TRANSPORT SCOTLAND
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Carbon Account for Transport No. 10: 2018 Edition

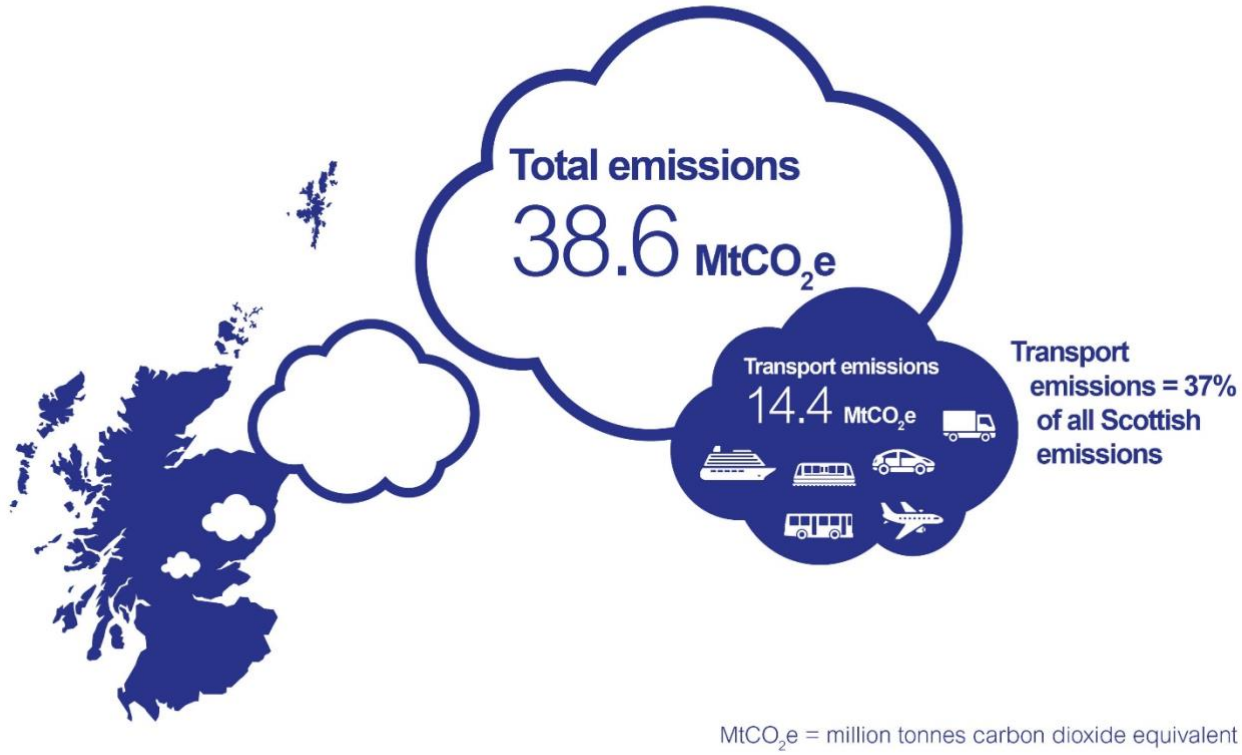
EXECUTIVE SUMMARY

The Carbon Account for Transport provides a balance sheet for Scotland's greenhouse gas emissions between 1990 and 2016, and the expected emission impacts of major transport infrastructure projects and regulatory measures.

The main findings from volume 10 are:

- Total greenhouse gas emissions for Scotland in 2016 were 38.6 megatonnes of carbon dioxide equivalent (Mt CO_2e). Transport, including International Aviation and Shipping (IAS), accounted for 14.4 Mt CO_2e, which is 37.3% of the total. In 2015, transport overtook energy supply as the largest sectorial contributor to Scottish greenhouse gas emissions.
- The latest National Atmospheric Emissions Inventory data now shows that Scottish transport emissions including IAS rose in 2015 and 2016.
- In 2016, road transport accounted for 68.1% of total transport emissions. Cars and goods vehicles (light and heavy combined) accounted for 40.1% and 24.4% of total transport emissions respectively.
- Looking at Scottish emissions over the period 1990-2016:
    - At 14.4 Mt CO_2e total transport emissions in 2016 were 2.5% below the 1990 level. Emissions from transport peaked at 16.1 Mt CO_2e in 2007.
    - At 5.8 Mt CO_2e, emissions from cars in 2016 were 0.2% below the 1990 level.
    - Aviation emissions accounted for 2.1 Mt CO_2e in 2016, a 50.0% rise on 1990. Domestic aviation emissions fell by 22.3% while international aviation emissions rose by 164.5% over the period.
    - Goods vehicles accounted for 3.5 Mt CO_2e in 2016, 28.1% above 1990. Of those, emissions from light goods vehicles increased by 81.3%, while emissions from heavy goods vehicles fell 0.4% over the period.
- Leading indicators imply that reducing transport emissions is becoming more challenging in the face of rising demand across a range of modes.

Transport emissions as a share of total Scottish emissions 2016

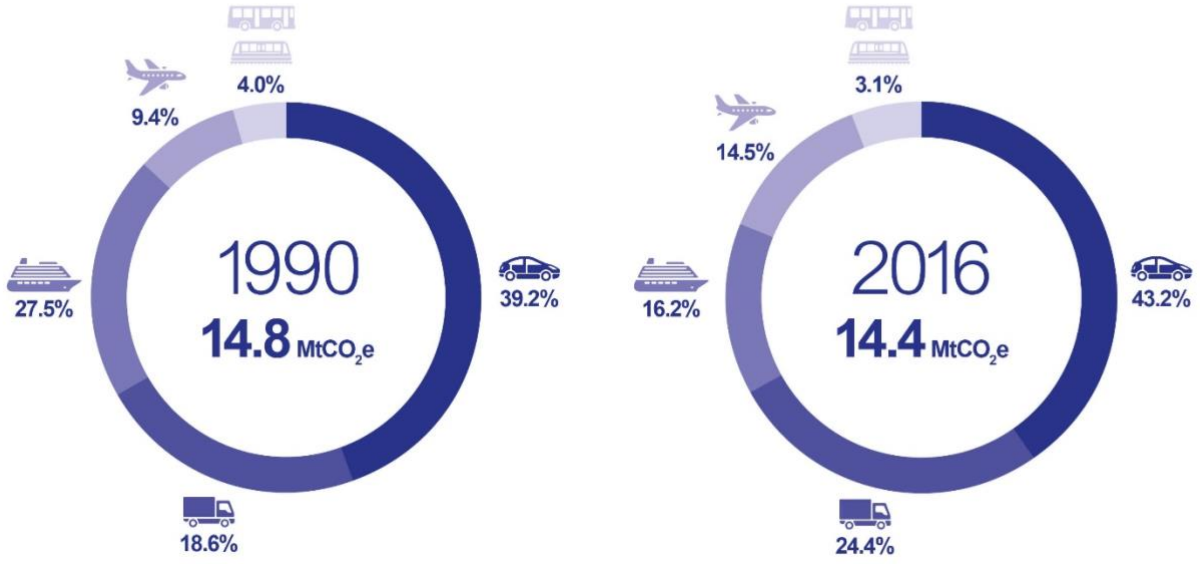


$MtCO_2e$ = million tonnes carbon dioxide equivalent

Change in transport emissions since 2008:

Change in emissions from key transport modes 2015-2016:

Breakdown of transport emissions by mode 1990-2016:



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1. Introduction

This is the tenth edition of the Carbon Account for Transport, which presents a detailed analysis of already published Scottish Transport emission data from the National Atmospheric Emissions Inventory (NAEI). This edition follows the same structure as last year's report, updating it to include the latest emissions data (1990 - 2016). This year's edition also contains a detailed examination of plug in vehicle charging points in Scotland (section 3).

1.1 Policy Context

The Climate Change (Scotland) Act 2009 created a statutory framework for reducing greenhouse gas emissions in Scotland. It includes annual and interim emissions targets with the overall aim of achieving an 80% reduction in emissions in 2050 against the 1990 baseline[1].

To help achieve the emissions reductions targets, The Scottish Government publishes regular statements and plans setting out how they can be achieved. The latest Climate Change Plan (CCP)[2], published in February 2018, sets out a possible emissions pathway to 2032, alongside policy options to achieve the annual targets. The Climate Change Plan contained a commitment to publish annual monitoring reports to assess progress against the delivery of the Plan. The first of these was published on 31 October 2018.

The Scottish Government introduced the Climate Change (Emissions Reduction Targets) (Scotland) Bill to the Scottish Parliament in May 2018 following advice from the Climate Change Committee. As introduced, the Bill would increase Scotland's ambition for emissions reduction by 2050 from 80% to 90% against 1990 levels, and adjust the way emissions are accounted for within the targets.

In the last five years, reductions in emissions from the power sector have enabled Scotland to reduce its overall emissions but meant that the share of Scotland's emissions from transport has increased substantially.

Emissions from transport are dependent on a number of factors, including the state of the economy. The key challenge for transport in the context of greenhouse gas emissions is to decouple rising demand from emissions increases as much as possible. The next decade will be critical in setting road transport in particular on a pathway to decarbonisation, with other sectors to follow suit in due course. These challenges will be considered as part of Transport Scotland's comprehensive review of the *National Transport Strategy* (NTS), focused around four themes: greener & healthier; enabling economic growth; tackling inequality; and delivering safe & resilient transport. The outcomes will inform the second Strategic Transport Projects Review (STPR2), for which planning is now underway. STPR2 will identify the transport interventions required to provide Scotland with a transport network fit for the 21st century.

Bold new plans for transport were announced in the Programme for Government 2017-2018, with a target set to phase out the need to buy petrol and diesel engine cars and vans by 2032. As the latest emissions figures available are for the period 1990-2016 they do not yet reflect the effects of this recent commitment.

[1] The next interim target is for total emissions from Scotland, including international aviation and shipping, to reach 40.72 Mt CO_2e by 2020. See page 3 of the Annual Targets Order.
[2] The Climate Change Plan is available to view here.

1.2 Purpose of the Carbon Account for Transport

Reducing emissions is one of the key strategic outcomes of the *National Transport Strategy*. It includes a commitment to publish a carbon balance sheet for transport to show the impact of policies and projects expected to have an impact on transport emissions, whether positive or negative. This commitment is met by the Carbon Account for Transport (CAT), which is published annually.

The CAT provides updates on the following information:

- Scottish transport emissions from 1990 to 2016
- Comparison of Scottish emissions with those of the UK as a whole, and other UK nations
- Emissions efficiency estimates across different modes of transport
- Key leading transport emissions indicators
- Scottish transport infrastructure projects likely to have a significant impact on emissions
- Scottish, UK and EU wide regulatory and fiscal measures likely to impact emissions

Each of the above monitors progress towards reducing transport emissions and support the development of future policies to meet the statutory targets. However, the CAT is not a decision making tool. Its purpose is to present data and analysis for the consideration of future transport options. The CAT is an element of a wider framework adopted across The Scottish Government to monitor emissions.

2. Historical Emissions Analysis

2.1 Background data and sources

All historical emissions data presented were originally published in *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2016* by the National Atmospheric Emissions Inventory[3]. Some information presented is from alternative sources where stated.

The inventory is compiled annually and consists of a time series of emissions back to 1990[4]. It is updated in full in every publication to take account of on-going improvements in estimation techniques and methodology. Emissions levels are presented in either mega-tonnes or kilo-tonnes[5] of carbon dioxide equivalent[6] (Mt CO_2e, Kt CO_2e).

Emissions from international aviation and shipping were not originally reported in the inventory, but have been included since 2009 under a separate category titled *Exports*. The Scottish Government has committed to including them in the emissions targets, hence references to maritime and aviation emissions refer to both domestic and international combined, unless otherwise stated.

Improvements to the methodology for estimating shipping emissions this year has resulted in an increase in the estimates for gas oil and fuel oil used in Scotland. This has caused recalculations for emissions from domestic navigation and fishing vessels. Changes to shipping have on average increased emissions by 1,5 Mt CO2e across the series.

In line with the methodology used to report against the Climate Change (Scotland) Act, emissions from transport reported only include those at the point of use, also known as tailpipe emissions. As a result, lifecycle and displaced impacts, such as the emissions from generating the electricity powering electric trains, are not included.

2.2 Emissions trends for Scotland

In 2016 emissions from all sectors amounted to 38.6 Mt CO_2e, down 10.3% from 43.0 Mt CO_2e in 2015. Source adjusted emissions[7] were 41.5 Mt CO_2e[8] in 2016, 45.2% below the 1990 baseline.

Measured at source, transport emissions including International Aviation and Shipping (IAS)[9] accounted for 14.4 Mt CO_2e in 2016, an increase of 2.3% on the previous year. The inventory states that transport emissions have now risen for three years[10]. Furthermore, in 2016 transport was the largest contributing sector to greenhouse gas emissions in Scotland.

The factors affecting transport emissions are numerous and complex. The 2008 recession was a contributing factor to the fall in emissions from that time, alongside investments in transport infrastructure, efficiency improvements and fluctuations in the price of oil. The significant fall in oil prices since 2014 is likely to have contributed to the increase in demand for fuel and travel in the period since.

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[3] *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2016*, National Atmospheric Emissions Inventory, Department for Business, Energy and Industrial Strategy, 2017.

[4] The emissions inventory does not produce a continuous time series – no figures are available for 1991 to 1994 and 1996 to 1997.

[5] A mega-tonne is 1 million tonnes = 10^6 tonnes. A kilo-tonne is 1,000 tonnes = 10^3 tonnes.

[6] All greenhouse gas emissions are given in carbon dioxide equivalent, which is denoted CO_2e. This means that the global warming potential of non-CO_2 greenhouse gases is converted to that of CO_2 in order to make comparisons easier. For example, the global warming potential for methane (CH_4) over 100 years is 21. This means that emissions of one million metric tons of methane are equivalent to emissions of 21 million metric tons of CO_2. (OECD)

[7] Emissions adjusted to account for Scotland's participation in EU-wide emissions trading and are used to measure progress against targets.

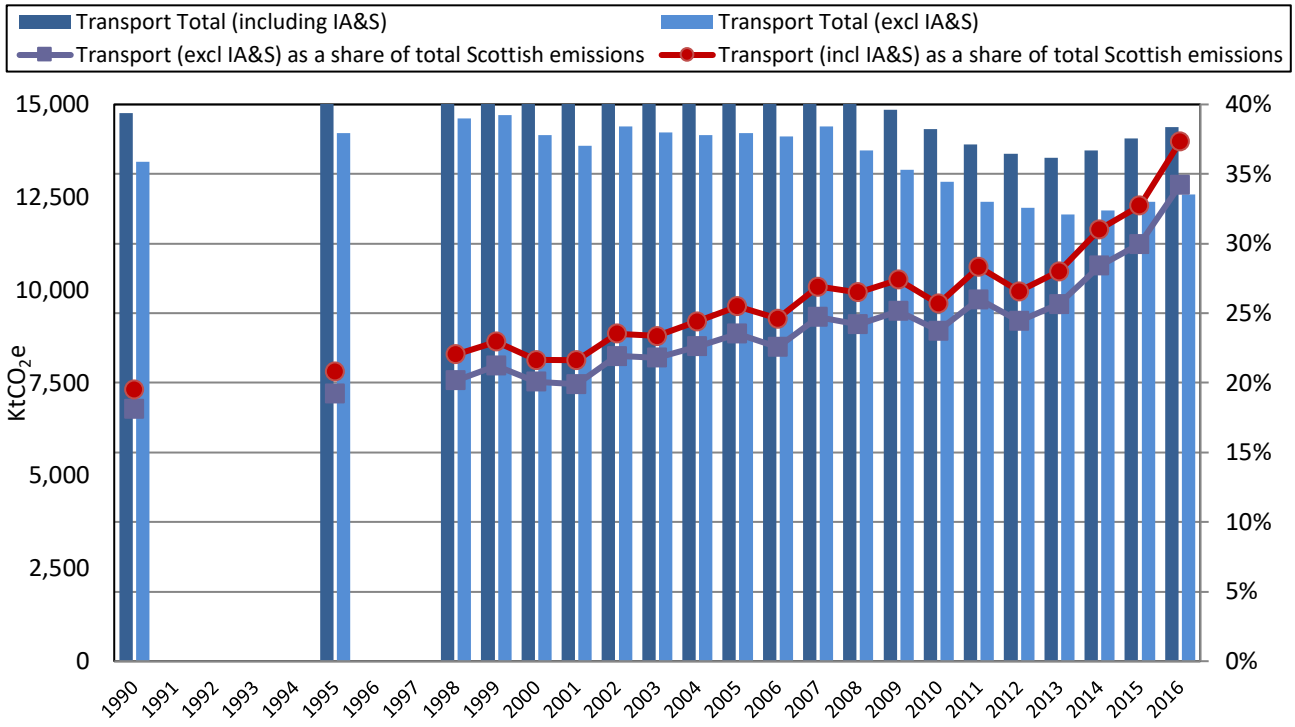
[8] *Scottish Greenhouse Gas Emissions 2016*, The Scottish Government, 2018,

[9] References to transport emissions as a whole in this document include IAS, except where stated.

[10] Volume 8 of the Carbon Account for Transport reported a very slight fall in transport emissions for 2014 on the previous year. The rise reported for 2014 in volume 9 is attributable to methodological changes in the emissions inventory.

Excluding IAS, transport accounted for 34.2% of Scottish greenhouse gas emissions in 2016. This proportion is 37.3% when including IAS. Figure 1 shows the growing prominence of transport as a source of greenhouse gas emissions since 1990.

Figure 1: Historical emissions from transport and its share of total emissions in Scotland



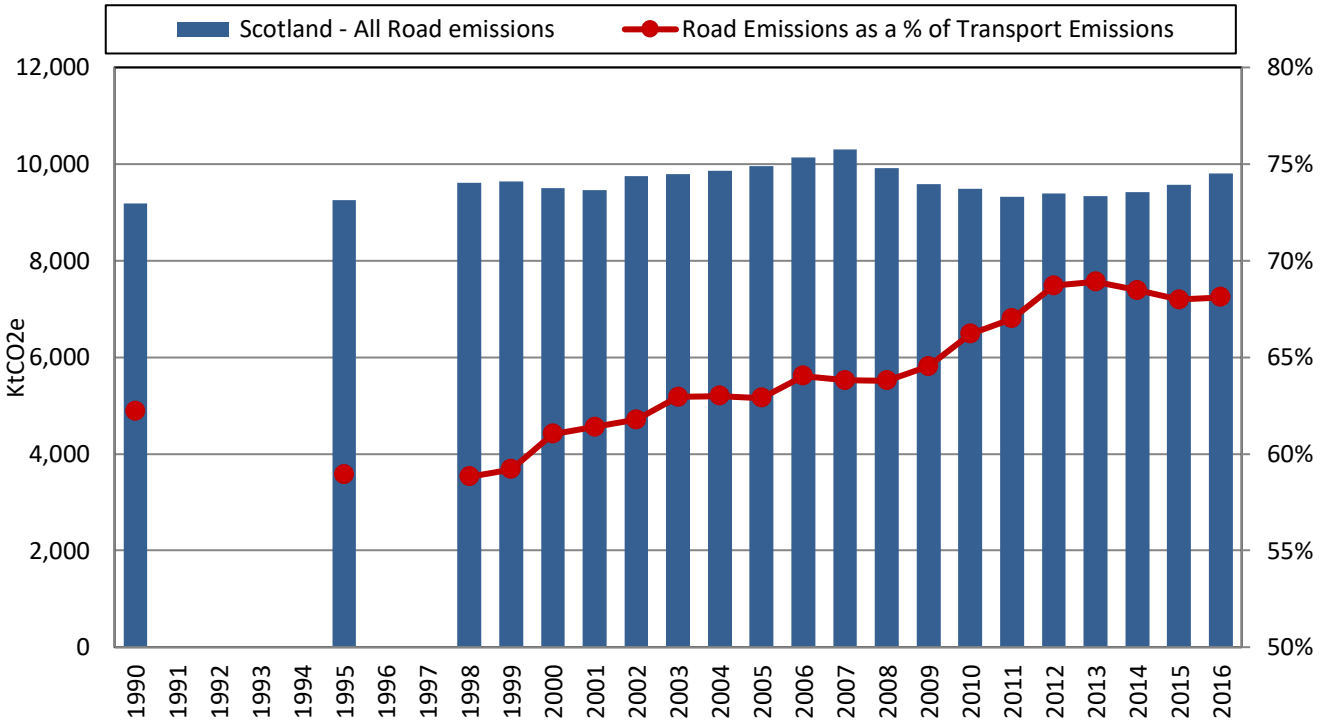
Source: National Atmospheric Emissions Inventory

2.3 Emissions analysis by transport sector

2.3.1 Road Transport

Road transport accounted for 9.8 Mt CO_2e in 2016. This is 68.1% of total transport emissions; a proportion which has generally risen since 1998. Figure 2 shows road emissions since 1990 with the proportion of transport emissions it accounts for.

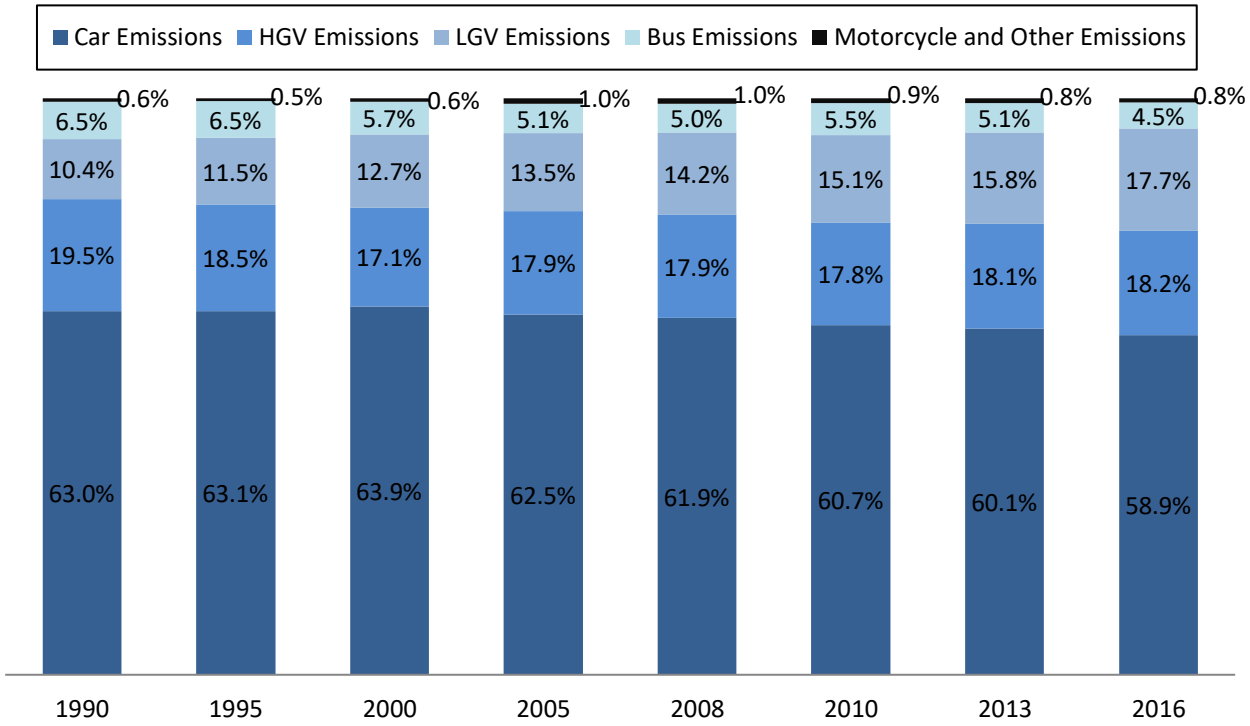
Figure 2: Historical road emissions in Scotland



Source: National Atmospheric Emissions Inventory

Figure 3 shows the proportion of road emissions for each vehicle type for selected years. Since 1990, there has been a slow shift towards goods vehicle emissions relative to cars.

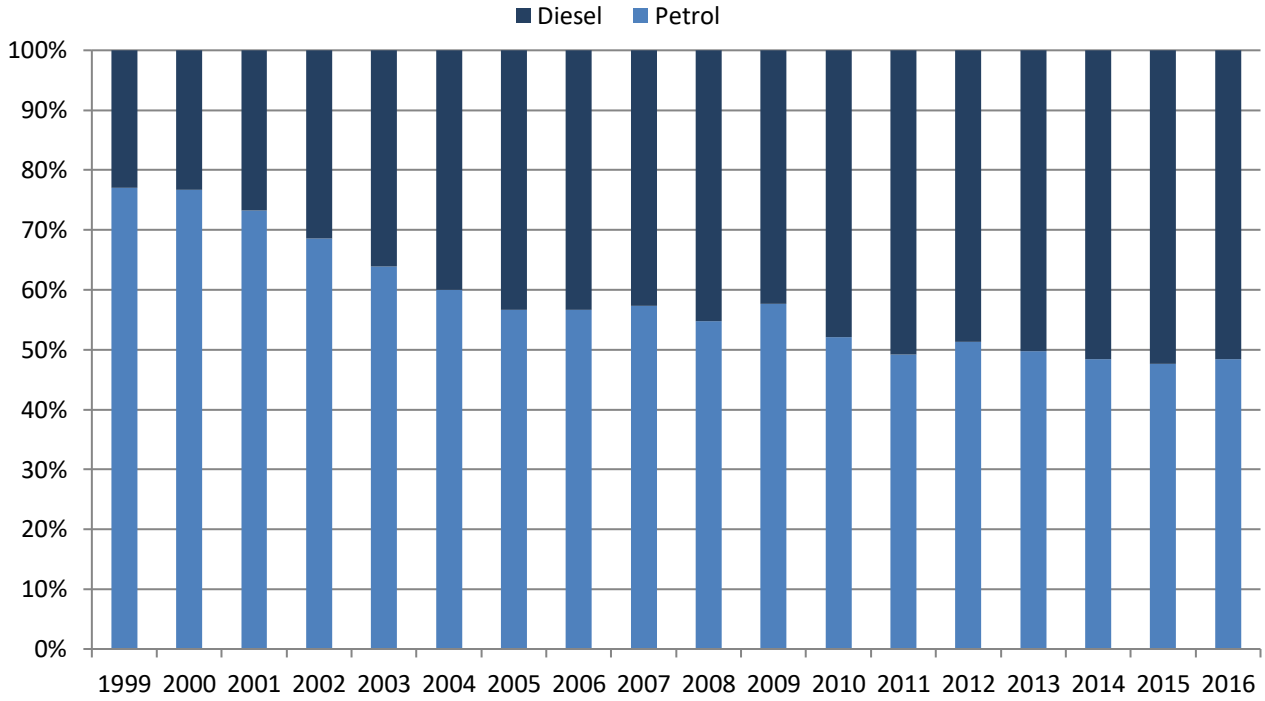
Figure 3: Emissions from vehicles as a proportion of road emissions for selected years



Source: National Atmospheric Emissions Inventory

Changing consumer preferences on fuel are a contributing factor to the falling proportion of road emissions from cars. Diesel cars tend to be more fuel efficient, and hence have lower greenhouse gas emissions. Figure 4 shows the increasing proportion of new vehicles powered by diesel relative to petrol. New registrations of diesel vehicles overtook those of petrol in 2013, however, a decline in the number of diesel cars being registered is expected in the future years, in part due to the 2017 changes in Vehicle Excise Duty (VED) which introduced a higher rate for diesel cars that don't meet the Real Driving Emissions 2 (RDE2) standard for nitrogen oxide emissions.

Figure 4: Distribution of new Scottish vehicle registrations over time

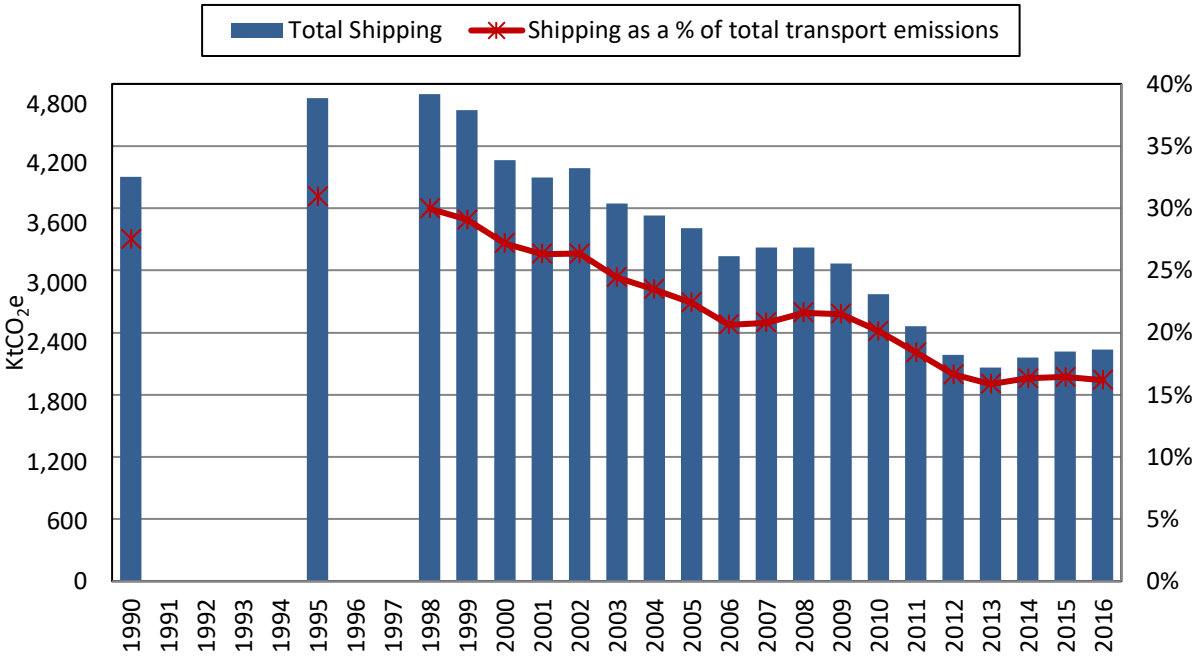


Source: Scottish Transport Statistics 2017 Table 1.1

2.3.2 Shipping

Shipping emissions were 2.3 Mt CO_2e in 2016. This is 16.2% of total transport emissions, an all-time low. Figure 5 shows a generally downward trend in total shipping emissions from their all-time peak in 1998.

Figure 5: Historical shipping emissions



Source: National Atmospheric Emissions Inventory

Figure 6 shows shipping emissions disaggregated into domestic and international. International shipping emissions are much more volatile than domestic emissions, which have seen a steady decrease overall but a slight increase in recent years. A potential reason for the volatility in international emissions is economic activity, which drives demand for imports and exports.

Figure 6: Historical domestic and international shipping emissions

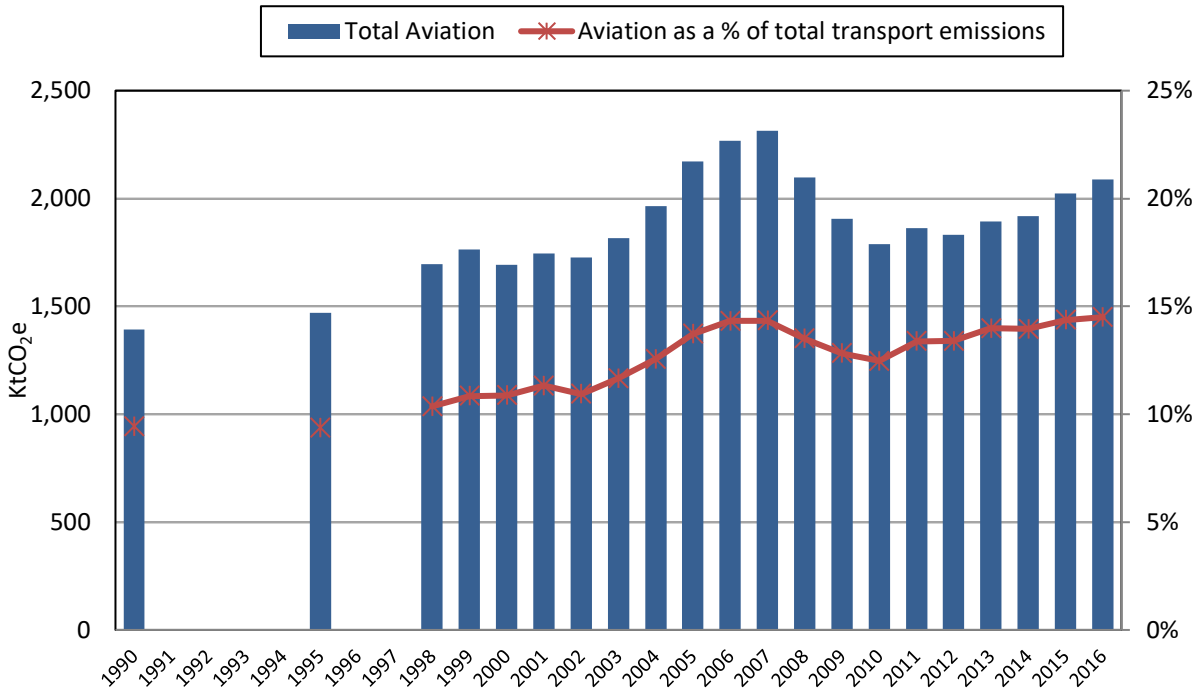
Source: National Atmospheric Emissions Inventory

2.3.3 Aviation

In 2016 total aviation emissions, including aircraft support vehicles and military aircraft, were 2.1 Mt CO_2e, an increase of 3.2% on 2015 and 50.0% above 1990. Aviation accounted for 14.5% of transport

emissions in 2016. Total aircraft movements fell 13.1%% between 2006 and 2016[11]. Contrasting with rising emissions this suggests the use of larger aircraft and / or higher load factors on planes. Figure 7 shows the trend in total aviation emissions since 1990.

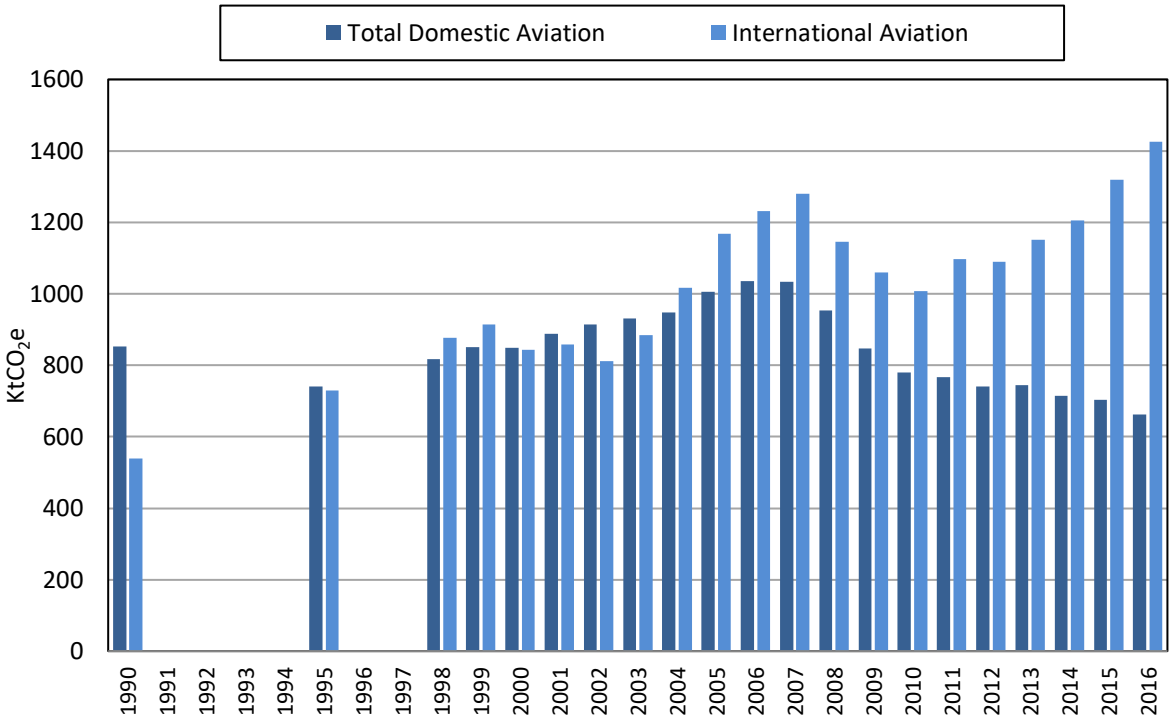
Figure 7: Historical aviation emissions and share of total transport emissions



Source: National Atmospheric Emissions Inventory

Figure 8 disaggregates the data in figure 7 to show domestic and international aviation emissions. In recent years, emissions from domestic aviation have fallen while international emissions have risen to a new high in 2016. Domestic aircraft movements fell -23.1% between 2006 and 2016, while international aircraft movements increased 5.5%[12].

Figure 8: Domestic and international aviation emissions over time



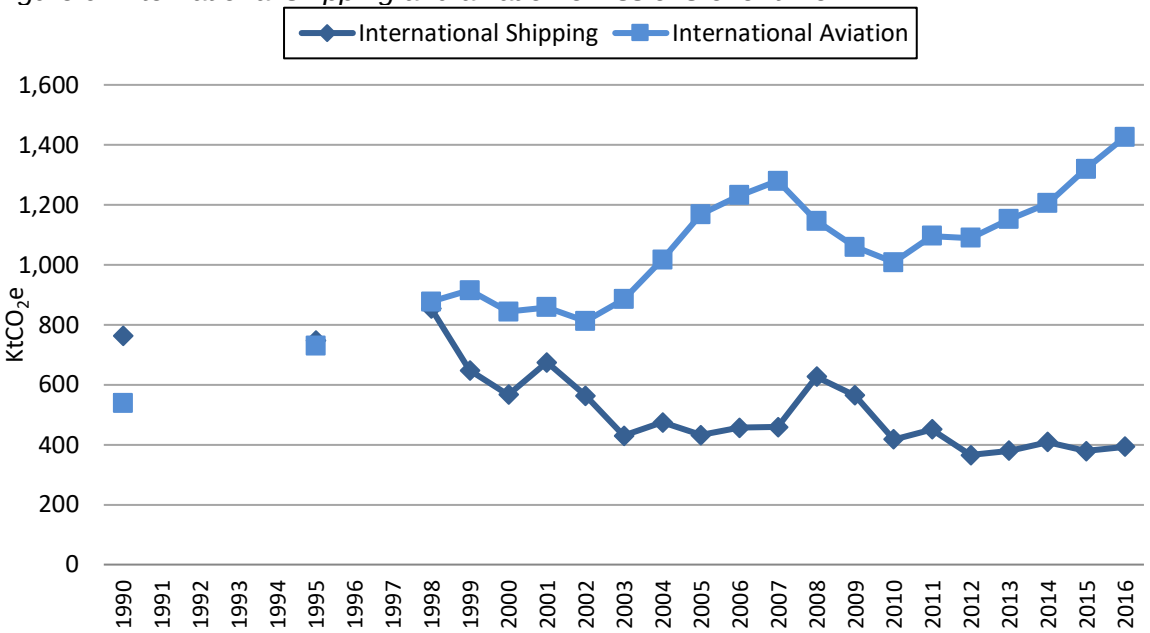
Source: National Atmospheric Emissions Inventory

[11] Scottish Transport Statistics Table 8.1.
[12] Scottish Transport Statistics Table 8.1

2.3.4 International aviation and shipping

Emissions from international aviation and shipping were 1.8 Mt CO_2e in 2016, a rise of 7.0% on the previous year, and 39.7% above the 1990 baseline. Figure 9 shows the pattern of international emissions over time, disaggregated by aviation and shipping. It is characterised by the general falling pattern of shipping emissions and the rising pattern of aviation emissions..

Figure 9: International shipping and aviation emissions over time

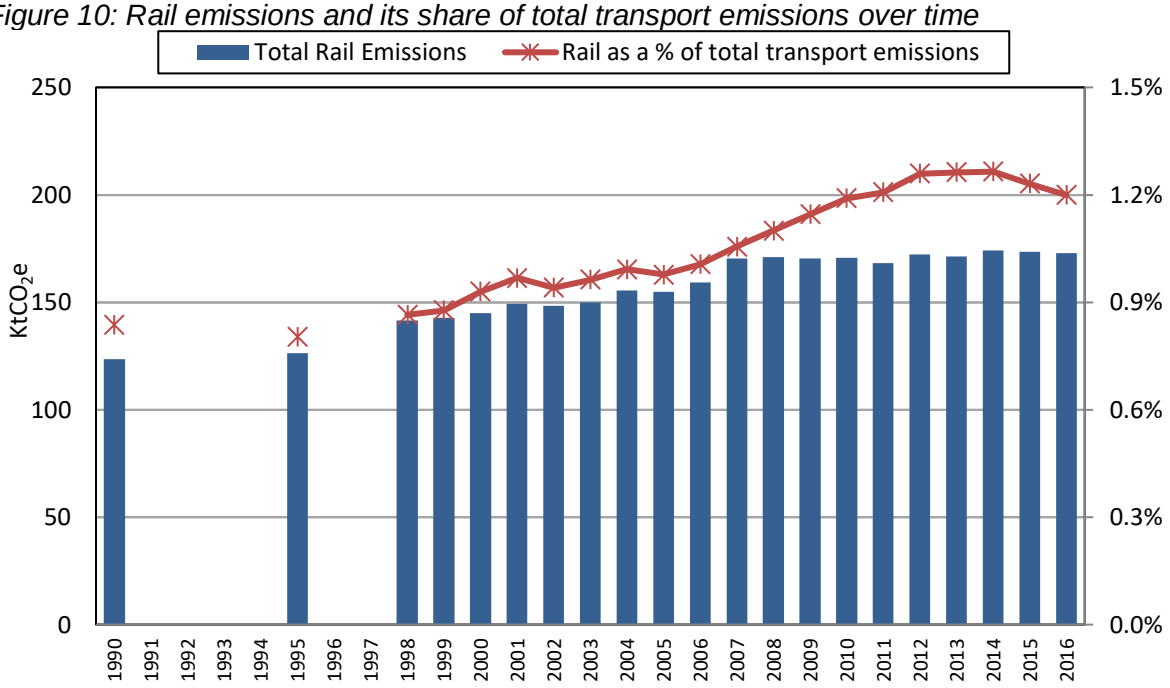


Source: National Atmospheric Emissions Inventory

2.3.5 Rail

Rail accounted for 0.17 Mt CO_2e in 2016; 0.4% below the previous year, but 39.9% above the 1990 level. In the ten years to 2015/16, passenger kilometres on Scotrail services increased by 21.2%, and scheduled train route kilometres increased 14.2%[13]. Figure 10 shows the trend of rail emissions since 1990.

Figure 10: Rail emissions and its share of total transport emissions over time



Source: National Atmospheric Emissions Inventory

[13] Scottish Transport Statistics Table 7.1

2.4 Road emissions by vehicle type

2.4.1 Cars

Emissions from cars rose in 2014, 2015 and 2016, having generally fallen since 2007. Between 2006 and 2016, car kilometres in Scotland rose from 34.5 million to 35.4 million[14], while emissions fell from 6.3 Mt CO_2e to 5.8 Mt CO_2e. Despite this improved fuel efficiency, in 2016 cars still accounted for 58.9% of road emissions and 40.1% of total transport emissions in Scotland. These are the highest proportions of any mode of transport.

2.4.2 Heavy Goods Vehicles

At 18.2%, HGVs accounted for the second largest proportion of road emissions in 2016. This is 12.4% of total transport emissions. At 1.8 Mt CO_2e, HGV emissions were 2.3% higher than the previous year, but 0.4% below the 1990 figure. Between 2006 and 2016 HGV kilometres in Scotland fell by 2.6%.

2.4.3 Light Goods Vehicles

LGV emissions were 81.3% higher in 2016 than in 1990. In 2016 they accounted for 1.7 Mt CO_2e, 6.4% more than the previous year. This is 17.7% of road emissions and 12.0% of total transport emissions. In the decade to 2016, light goods vehicle kilometres in Scotland rose 27.9%, from 5.8 million to 7.4 million.

2.4.4 Buses and coaches

Buses and coaches accounted for 0.4 Mt CO_2e in 2016, a drop of 6.6% on the previous year. Bus emissions have gently declined since 1990, and in 2016 stand 26.4% below this 1990 figure. Between 2006 and 2016, published public service vehicle kilometres fell -10.2%[15].

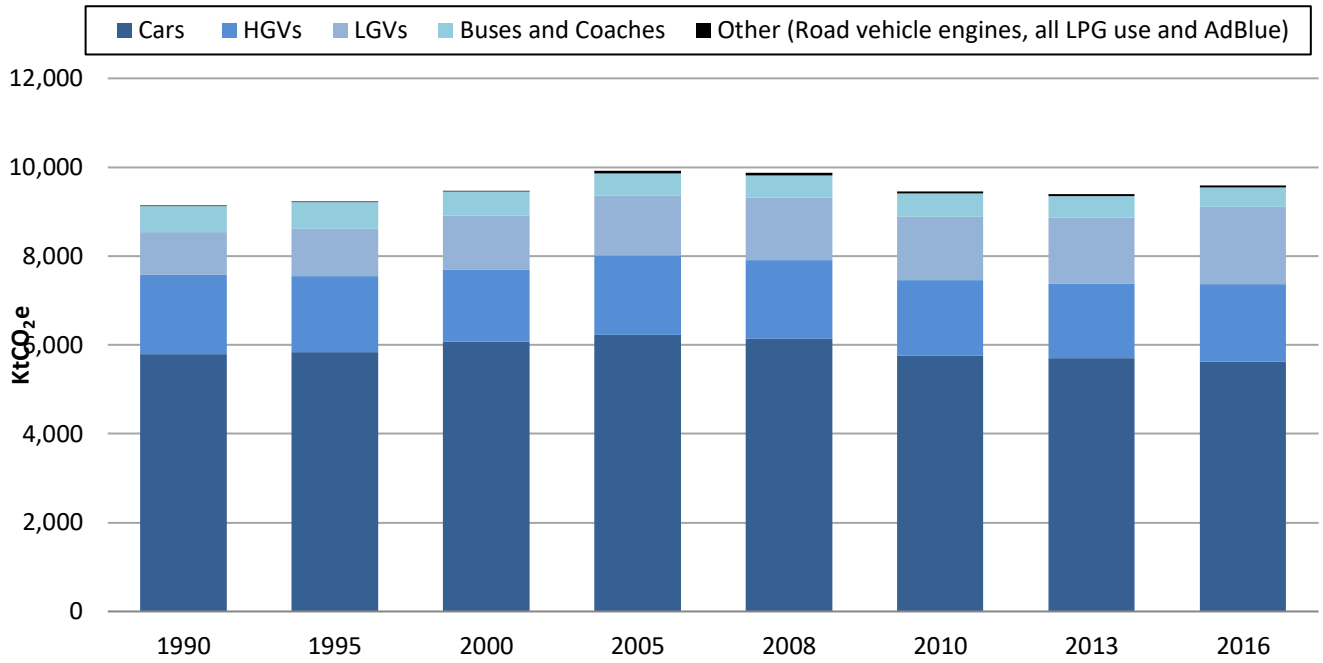
2.4.5 Motorcycles

Motorcycles emitted 0.034 Mt CO_2e in 2016. This is only 0.3% of road emissions and 0.2% of transport emissions. Motorcycle emissions have been low since 1990, and as such have never significantly impacted Scotland's transport emissions in the time the emissions inventory has been collated.

Figures 11, 12 and 13 illustrate changes in road emissions by vehicle type, the changing share of road emissions attributable to different vehicle types and year on year changes in emissions of different vehicle types respectively.

[14] Unless otherwise referenced, all kilometres quoted in section 2.4 are from Scottish Transport Statistics Table 5.3.
[15] Scottish Transport Statistics Table 2.3a. The emissions inventory is also not clear on the definition of a bus. This could be a public service vehicle, but could also be a vehicle with 9 or more seats, as per the Department for Transport definition.

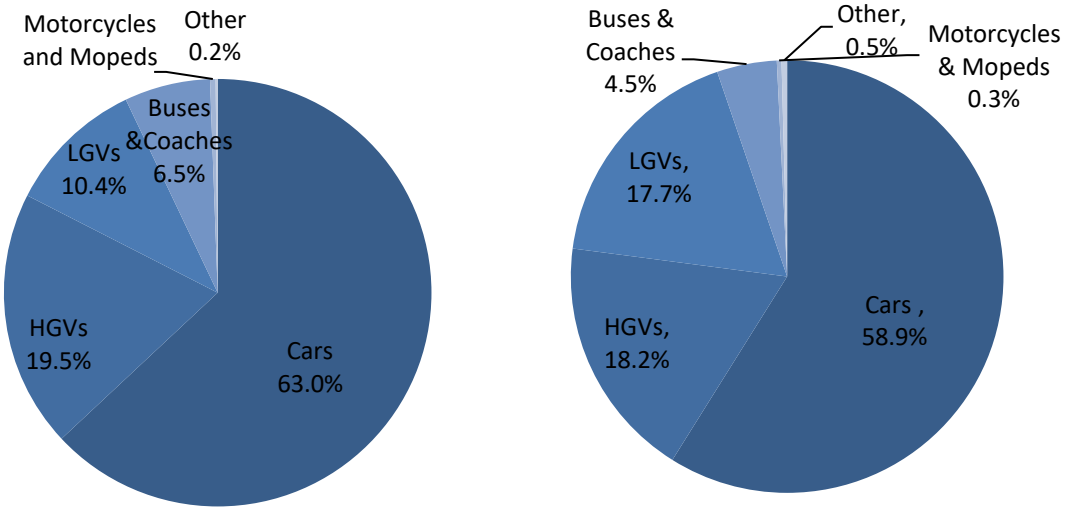
Figure 11: Road emissions by vehicle type, selected years



Source: National Atmospheric Emissions Inventory

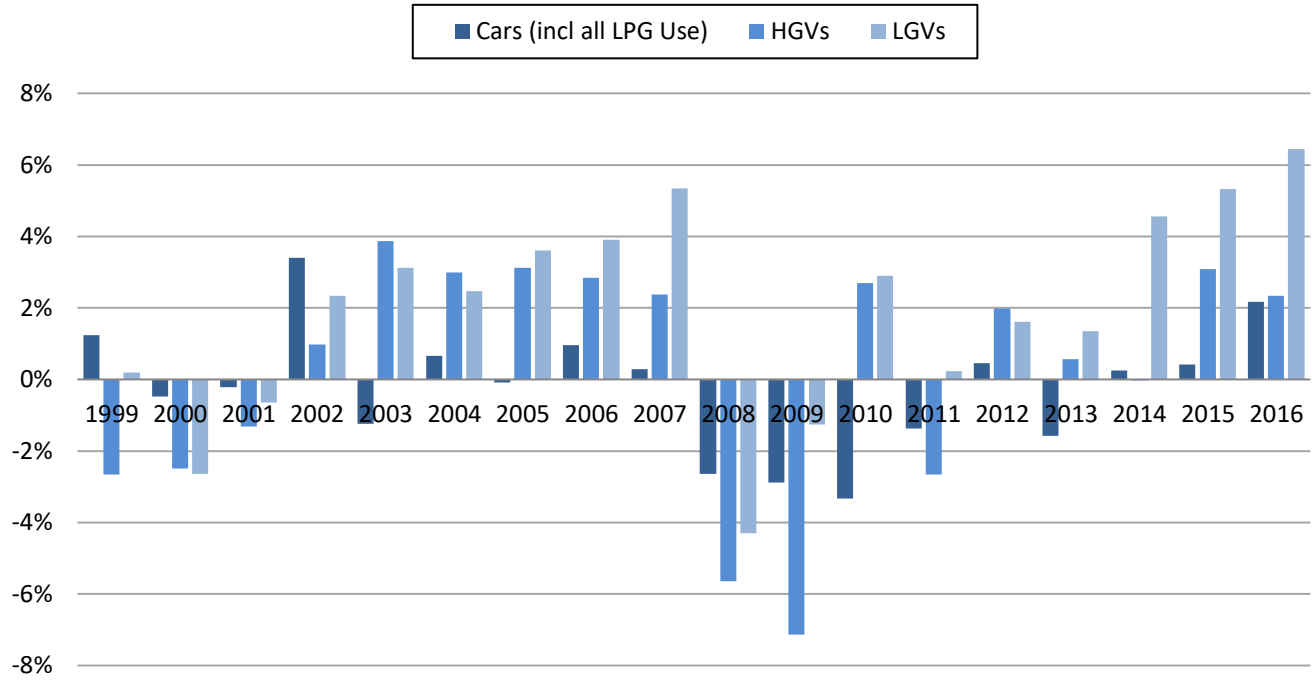
Figure 12: Share of road emissions by vehicle type, 1990 and 2016

1990: total road emissions = 9.1 Mt CO_2e 2016: total road emissions = 9.8 Mt CO_2e



Source: National Atmospheric Emissions Inventory

Figure 13: Year on year change in emissions by vehicle type, 1999-2016



Source: National Atmospheric Emissions Inventory

2.5 Road emissions by type of road

2.5.1 Rural

At 4.9 Mt CO_2e in 2016, rural road emissions were 2.8% above the previous year, and 5.6% above 1990. Rural emissions accounted for 50.2% of road emissions.

2.5.2 Urban

At 3.0 Mt CO_2e in 2016, urban road emissions are 1.4% above the previous year, but -12.0% below 1990. Urban emissions accounted for 30.7% of road emissions in 2016, down from 37.1% in 1990.

According to Scottish Transport statistics, over the past ten years there has been an increase in traffic on rural roads while traffic on urban roads has remained steady.

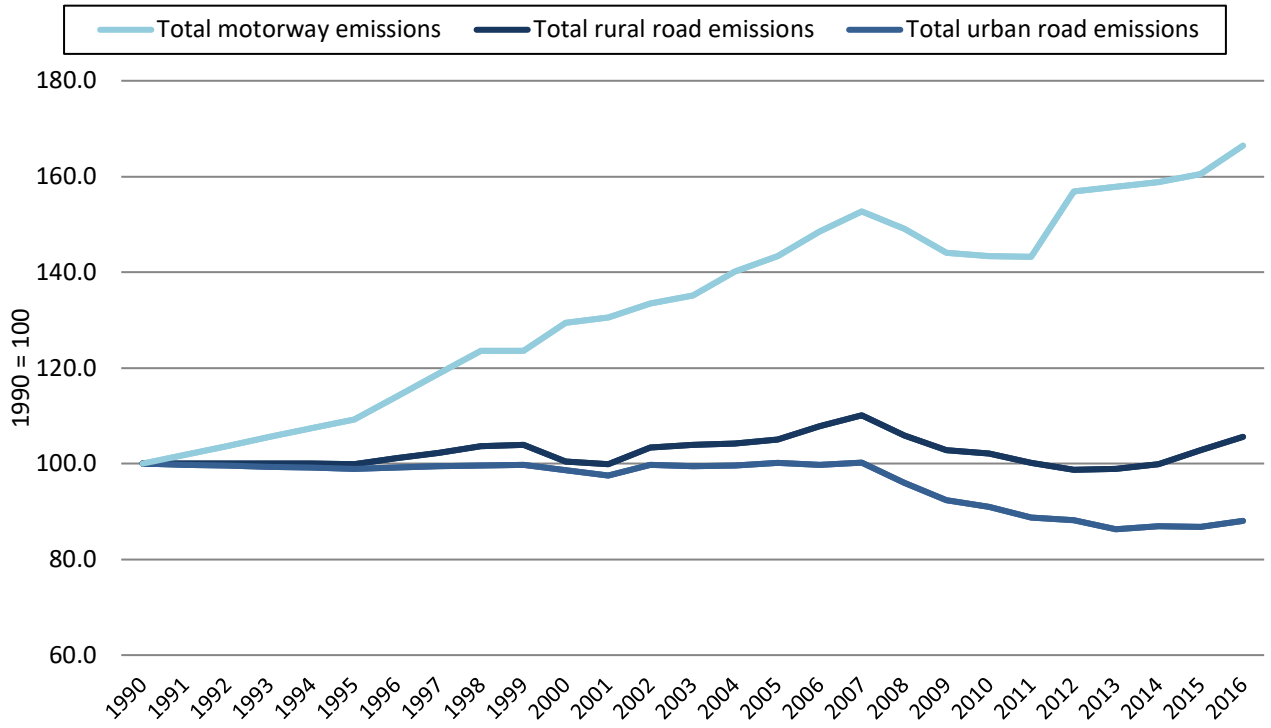
2.5.3 Motorways

At 1.9 Mt CO_2e in 2016, motorways emissions are at their highest level on record, 66.4% higher than 1990. Motorways contribute the smallest proportion of road emissions, at 19.1%, up from 12.2% in 1990.

The proportion of total vehicle miles driven on motorways has increased over time which has resulted from motorways increasing in length.

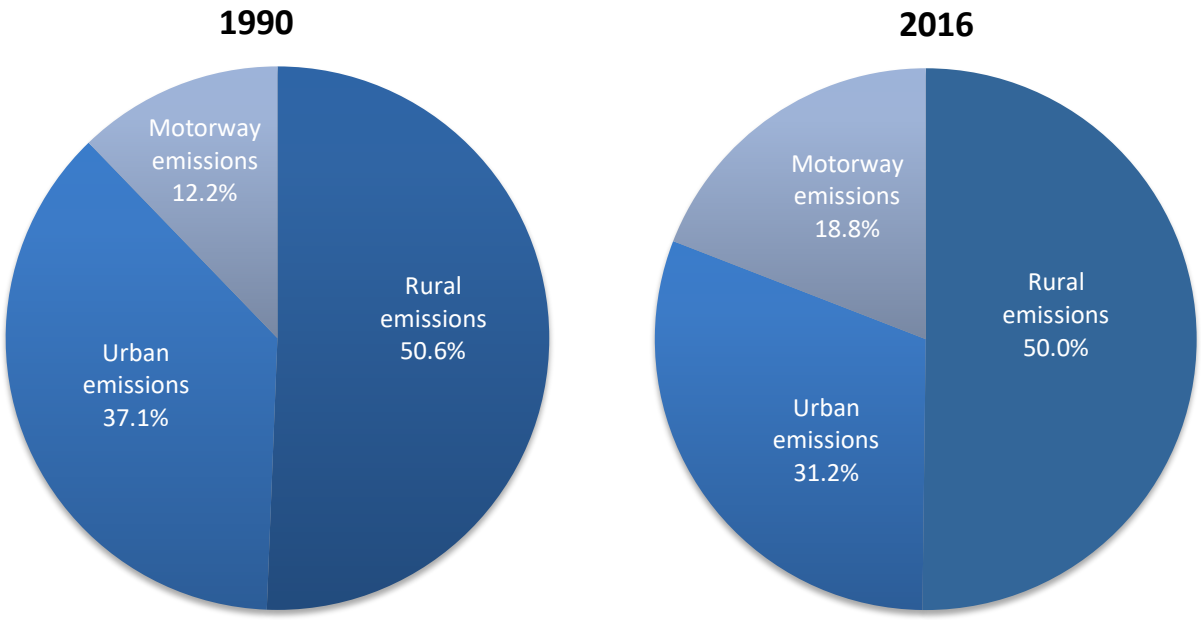
Figure 14 shows an index of emissions from different types of road since 1990.

Figure 14: Emissions by road type (1990=100)[16]



Source: National Atmospheric Emissions Inventory

Figure 15: Share of road emissions by road type

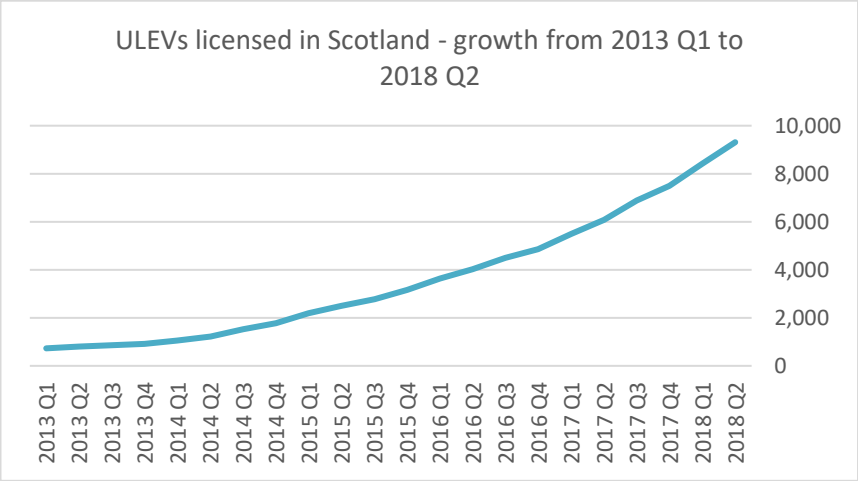


Source: National Atmospheric Emissions Inventory

[16] Note that because of the lack of data for the period 1991-1994 and 1996-1997, a linear extrapolation of the data is depicted in this graph.

3. Ultra Low Emission Vehicle Charging Network – Special Focus

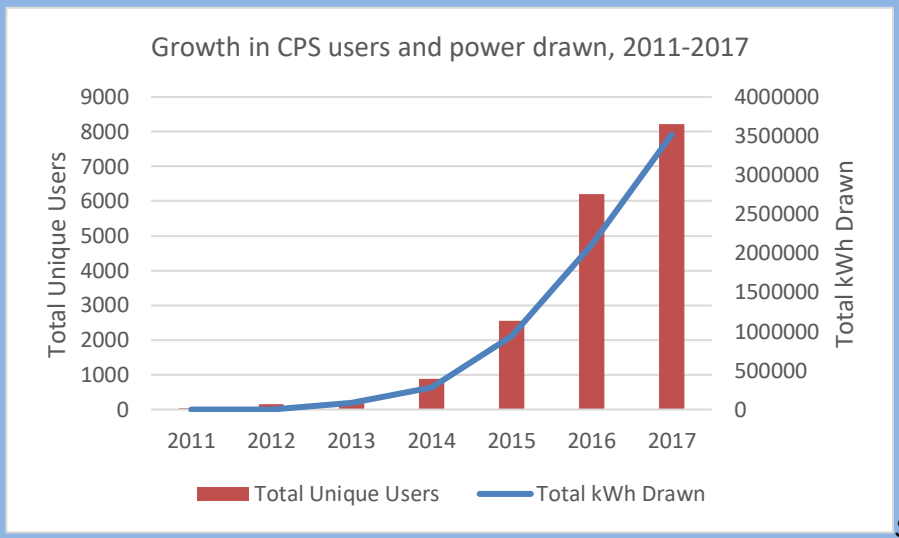
Cars accounted for 40.1% of total transport emissions in Scotland in 2016, the highest proportion of any mode of transport. Bold new plans for transport were announced in the Programme for Government 2017-2018, with a target set to phase out the need to buy petrol and diesel engine cars and vans by 2032, a full eight years ahead of the UK Government. This will be driven by a significant increase in the uptake of ultra-low emission electric vehicles which will account for a significant proportion of overall emissions reduction.



Source: DfT Vehicle Statistics

A key barrier identified to a more rapid take-up of electric vehicles is 'range anxiety'. 41% of respondents to the 2017 Scottish Household Survey said they would consider buying an electric car or van. However, for those who said they would not consider buying an electric vehicle, the distance that could be travelled on a single charge (45%) and the availability or convenience of charging points (also 45%) were the main deterrents.

The ChargePlace Scotland network of publically available EV charging points is one of the most comprehensive networks in Europe with over 800 points, including over 175 rapid charge points. In 2017, the Charge Place Scotland network was used over 420,000 times by over 8,000 members, enabling 12.8 million electric vehicle miles to be travelled.



Source: CPS

To continue addressing 'range anxiety' Transport Scotland are investing £15 million to add an additional 1,500 new charge points in homes, businesses and local authority land, including 150 new public charge points. In addition, the Switched on Towns and Cities Challenge Fund will help expand the provision of publicly available EV charging infrastructure into new as well as existing areas of a town or city and address EV charging issues associated with tenement buildings or residential properties that lack off-street parking.

4. Comparison of key Scottish and UK transport emissions statistics

Figure 16 compares emission shares and performance in Scotland to the UK as a whole.

- In 2016, Scottish transport accounted for 10.0% of UK transport emissions excluding international aviation and shipping, and 8.6% including them.
- Scotland's share of UK emissions from buses and coaches, rural roads and domestic aviation were higher in 2016 than Scotland's share of total UK transport emissions.
- However, Scotland accounts for proportionally less than the UK as a whole for motorway and international aviation emissions.
- Total transport emissions fell 2.5% in Scotland between 1990 and 2016, while they rose 10.9% in the UK.
- However, removing international aviation and shipping shows a 6.5% fall in Scotland and a 1.8% fall in UK over the same period. The large rise in total UK emissions over the period is attributable to the growth in international aviation traffic.

Figure 16: Comparison of Scottish and UK greenhouse gas emissions

	2016 Emissions			2015-2016 % Changes		1990-2016 % Change	
Emissions are given in kt CO_2e	Scotland	UK	Scotland as % of UK	Scotland	UK	Scotland	UK
Transport incl. IAS	14,397	168,334	8.6%	2.3%	2.0%	-2.5%	10.9%
Transport excl. IAS	12,579	125,754	10.0%	1.6%	1.9%	-6.5%	-1.8%
Road Transport	9,806	114,195	8.6%	2.4%	2.4%	6.8%	3.3%
of which:							
Cars	5,775	70,279	8.2%	2.2%	2.1%	-0.2%	-2.8%
HGVs	1,782	20,254	8.8%	2.3%	2.2%	-0.4%	-1.0%
LGVs	1,734	19,164	9.0%	6.4%	5.5%	81.3%	64.7%
Bus and coach	439	3,463	12.7%	-6.6%	-6.6%	-26.4%	-34.1%
Motorcycles	34	543	6.3%	1.6%	3.7%	-0.2%	-29.6%
Rural	4,894	45,670	10.7%	2.8%	3.2%	5.6%	8.7%
Urban	2,993	40,922	7.3%	1.4%	1.3%	-12.0%	-16.3%
Motorway	1,863	26,939	6.9%	3.7%	2.7%	66.4%	39.6%
Rail Transport	173	2,019	8.6%	-0.4%	-0.6%	39.9%	3.3%
Domestic Aviation	565	2,592	21.8%	-7.0%	-6.2%	-29.8%	-51.9%
Total Aviation	2,088	37,168	5.6%	3.2%	0.9%	50.0%	75.3%
Domestic Maritime	1,939	6,369	30.4%	0.4%	-2.2%	-41.3%	-35.8%
Total Maritime	2,331	14,952	15.6%	0.9%	2.3%	-42.6%	-17.3%

Source: National Atmospheric Emissions Inventory

Figure 17 breaks down UK emissions into its four constituent nations.

- In Scotland in 2016, total transport emissions including IAS were 2.5% below the 1990 baseline. This is a smaller proportional decrease than in Wales, but better than in England and Northern Ireland, where emissions have risen since 1990.

Figure 17: Comparison of Scottish, English, Welsh and Northern Irish Greenhouse Gas Emissions from Transport

			Road	Rail	Aviation	Aviation (incl.IA)	Maritime	Maritime (incl. IS)	All Transport	All Transport (incl. IAS)
SCOTLAND	Emissions	2016	9,806	173	662	2,088	1,939	2,331	12,579	14,397
	Change in emissions	2015 - 2016	2.4%	-0.4%	-5.8%	3.2%	0.4%	0.9%	1.6%	2.3%
		1990 - 2016	6.8%	39.9%	-22.3%	50.0%	-41.3%	-42.6%	-6.5%	-2.5%
ENGLAND	Emissions	2016	94,630	1,711	2,226	34,568	3,800	11,380	102,367	142,289
	Change in emissions	2015 - 2016	2.4%	-0.7%	-4.8%	0.7%	-3.8%	2.7%	1.9%	1.9%
		1990 - 2016	1.9%	-1.5%	-49.2%	79.3%	-34.0%	-8.7%	-2.3%	12.6%
WALES	Emissions	2016	5,792	96	53	126	371	794	6,312	6,808
	Change in emissions	2015 - 2016	2.3%	-0.6%	-1.1%	3.7%	-1.2%	0.4%	2.0%	2.1%
		1990 - 2016	3.8%	40.1%	-70.0%	-50.2%	-34.4%	-28.4%	-1.2%	-2.9%
N. IRELAND	Emissions	2016	3,968	39	229	387	238	426	4,475	4,820
	Change in emissions	2015 - 2016	2.3%	0.3%	-2.7%	2.5%	0.2%	4.4%	1.9%	2.5%
		1990 - 2016	34.9%	57.6%	-1.1%	35.7%	-9.9%	8.4%	29.3%	32.3%

Source: National Atmospheric Emissions Inventory

5. Efficiency of Transport Modes

The efficiency of different transport modes can be compared when measured in terms of CO_2e per passenger kilometre (ppkm). These measures provide another means of considering transport emissions. Figure 18 is compiled from data published in the UK Company Reporting Guidelines[17].

- Coach is the least emitting means of travel per passenger kilometre, followed by rail.
- The most emitting mode of travel is domestic aviation, at 158 g CO_2e/ppkm (per passenger kilometre).
- Most modes have seen significant improvements in emissions per passenger kilometre in recent years, notably in rail and in domestic and short haul international aviation.

[17] *Greenhouse gas reporting: conversion factors 2017*, Department for Business, Energy and Industrial Strategy, 2017.

Figure 18: Emissions per Passenger Kilometre of Selected Transport Modes

Sector	Mode and fuel	gCO_2e/ppkm							
		2012	2013	2014	2015	2016	2017	2018	% Change 2012-2018
Road	Average petrol car	134	131	128	127	128	124	122	-8.4%
	Average diesel car	124	121	123	121	122	119	118	-4.4%
	Average petrol hybrid car	89	87	89	85	88	79	84	-5.6%
	Average petrol motorbike	119	119	120	120	120	117	115	-3.1%
	Average bus	112	112	109	109	102	103	101	-9.8%
	Average coach	29	29	29	29	29	28	28	-2.5%
Rail	National rail	58	49	47	45	49	47	44	-24.0%
	Light rail and tram	68	60	62	55	54	44	40	-41.3%
Ferry (Large RoPax)	Average foot and car passengers	116	116	116	116	116	116	113	-2.8%
Aviation	Average domestic flights	180	173	155	158	147	141	158	-12.4%
	Average short haul international	104	102	88	90	89	85	86	-17.3%
	Average long haul international	119	120	111	105	101	104	112	-5.4%

Source: UK Company Reporting Guidelines

6. Leading Indicators

The emissions data presented in this report are not published until around 18 months after the end of the last year reported. As a result, we cannot present any information about Scottish emissions in 2017 at this stage. However, there are some indicators of transport emissions available for Scotland.

- Scottish road vehicle kilometres travelled: In 2017 kilometres travelled were higher than at any point in the 10 years prior.
- Sales of plug-in vehicle grant eligible cars in Scotland: 2017 sales are 57% higher than 2016.
- Aircraft movements: this is the number of take offs and landings at Scottish airports. These are rising, but by a smaller proportion than aviation emissions. This suggests that emissions per aircraft movement are rising, but the reasons behind this are not certain.
- Provisional 2017 UK transport emissions: An estimate published earlier than the NAEI shows UK transport emissions excluding international aviation and shipping remaining the same as the previous year.
- UK domestic transport fuel consumption: tracks total transport fuel sales. In 2017 this indicator rose 0.1% on the previous year.
- Scottish GVA: The 1.3% growth seen in the year to Q1 2018 is slower than in previous years.
- Scottish forecourt pump prices July 2017 – July 2018: prices of both petrol and diesel increased by 11.7% and 14.3% respectively.

Collectively the indicators imply that reducing transport emissions is becoming more challenging in the face of rising demand across a range of modes.

Figure 19: Leading Indicators of Emissions in 2017

No.	Indicator	2016	2017	Average growth p.a.	Growth
				(2003-2017)	(2016-2017)
1	Scottish road vehicle kilometres travelled (million vehicle kilometres)	46.2	47.6	1.0%	3.1%
2	Sales of Plug in Grant cars in Scotland	1,367	2,150	-	57%
3	Aircraft movements	481,334	495,096	1.7%	2.9%
4	UK transport emissions (excl. IAS) ($MtCO_2e$)	124.4	124.4	-0.5%	0.0%
5	UK domestic road fuel consumption by transport (million tonnes)	36.671	36.724	-0.5%	0.1%
6	Average CO2/km of petrol cars registered for the first time in Scotland	123.8	122.5	*2003 Data Unavailable*	-1.1%
7	Average CO2/km of diesel cars registered for the first time in Scotland	119.2	118.4	*2003 Data Unavailable*	-0.7%

					Growth
8	Scottish year-on-year GVA growth (to Q1 2018)	-	-	-	1.3%
9	Scottish year-on-year change in a) petrol and b) diesel prices (July 17 - July 18) - NOMINAL				a) 11.7% b) 14.3%

Sources: 1,2: Department for Transport; 3: Civil Aviation Authority; 4-7: Department for Business, Energy and Industrial Strategy; 8: The Scottish Government; 9: AA Fuel Price Report.

7. Predicted emissions impact of major infrastructural projects

This chapter examines the emissions arising from infrastructure projects and policies expected to impact Scottish transport emissions in the future.

7.1 Infrastructure Projects

As each project is independently commissioned, the exact methodology used to estimate the emissions impact may differ, depending on the type of intervention and the modelling approach adopted. Furthermore, emissions estimates are frequently assessed in isolation, and therefore do not consider any interactions between measures and resulting emissions. There are also likely to be local impacts which may not be captured or presented consistently between infrastructure projects. Where possible, the net impacts at a Scottish level are presented. Because of these variances, the impacts presented are intended only to inform the direction and order of magnitude of the resulting change in emissions. In most cases, the impact quoted is from the project specific environmental statement. Note that comparisons between these impacts and the published NAEI data are not statistically valid, and may lead to incorrect conclusions being drawn.

7.1.1 Methodology

Scottish Transport Appraisal Guidance (STAG) recommends that greenhouse gas emissions from road traffic are calculated according to methodology in the Design Manual for Roads and Bridges (DMRB). This is a comprehensive manual which accommodates current standards, advice notes and other published documents relating to trunk road works.

For rail projects, STAG recommends using the Rail Emissions Model Final Report produced for the Strategic Rail Authority. It contains the estimated emissions factors for different models of diesel and electric trains.

No established guidelines exist for other travel modes.

7.1.2 Predicted Emissions Impacts

The projects and their respective emissions impacts are shown in the table below. Details of each project are shown through the hyperlinks in the table. The emission estimates are forecast changes in greenhouse gas emissions with the project compared to without the project in a given future assessment year or in aggregate in the case of the Edinburgh to Glasgow (Rail) Improvement Project.

Figure 20: Estimated emissions impacts of infrastructure projects

Project title	Published emissions estimate
M74 Raith Interchange	+10 ktCO2e p.a. from 2020
M8 M73 and M74 Network Improvements	+2 ktCO2e p.a. by 2020
M8 Baillieston-Newhouse	+30 ktCO2e p.a. from 2020
A90 Balmedie-Tipperty	+2 ktCO2e p.a. from 2010[18]
A90 Aberdeen Western Peripheral Road	+10 ktCO2e p.a. from 2027
Forth Replacement Crossing	+20 ktCO2e p.a. in 2032
Edinburgh-Glasgow (Rail) Improvements Programme	-33 ktCO2e from 2017[19]

Sources: Assessments of individual projects

7.2 Fiscal and Regulatory Measures

Certain fiscal and regulatory measures have the potential to impact greenhouse gas emissions from transport, though the Scottish Government has limited influence on many of them because the majority are reserved to either the UK Government or the European Union. However, Scottish Ministers still have considerable autonomy over many other policies which can affect greenhouse gas emissions, particularly in regards to behavioural changes and mode switching to lower or zero emitting modes.

The Climate Change Plan, published in February 2018, provides an up to date and comprehensive analysis of policies under the jurisdiction of The Scottish Government, and their impact on emissions out to 2032.

The measures for which impact assessments have been conducted are:

- Air Departure Tax (yet to be enacted): this is the Scottish replacement to Air Passenger Duty, which is a tax levied on seats departing from UK airports. It is set by the UK Government. The new tax is set by The Scottish Government, and is levied on flights departing from Scottish airports only. The Scottish Government wishes to reduce the overall burden of the tax by -50%, which is expected to increase demand for air travel.
- Inclusion of aviation in European Union Aviation Emissions Scheme: these are regulations which came into force in the UK in 2010. Under the regulations, each airline operating in Europe receives a tradable allowance covering a certain level of emissions each year. They are required to monitor, report and verify their emissions, and to surrender allowances against them. This allows the aviation sector to take responsibility for its greenhouse gas emissions in the most cost effective way.
- Fuel Duty: this is a tax levied on petrol, diesel and other hydrocarbon based fuels. Due to high oil prices, the 2011 budget cut fuel duty by 1 penny per litre. All subsequent planned rises have been cancelled.

There are also some policies which are likely to impact emissions which have not been quantified in analysis. These are:

- Vehicle Excise Duty: from 1st April 2017, the first year rates for newly registered cars will be determined by emissions levels. Thereafter petrol or diesel cars are charged £140 per year, alternative fuel[20] cars are charged £130, and electric vehicles are not charged. Cars with a retail price exceeding £40,000 pay a higher annual rate. The emissions impact is not quantified, but the UK Government website states “by strengthening the incentive to purchase zero-emission cars

[18] This was the assumed opening date at the time of the environmental statement.
[19] Impact from operational emissions
[20] Alternative fuel vehicles include hybrids, bioethanol and liquid petroleum gas.

and ULEVs over conventionally fuelled cars this measure is expected to contribute to the UK's carbon emissions targets"[21].

- Company car tax: the June 2010 budget introduced measures to make this tax more favourable to lower emitting cars. These have continued to be revised in subsequent budgets.
- Fuel Benefit Charge: the provision of free fuel to company car drivers results in a perverse environmental incentive. The aim of the fuel benefit charge is to tax this benefit as though it were income by calculating the personal benefit a car gives to its user(s). The charge for a car in 2017/18 is £22,600. The amount paid is a percentage of this amount which depends on the emissions per kilometre of the car. A more lenient scheme is in operation for vans.

The table below shows the impact of measures with quantified impacts affecting Scotland at the time of publication.

Figure 21: Estimated emissions impacts of fiscal and regulatory measures

Project title	Published emissions estimate
Air Departure Tax (currently Air Passenger Duty UK wide)	Maximum +104.8 kt CO_2e in 2021 as a result of a -50% reduction across all bands.
Inclusion of aviation in EU ETS	-183 Mt CO2e* p.a. in 2020 (across Europe)
Fuel Duty	+0.5 Mt CO2e p.a. by 2013 from two freezes (UK) Negligible impact from Rural Fuel Rebate

Sources: Various – see hyperlinks.

[21] *Policy paper: Vehicle Excise Duty*, HMRC, 2015.

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