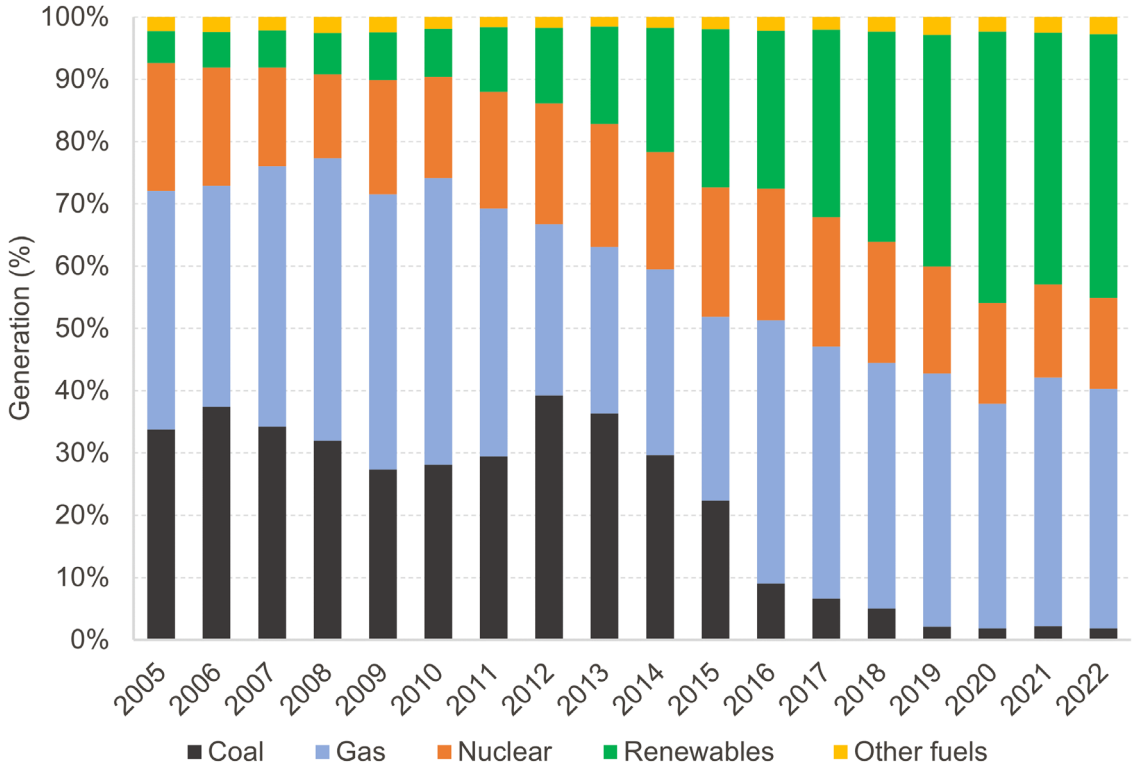
Table 4 shows that electricity use by domestic and non-domestic consumers in Glasgow has decreased by approximately 38% and 25%, respectively. This has led to a reduction in CO2 emissions of around 211 ktCO2e and 203 ktCO2e, as illustrated by the diagonal and vertical patterned green bars in **Chart 4**. Together, these reductions represent 21% of the total CO2 emissions reduction in Glasgow between 2005 and 2022.

The solid green bars in **Chart 4** depict the reduction in electricity emissions that is unrelated to changing patterns of electricity consumption but is instead driven by a decline in the (UK) implied emissions intensity factor.

Between 2005 and 2022, the CO2 emissions produced per GWh of electricity consumed fell by 61%, as shown in the final column of **Table 4**.

This reduction in emissions intensity of electricity – a national trend driven by the shift from coal-fired generation to natural gas and renewable generation and improvements in generation plant efficiency – accounts for the largest single share of Glasgow's CO2 emissions reductions, at 46%. **Chart 5** shows how the generation mix has changed over the 2005 to 2022 period.

Chart 5: Share of electricity generation by fuel, 2005-2022



Source: *DUKES Table 5.6*

Glasgow is not unique in the proportion of emissions reductions attributable to the decline in the UK average emissions intensity factor. Redoing the above analysis for all eight local authorities in Glasgow City Region - **Table 5**, shows that for all a significant portion of their overall emissions reductions come from the decarbonisation of the UK's electricity generation.

Table 5: Proportion of total reduction from UK-wide decarbonisation of electricity generation (2005-2022)

Glasgow City Region Local Authorities	Reduction (%)
East Dunbartonshire	44%
East Renfrewshire	40%
Glasgow City	46%
Inverclyde	50%
North Lanarkshire	36%
Renfrewshire	40%
South Lanarkshire	42%
West Dunbartonshire	44%

Source: *DESNZ and FAI Calculations*

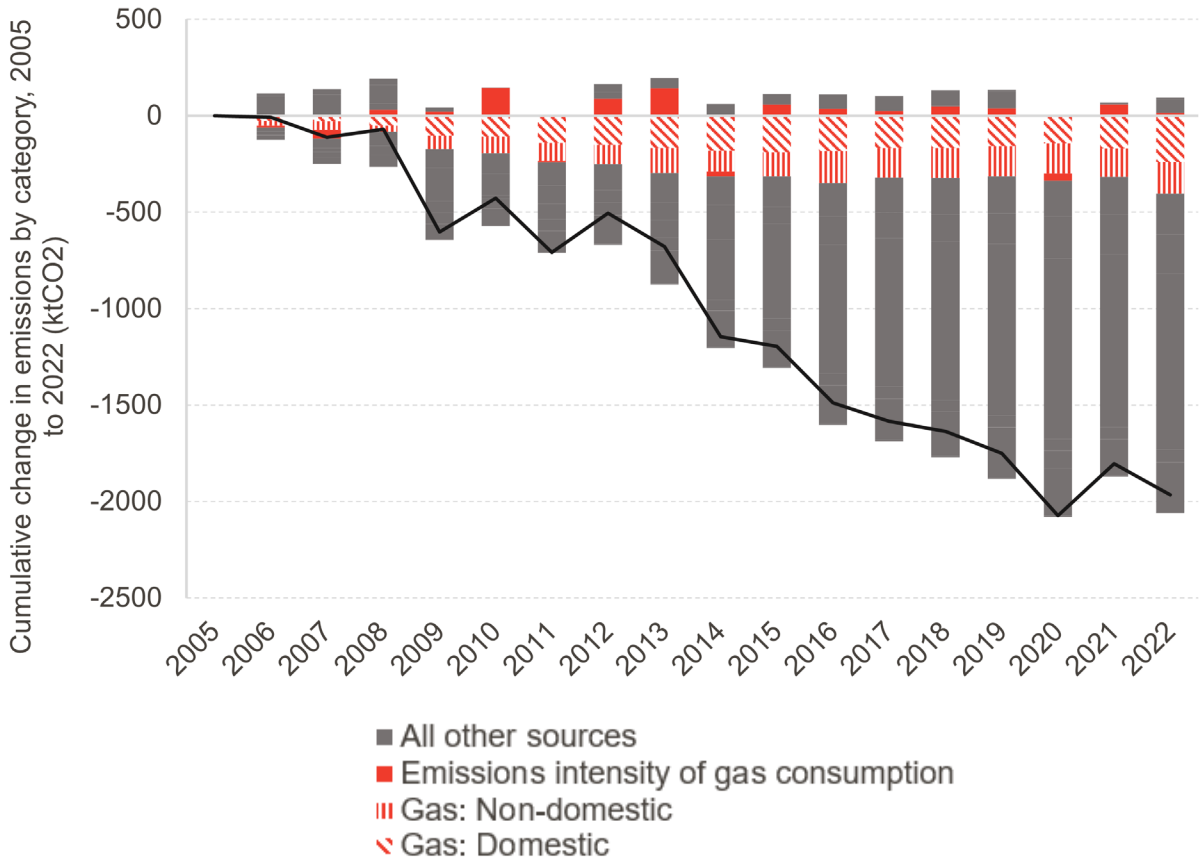
Together, these charts and tables illustrate the story of Glasgow's reductions in emissions from electricity consumption. Since 2005, emissions have fallen due to a combination of lower overall electricity consumption and the decarbonisation of the UK's electricity generation. However, it remains uncertain whether electricity consumption will continue to decline, especially as many decarbonisation strategies rely on consumers shifting from fossil fuels to electricity.

While significant opportunities remain to reduce emissions further by decarbonising the electricity mix, these are largely beyond the control of local governments and depend on national policy decisions.

Emissions from Gas Consumption in Glasgow

In Glasgow, emissions from gas consumption totalled 1,264 ktCO2e in 2005. By 2022, this had fallen by 31% to 875 ktCO2e. This decline in gas emissions represents about 20% of the total reduction in Glasgow's emissions during this period.

Chart 6: Glasgow (Gas highlighted) CO2 emissions reduction by source (ktCO2e), 2005-2022



Source: *DESNZ and FAI Calculations*

As with electricity emissions, gas emissions are attributed to each local authority based on gas consumption data, combined with the UK average emissions intensity factor (ktCO2e/GWh) for each year.

Subnational gas consumption data, provided by DESNZ, provides consumption in GWh for domestic and non-domestic users across all Scottish local authorities. As with electricity emissions we used these estimates to calculate the implied emissions intensity factor.

Table 6: Glasgow gas consumption and emissions data, 2005-2022

Year	Domestic electricity consumption (GWh)	Non-domestic electricity consumption (GWh)	Total electricity consumption (GWh)	Electricity emissions (ktCO2)	Implied emissions intensity factor (ktCO2/ (total) GWh)
2005	1333	2109	3442	1816	0.53
2006	1293	2112	3405	1899	0.56
2007	1245	2073	3319	1860	0.56
2008	1201	2168	3369	1873	0.56
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2014	1059	1788	2847	1178	0.41
2015	1034	2006	3040	1079	0.35
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2020	957	1499	2456	478	0.19
2021	899	1567	2467	520	0.21
2022	824	1578	2402	491	0.20
Change 05-22	-509	-531	-1040	-1325	-0.33
Change 05-22%	-38%	-25%	-30%	-73%	-61%

Source: *DESNZ and FAI Calculations*

Table 6 shows that between 2005-2022, domestic gas consumption decreased by 1248 ktCO2e (33%), while non-domestic gas consumption fell by 876 ktCO2e (29%). These reductions can be seen by the red diagonal and vertical patterned bars in **Chart 6**.

Unlike electricity emissions, where the reduction in consumption did not fully explain the total change in emissions, the decrease in gas consumption entirely accounts for the change in gas emissions.

This is expected, given slight increase in the emissions intensity factor for gas, as shown in the final column of **Table 6**.

Overall, the reduction in gas emissions has played a key role in Glasgow's CO_2 emissions decline. Reducing gas emissions significantly would require a switch to alternative methods of heating within Glasgow's building stock.

A recent report by Changeworks looked at eight zero direct emissions heating systems (ZDEH) case studies implemented by social landlords in Scotland.

While the report primarily focused on the transition from electric storage heating to air source heat pumps—the most common change—it also highlighted several challenges that could influence a future shift from gas to ZDEH systems.

Emissions from Road Transport in Glasgow

Road transport emissions fell from 961 $ktCO_2e$ in 2005 to 774 $ktCO_2e$ in 2022, marking a 20% reduction. Among Glasgow's three main emissions sources—electricity, gas, and road transport—this decline represents the smallest proportional decrease since 2005.

Road transport consistently accounted for 98% of total transport emissions each year from 2005 to 2022. The remaining 2% includes emissions from diesel railways, alternative fuel vehicles (e.g., liquified petroleum gas), inland waterways, and aircraft support vehicles.

It is also interesting to note that emissions from rail transport in DESNZ local authority emissions are currently allocated to Glasgow's non-domestic electricity emissions, rather than being reported in a separate sub-sector within transport emissions estimates.

Road transport emissions for the three road types—A-roads, motorways, and minor roads—are calculated by combining emissions factors with traffic data for various vehicle types, including passenger cars, light goods vehicles (LGVs), rigid and articulated heavy goods vehicles, buses/coaches, and mopeds/motorcycles, as shown in **Table 7**.

Table 7: Glasgow traffic estimates and transport emissions, 2005-2022

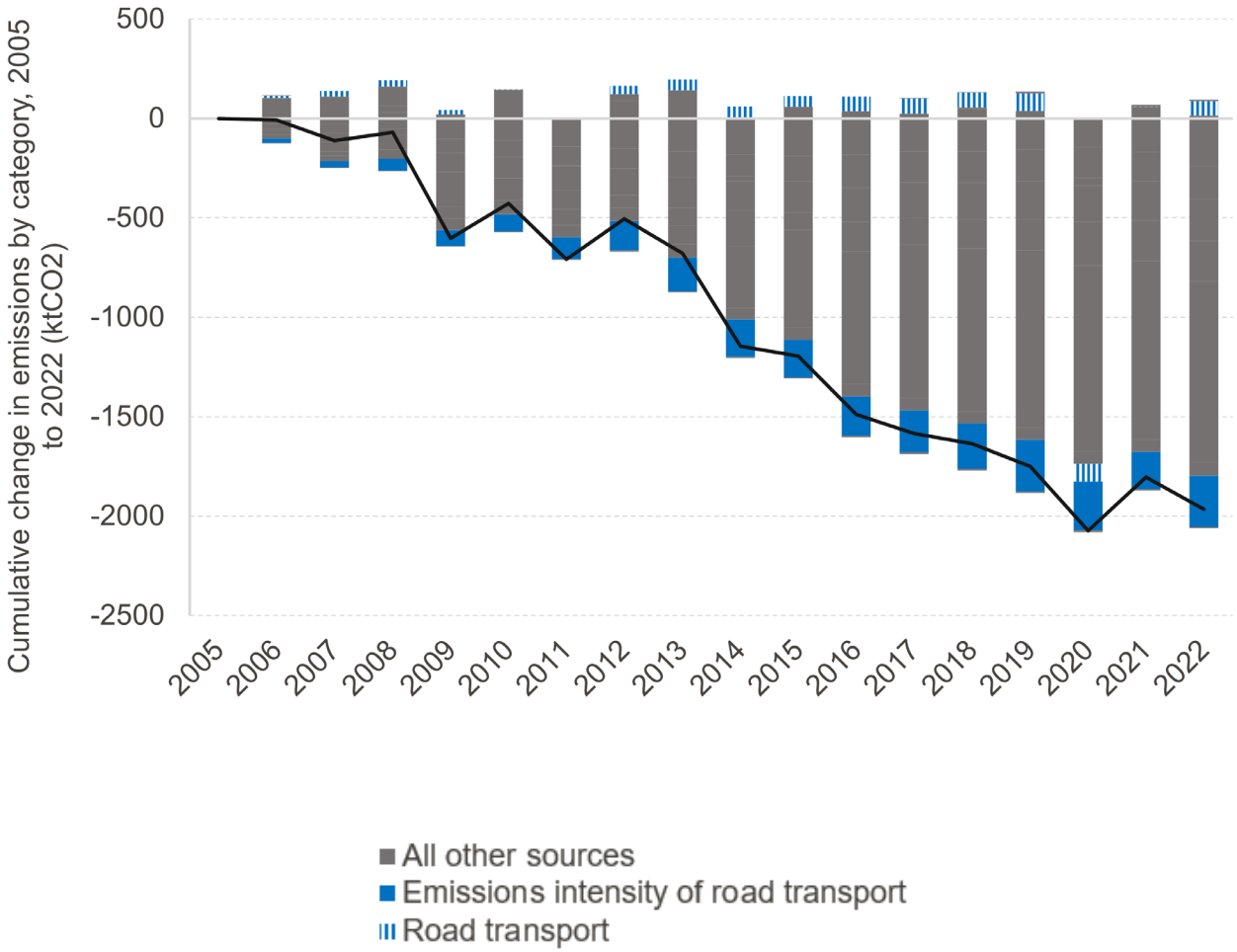
Year	Road Transport (A roads) ($ktCO_2$)	Road Transport (Motorways) ($ktCO_2$)	Road Transport (Minor roads) ($ktCO_2$)	**Road Transport total ($ktCO_2$)**	Total miles driven (million)	Implied emission intensity ($ktCO_2$ / million miles)
2005	237	303	422	**961**	2,036	0.47
2006	227	308	416	**951**	2,061	0.46
2007	222	312	422	**956**	2,092	0.46
2008	212	314	411	**936**	2,107	0.44
2009	207	307	389	**903**	2,083	0.43
2010	205	306	366	**877**	2,034	0.43
2011	197	315	343	**855**	2,040	0.42
2012	191	334	332	**856**	2,132	0.40
2013	190	340	315	**846**	2,161	0.39
2014	191	336	307	**833**	2,179	0.38
2015	186	341	300	**827**	2,162	0.38
2016	186	353	299	**839**	2,215	0.38
2017	179	359	289	**827**	2,223	0.37
2018	169	352	286	**806**	2,217	0.36
2019	164	348	274	**786**	2,251	0.35
2020	130	269	227	**626**	1,740	0.36
2021	146	307	320	**774**	1,998	0.39
2022	147	306	321	**774**	2,175	0.36
Change from 05-22	-90	4	-101	**-187**	139	0.12
% Change 05-22	-38%	1%	-24%	**-20%**	7%	25%

Source: *DESNZ and FAI Calculations*

The change in transport emissions is the result of two opposing factors, as illustrated in **Chart 7**: (1) the vertical patterned blue bars represent the change in emissions due to the increase in total miles driven in Glasgow—a key factor in calculating road transport emissions, and (2) the solid blue bars show the change in emissions resulting from adjustments to the emissions factor—measured as $ktCO_2e$ per million miles driven.

As shown in **Table 7**, the total number of miles driven in Glasgow increased by 7% between 2005 and 2022, reaching 2.175 billion miles in 2022. This rise in road transport activity alone would have resulted in an additional 71 $ktCO_2e$ in emissions.

Chart 7: Glasgow (Road Transport highlighted) CO2 emissions reduction by source (ktCO2e), 2005-2022



Source: *DESNZ and FAI Calculations*

This (hypothetical) increase however was more than offset by emissions reduction of 258 ktCO2e brough about by the 25% decrease in the implied road emissions factor, shown in the final column of **Table 7**.

The net impact of these two factors is an overall reduction in road transport emission of 187ktCO2e or 20% between 2005 and 2022.

As noted at the start of this section, road transport emissions are not declining as rapidly as electricity or gas emissions.

4. Interaction with policy

Transport Policy

Scottish local authorities, in part due to their role as transport authorities, can significantly contribute to reducing transport emissions. Glasgow City Council's 2022 Transport Strategy outlines a range of transport-related policies aimed at achieving several goals by 2030, including net-zero carbon emissions, reducing inequalities, fostering economic success, and promoting greater inclusivity.

Two decarbonisation policies listed in **Box 1**, serve as case studies to illustrate the strengths and weaknesses of local authority-level territorial emissions data in capturing the impact of transport decarbonisation efforts.

Box 1: Glasgow City Council Transport Policies

Policy 8:
The Council will collaborate with partners to reduce car vehicle kilometres in the city by at least 30% by 2030, contributing significantly to Scotland's national target of a 20% reduction.
Policy 101:
The Council will continue to work with bus operators and SPT in the City to move towards a low carbon fleet and build on the success of the Low Emissions Zone in Glasgow City Centre. • Action 101.A: Explore options to utilise the ongoing development of Glasgow's Low Emission Zone to contribute towards carbon reductions from transport in the city centre. • Action 101.B: Work with transport stakeholders in the city to support rapid transition to cleaner public transport as part of the City's Low Emissions Zone.

Source: *Glasgow Transport Strategy 2022*

Policy 8: Reduction in miles driven

Building on Scotland's national policy of reducing car vehicle miles by 20%, Glasgow has set its own ambitious target of achieving a 30% reduction. This is one area where the policy's impact is expected to be clearly reflected in reported emissions statistics. Between 2020 and 2021, vehicle kilometres in Glasgow decreased by 23%, likely due to pandemic restrictions, leading to a corresponding 20% reduction in CO_2 emissions. Over the period between 2005 and 2022 however we see (**Table 7**) that total miles driven in Glasgow have increased by 7%.

Since road transport emissions are calculated based on the estimated number of miles driven by different vehicle classes across three road types, the impact of this policy will be reflected in emissions statistics—though not perfectly.

The three road types—urban, rural, and motorway—each have different emissions factors due to variations in the vehicle kilometres assumed for each class of vehicle.

Table 8 shows the NAEI vehicle fleet composition data for Scotland used in calculating road transport emissions for Glasgow. Data up to 2020 are based on actual road traffic statistics published by the Department for Transport, while estimates for later years rely on DfT's Road Traffic Forecast for the UK, excluding London.

Consequently, a 30% reduction in vehicle kilometres on motorways would likely have a different emissions impact than the same reduction on urban roads. This is due to the lag time in data projections, which are based on existing estimates and may not account for a significant decrease in vehicle kilometres across all road types.

Table 8: Share of vehicle kilometres driven on Scottish roads by road type and vehicles class, 2013-2022

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Urban	Electric car	0%	0%	0%	0%	0%	0%	1%	1%	2%	3%
	Petrol car	47%	46%	46%	45%	44%	44%	45%	43%	42%	43%
	Diesel car	35%	35%	35%	36%	36%	37%	35%	33%	33%	32%
	Electric LGV	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Petrol LGV	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
	Diesel LGV	12%	13%	13%	14%	15%	14%	15%	17%	18%	18%
	Rigid	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%
	Artic	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%
	Bus & Coach	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
	Motorcycle	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%
Rural	Electric car	0%	0%	0%	0%	0%	0%	1%	1%	2%	3%
	Petrol car	42%	40%	38%	37%	35%	36%	37%	37%	37%	38%
	Diesel car	35%	36%	38%	38%	38%	38%	36%	34%	33%	31%
	Electric LGV	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Petrol LGV	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%
	Diesel LGV	15%	15%	16%	17%	18%	18%	18%	20%	20%	20%
	Rigid	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%
	Artic	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%
	Bus & Coach	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
	Motorcycle	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Motorway	Electric car	0%	0%	0%	0%	0%	0%	1%	1%	2%	2%
	Petrol car	32%	31%	29%	29%	28%	28%	31%	29%	33%	34%
	Diesel car	41%	42%	43%	44%	44%	43%	41%	37%	32%	31%
	Electric LGV	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Petrol LGV	1%	1%	1%	0%	0%	0%	0%	1%	0%	0%
	Diesel LGV	13%	14%	14%	14%	15%	15%	15%	18%	18%	18%
	Rigid	4%	4%	4%	4%	4%	4%	4%	5%	5%	5%
	Artic	7%	7%	7%	7%	7%	7%	7%	9%	9%	9%
	Bus & Coach	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%
	Motorcycle	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Note: 2021 and 2022 values are projections while values between 2013 and 2020 come from Road Traffic Statisitcs

Source: *NAEI Base 2022*

Policy 101: Decarbonisation of the local bus fleet

One of the most notable recent developments in Glasgow has been the electrification of the bus fleet. This shift from diesel to electric power could be expected to impact emissions in two ways: (1) a reduction in road transport emissions due to lower diesel consumption, and (2) an increase in non-domestic electricity consumption, potentially raising electricity emissions.

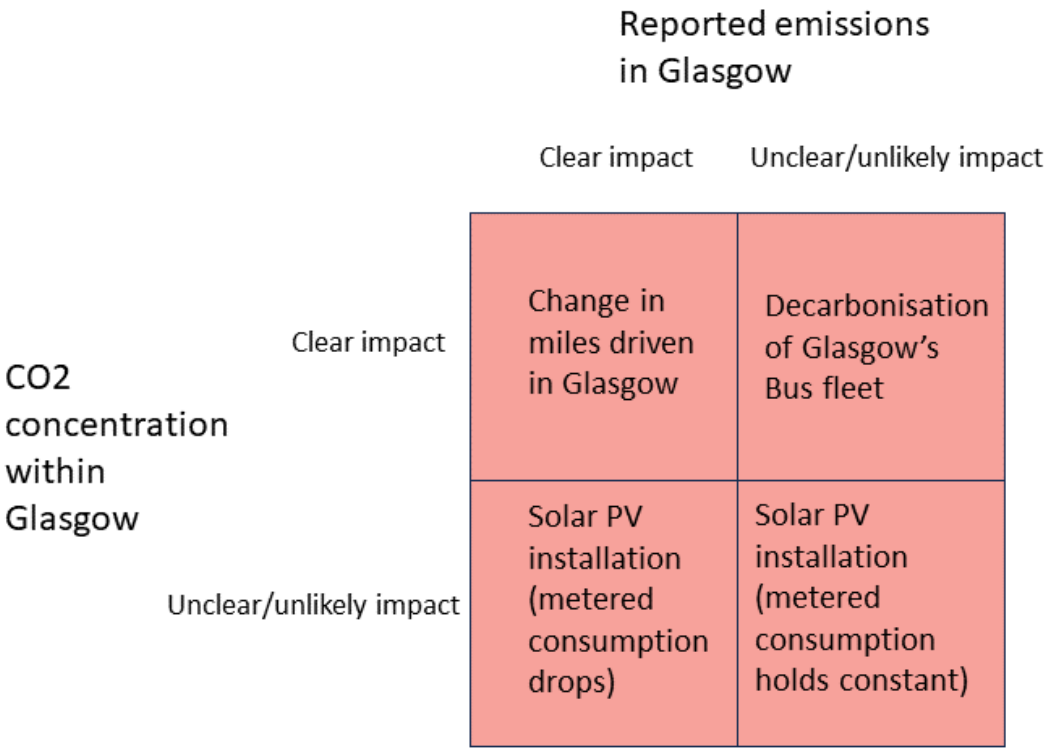
However, the 2022 Local Authority GHG Technical Report notes that all heavy goods vehicles (HGVs) and buses are still assumed to run on diesel, suggesting that any reduction in emissions from reduced diesel use is not being captured.

The second anticipated effect—increased electricity consumption from electrification—is likely being recorded through non-domestic meters. This may lead to the unintended consequence of emissions per mile driven by buses being higher rather than lower, as the process effectively double counts the emissions impact.

These limitations reflect the challenges of using spatially disaggregated UK Greenhouse Gas Inventory estimates at the local authority level.

The current limitations of reported emissions estimates to account for the impact of decarbonisation policies such as the electrification of the bus fleet could undermine policy headed in the right direction. One way of thinking about the impact of various policies on emissions can be demonstrated using the 2x2 matrix shown in **Diagram 2**.

Diagram 2: Local policy impact matrix



Source: *FAI*

Some policies, such as reducing car vehicle miles, will impact on both reported emissions and reduce CO2 concentrations in the city, as less fuel is burned (top left quadrant).

However, other policies, like the decarbonisation of the local bus fleet (top right quadrant), may not affect reported emissions due to the limitations discussed earlier, despite driving down CO2 concentrations within the city. In such cases, policies aimed at reducing emissions and improving air quality through fleet decarbonisation may be undermined because its impact is not reflected in the territorial emissions metric produced by DESNZ.

We recommend that, until local authority territorial emissions estimates account for city-level vehicle splits and update the assumption that all buses run on diesel, other metrics - such as local air quality monitoring, or vehicle kilometres driven by diesel opposed to electric busses - should be used to capture the impact of fleet decarbonisation policies.

Local generation – solar PV installation

Glasgow City Council is currently implementing a phased programme to increase the number of solar panels on its buildings as part of its decarbonisation efforts. Local generation at the point of consumption offers an interesting opportunity to analyse its potential impact on reported territorial emissions.

If solar panels are installed and result in a reduction in metered non-domestic electricity use, the impact would likely align with the lower left quadrant of **Diagram 2**. In this scenario, there would be no change in CO2 concentrations within the city, as emissions related to electricity generation occur at the point of production (across the GB electricity grid). However, there would be a reduction in territorial emissions due to lower non-domestic electricity consumption (and the allocation of emissions to end users in the DESNZ metric).

Alternatively, should installation of solar panels lead to an overall increase in electricity consumption, the installation of solar panels leads to little or no reduction in metered electricity consumption via increased total consumption.

While this scenario may be more likely in domestic settings, it is possible to imagine efficiency measures being relaxed combined with an expansion of technology being utilised in a non-domestic setting.

If solar PV installations do not significantly reduce metered electricity use, the emissions impact would reflect the lower right quadrant of **Diagram 2**. In this case, there would be no reduction in CO2 concentrations in Glasgow, and possibly no change in reported emissions as non-domestic electricity consumption remains stable.

5. Conclusions

This report examines the trends and challenges in territorial CO2 emissions across Glasgow City and the Glasgow City Region local authorities. Using Glasgow as a case study, the analysis explores the main drivers of emissions reductions, how emissions are spatially disaggregated to the local authority level, and the limitations of current data and methodologies for accurately assessing the impact of decarbonisation policies.

The report finds that the primary driver of Glasgow's emissions reductions between 2005 and 2022 is a reduction in emissions from electricity consumption. This progress comes primarily from the decarbonisation of the UK electricity grid at the national level and in part from a reduction in the consumption of electricity in Glasgow. Reductions in gas consumption and a lower emitting vehicle fleet also play a part in Glasgow's progress. Our findings highlight the challenge of monitoring local policy actions with spatially disaggregated GHG Inventory data.

The report also highlights the challenges in accurately capturing the emissions reductions from road transport. Glasgow's goal of reducing car vehicle kilometres by 30% by 2030 serves as a case study, showing that while reductions in car usage are being reflected in road traffic emissions, the current data calculation methods at the national level do not fully account for local policy interventions, such as the electrification of the bus fleet.

The shift from diesel to electric-powered buses, for instance, illustrates how emissions reductions at the local level are being underreported. The 2022 Local Authority GHG Technical Report assumes that all heavy vehicles, including buses, still run on diesel, meaning the positive impact of electrification is not fully captured. Additionally, any increase in non-domestic electricity consumption from electrification may be counted as higher emissions, compounding the challenge of measuring progress.

This report underscores the limitations of the current spatially disaggregated greenhouse gas estimates and the need for more refined data that accurately reflects local actions. Local authorities, despite playing a critical role in transport decarbonisation, face significant challenges in demonstrating the true impact of their policies due to these methodological choices.

Fraser of Allander Institute
University of Strathclyde
199 Cathedral Street
Glasgow G4 0QU
Scotland, UK

Telephone: 0141 548 3958
Email: fraser@strath.ac.uk
Website: fraserofallander.org
Follow us on Twitter via @Strath_FAI
Follow us on LinkedIn: FAI LinkedIn
