TRANSPORT SCOTLAND
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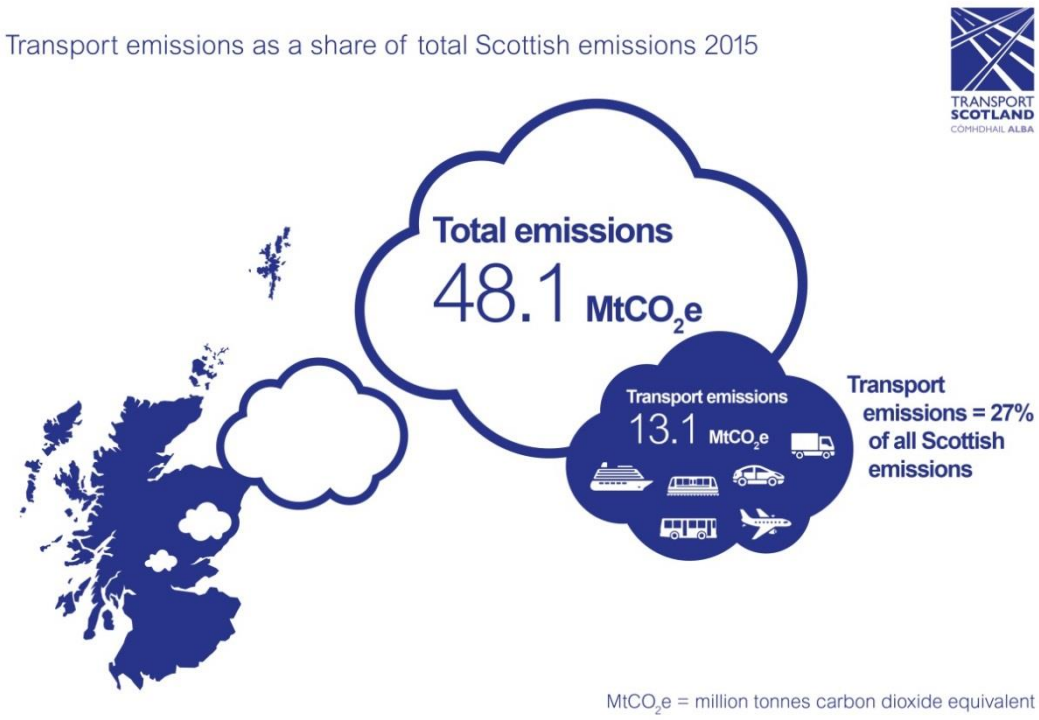
Carbon Account for Transport No. 9: 2017 Edition

EXECUTIVE SUMMARY

The Carbon Account for Transport provides a balance sheet for Scotland's greenhouse gas emissions between 1990 and 2015, and the impacts of transport related policies and projects expected to affect these emissions.

The main findings from volume 9 are:

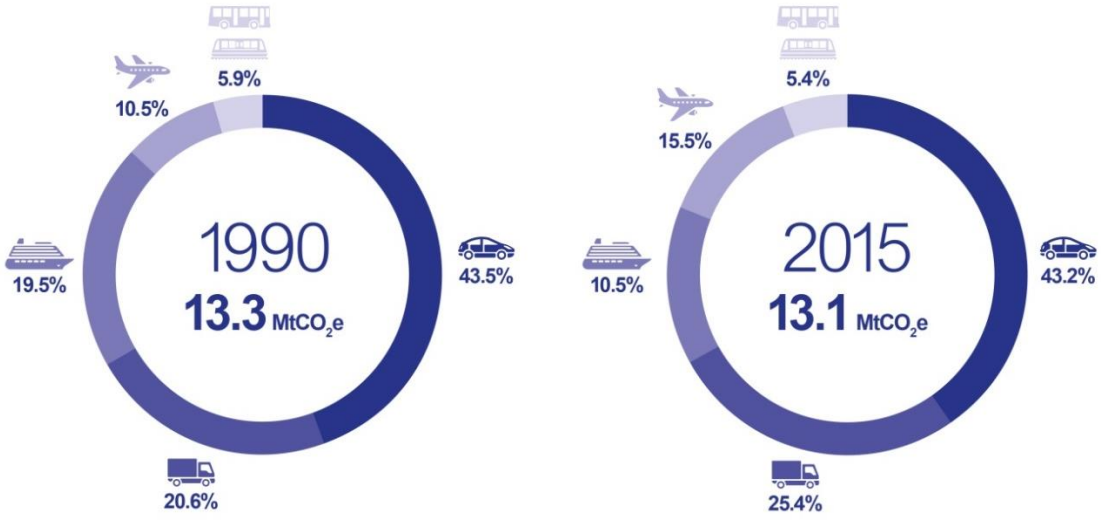
- Total greenhouse gas emissions for Scotland in 2015 were 48.1 megatonnes of carbon dioxide equivalent (Mt CO_2e). Transport, including International Aviation and Shipping (IAS), accounted for 13.1 Mt CO_2e, which is 27.4% of the total. In 2015, transport overtook energy supply as the largest sectorial contributor to Scottish greenhouse gas emissions.
- The latest National Atmospheric Emissions Inventory data now shows that Scottish transport emissions including IAS rose in 2014 and 2015.
- In 2015, road transport accounted for 72.7% of total transport emissions. Cars and goods vehicles (light and heavy combined) accounted for 43.2% and 25.4% of total transport emissions respectively.
- Looking at Scottish emissions over the period 1990-2015:
    - At 13.1 Mt CO_2e total transport emissions in 2015 were -1.1% below the 1990 level. Emissions from transport peaked at 14.9 Mt CO_2e in 2007.
    - At 5.7 Mt CO_2e, emissions from cars in 2015 were -2.0% below the 1990 level.
    - Aviation emissions accounted for 2.0 Mt CO_2e in 2015, a 46.1% rise on 1990. Domestic aviation emissions fell by -22.6% while international aviation emissions rose by 144.1% over the period.
    - Goods vehicles accounted for 3.3 Mt CO_2e in 2015, 21.8% above 1990. Of those, emissions from light goods vehicles increased by 69.2%, while emissions from heavy goods vehicles fell -3.5% 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.
- The specific infrastructure projects outlined add an estimated 0.07 Mt CO_2e per annum, which is 0.5% of 2015 transport emissions. This excludes the operational emissions impact from the Edinburgh-Glasgow Improvement Project.



Change in transport emissions since 2007:

Change in emissions: per passenger kilometre for short-haul aviation and cars and per kilometre for HGVs, 2016-2017:

Breakdown of transport emissions by mode 1990-2015:



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1. Introduction

This is the ninth edition of the Carbon Account for Transport. It is presented in a more concise format to previous reports for ease of use. For the first time, this edition includes time series data tables alongside the main report, as well as the usual infographics depicting key headlines. This year's edition also contains a detailed examination of low emissions buses in Scotland.

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. Work on the latest Climate Change Plan (CCP)[2] is underway, and will be published in early 2018. This will set out a possible emissions pathway to 2032, alongside policy options to achieve the annual targets.

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.

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 2015
- 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.

[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 Draft Climate Change Plan is available to view here.

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: 1990-2015* 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.

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 2015 emissions from all sectors amounted to 48.1 Mt CO_2e, down -3.0% from 49.5 Mt CO_2e in 2014. Source adjusted emissions[7] were 45.5 Mt CO_2e[8] in 2015, -41.0% below the 1990 baseline.

Measured at source, transport emissions including International Aviation and Shipping (IAS)[9] accounted for 13.1 Mt CO_2e in 2015, an increase of 0.4% on the previous year. The inventory states that transport emissions have now risen for two years[10]. Furthermore, in 2015 transport was the largest contributing sector to greenhouse gas emissions in Scotland, overtaking energy production for the first time.

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.

Excluding IAS, transport accounted for 23.6% of Scottish greenhouse gas emissions in 2015. This proportion is 27.4% when including IAS. Figure 1 shows the growing prominence of transport as a source of greenhouse gas emissions since 1990.

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[3] *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2015*, 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)

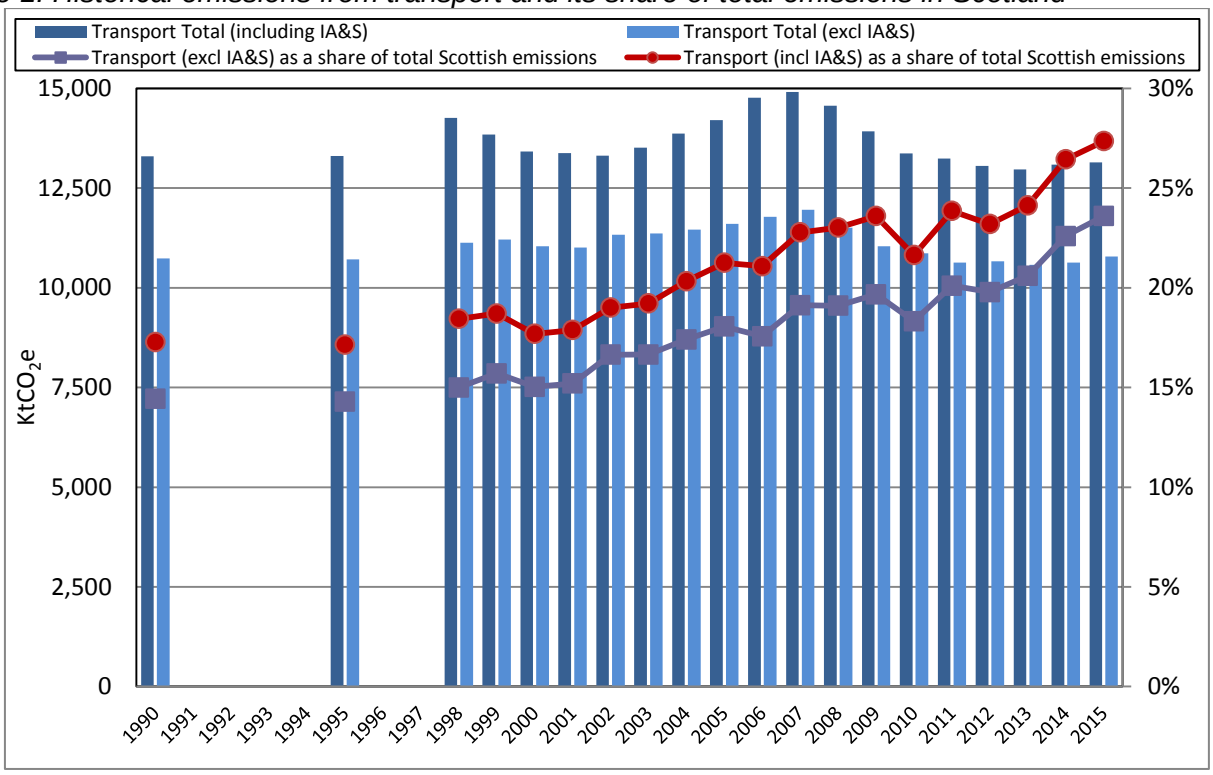
[7] Emissions adjusted to account for Scotland's participation in EU-wide emissions trading and are used to measure progress against targets.

[8] *Scottish Greenhouse Gas Emissions 2015*, The Scottish Government, 2017,

[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.

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



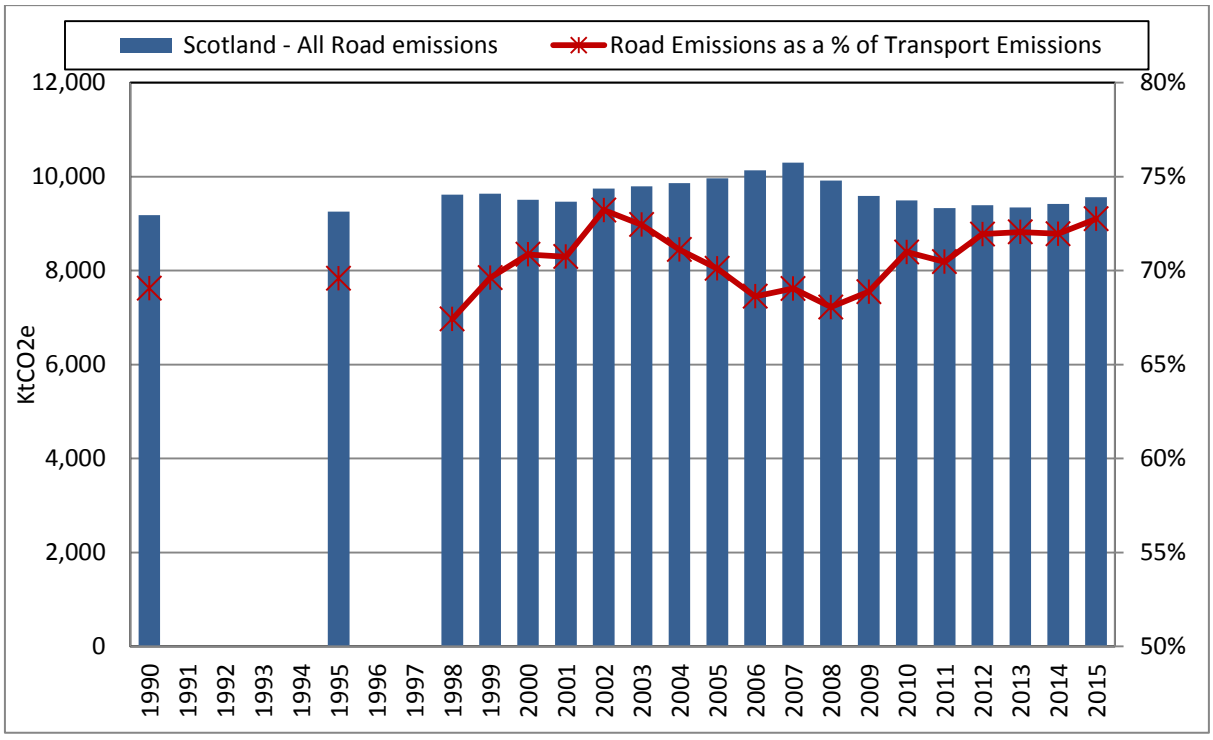
Source: National Atmospheric Emissions Inventory

2.3 Emissions analysis by transport sector

2.3.1 Road Transport

Road transport accounted for 9.6 Mt CO_2e in 2015. This is 72.7% of total transport emissions; a proportion which has generally risen since 2008. Figure 2 shows road emissions since 1990 with the proportion of transport emissions it accounts for.

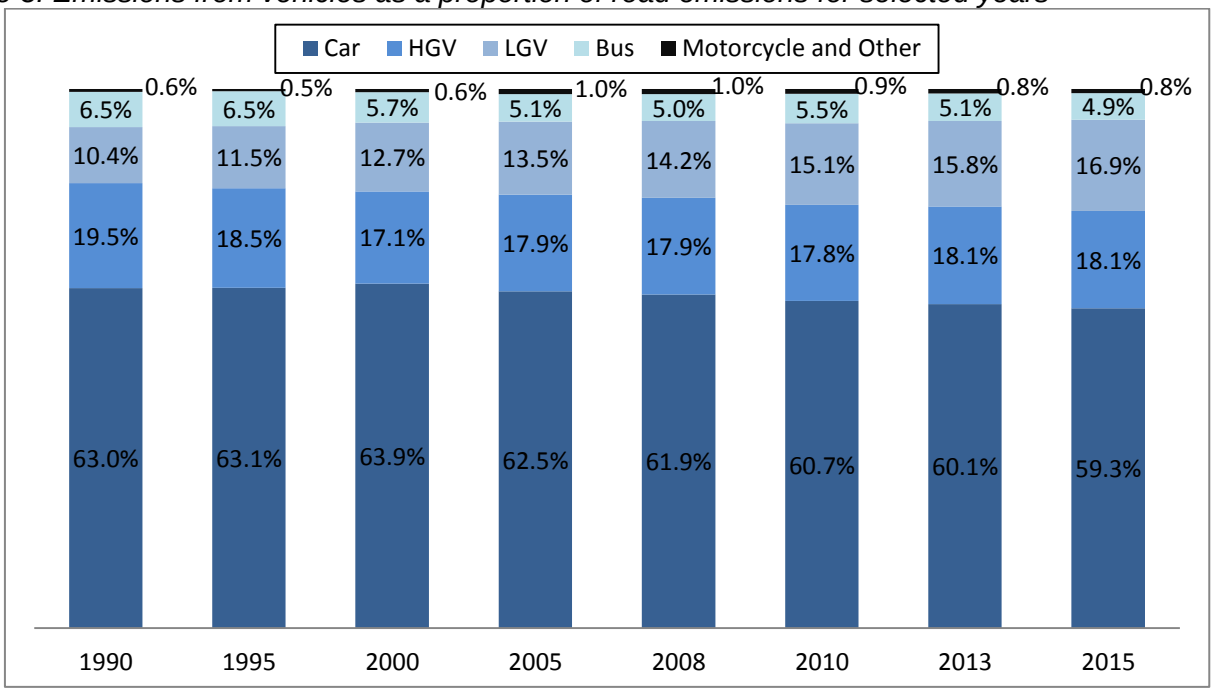
Figure 2: Historical road emissions in Scotland



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.

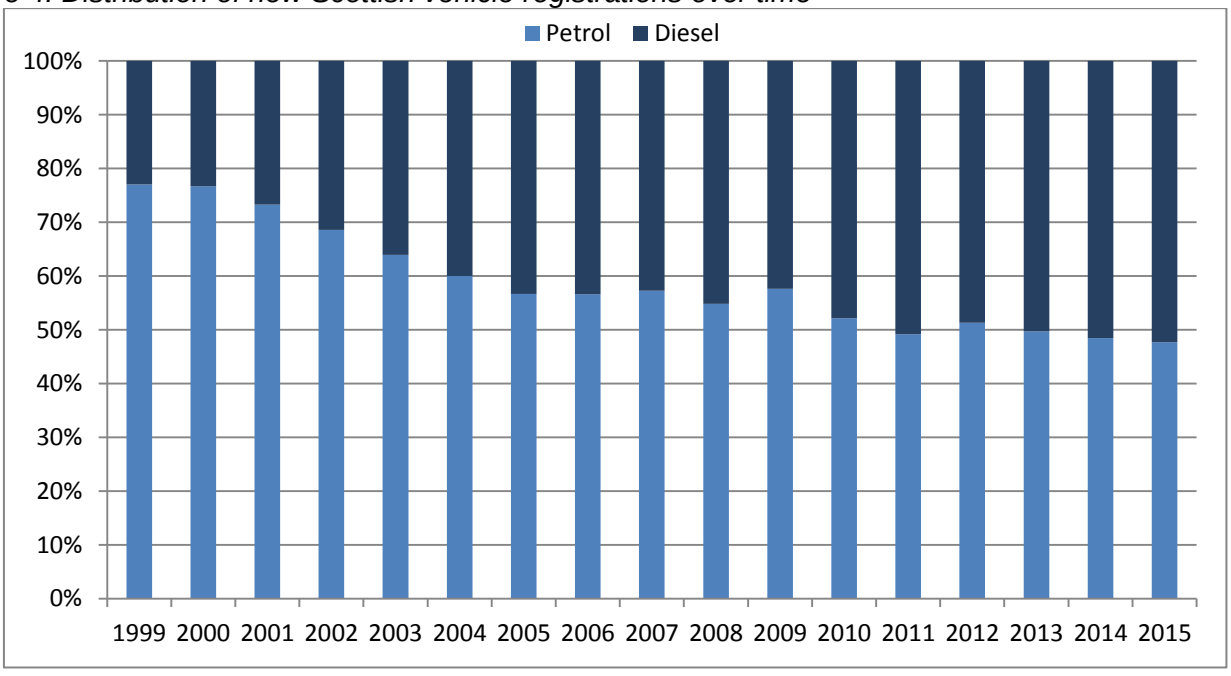
Figure 3: Emissions from vehicles as a proportion of road emissions for selected years



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.

Figure 4: Distribution of new Scottish vehicle registrations over time

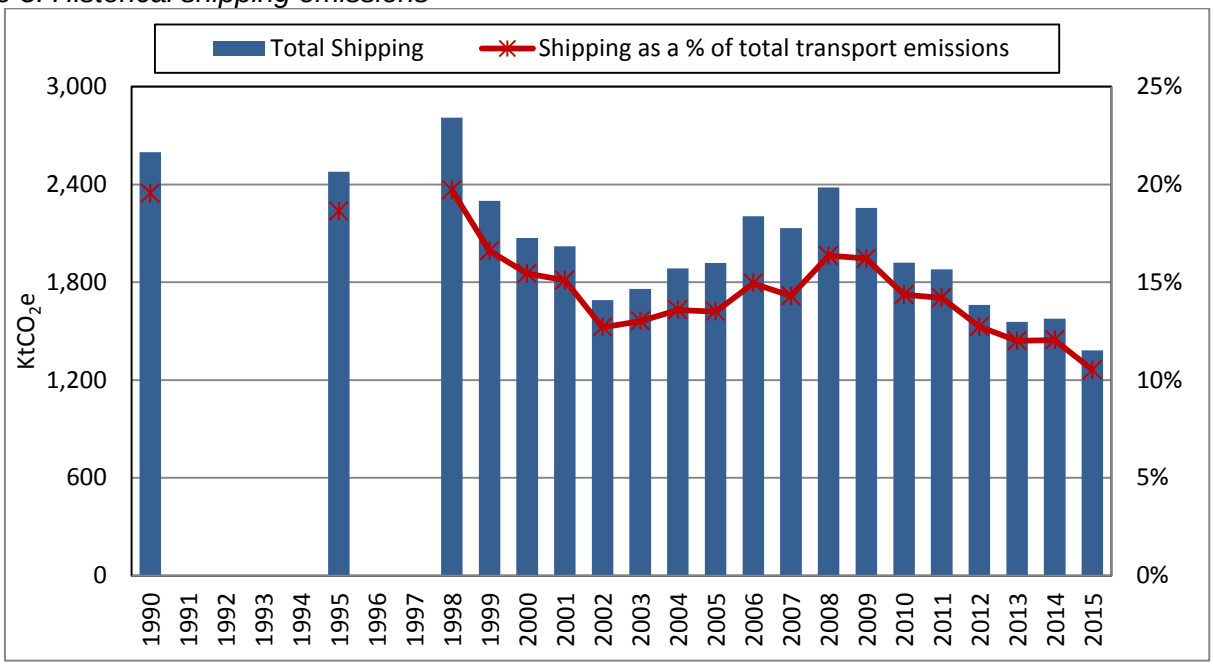


Source: Scottish Transport Statistics 2016 Table 1.1

2.3.2 Shipping

Shipping emissions were 1.4 Mt CO_2e in 2015. This is 10.5% 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.

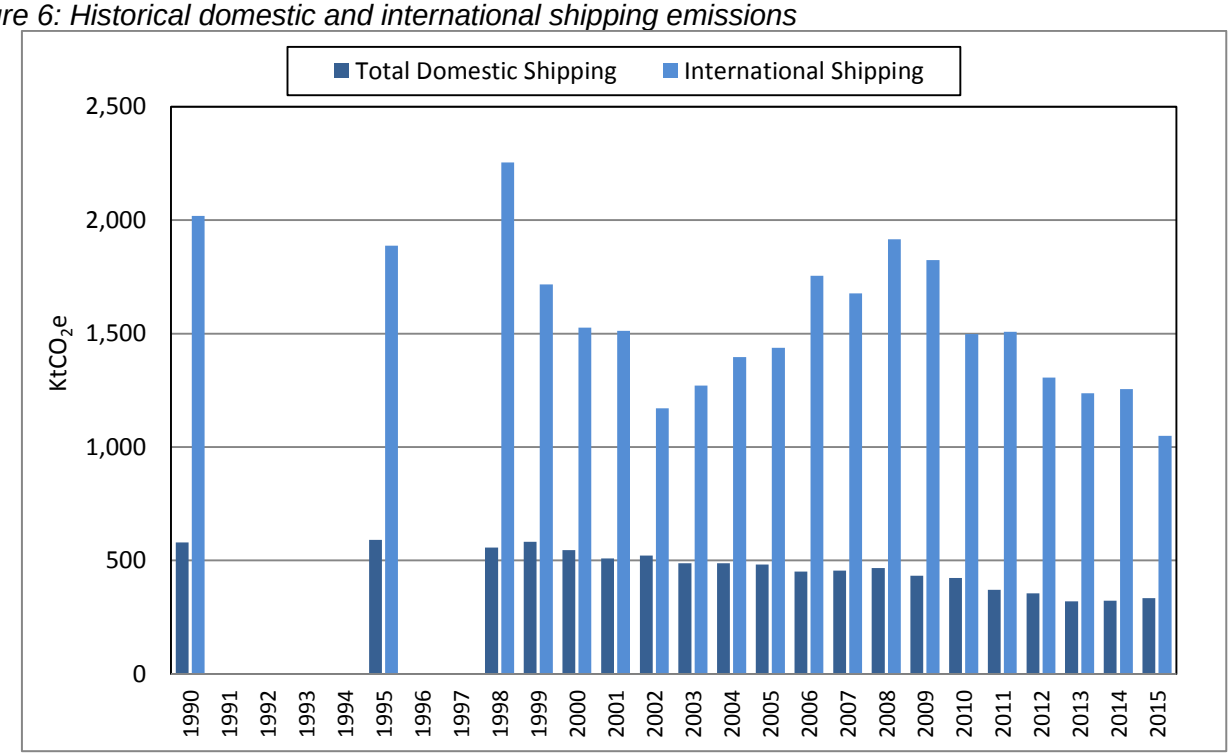
Figure 5: Historical shipping emissions



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. 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



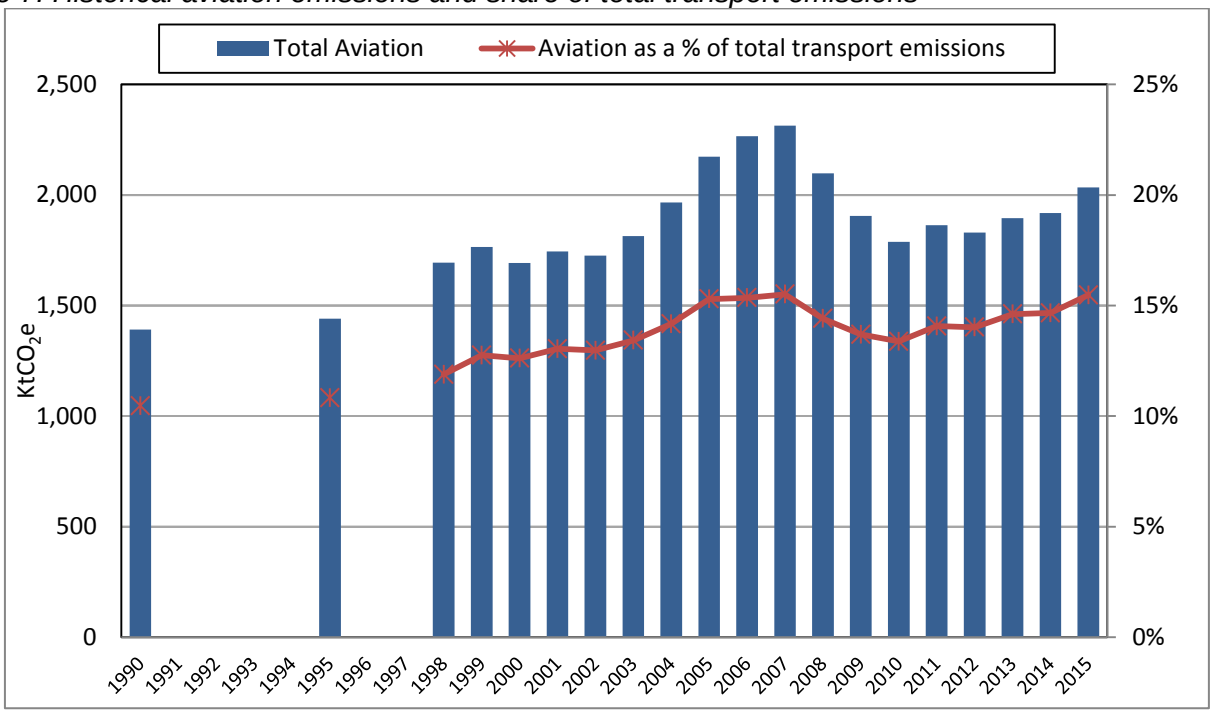
Source: National Atmospheric Emissions Inventory

2.3.3 Aviation

In 2015 total aviation emissions, including aircraft support vehicles and military aircraft, were 2.0 Mt CO_2e, an increase of 6.0% on 2014 and 46.1% above 1990. Aviation accounted for 15.5% of transport emissions in 2015. Total aircraft movements fell -11.8 % between 2005 and 2015[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.

[11] Scottish Transport Statistics Table 8.1.

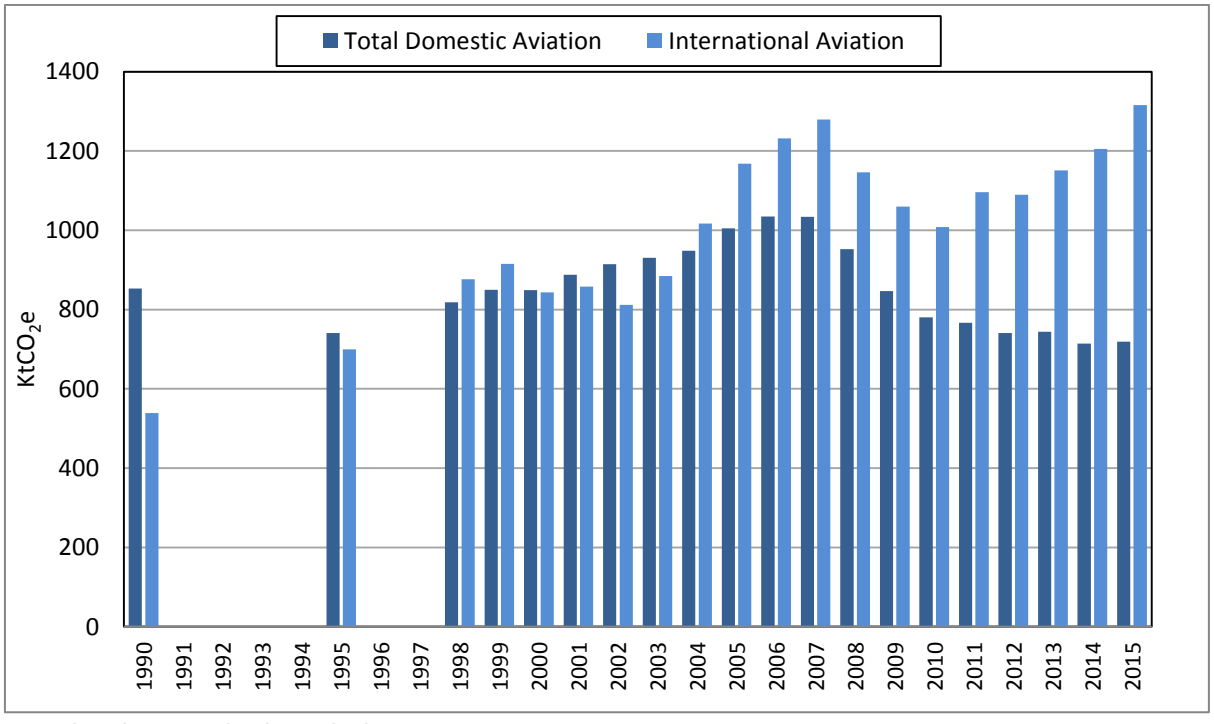
Figure 7: Historical aviation emissions and share of total transport emissions



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 2015. Domestic aircraft movements fell -18.8% between 2005 and 2015, while international aircraft movements increased 10.9%[12].

Figure 8: Domestic and international aviation emissions over time



Source: National Atmospheric Emissions Inventory

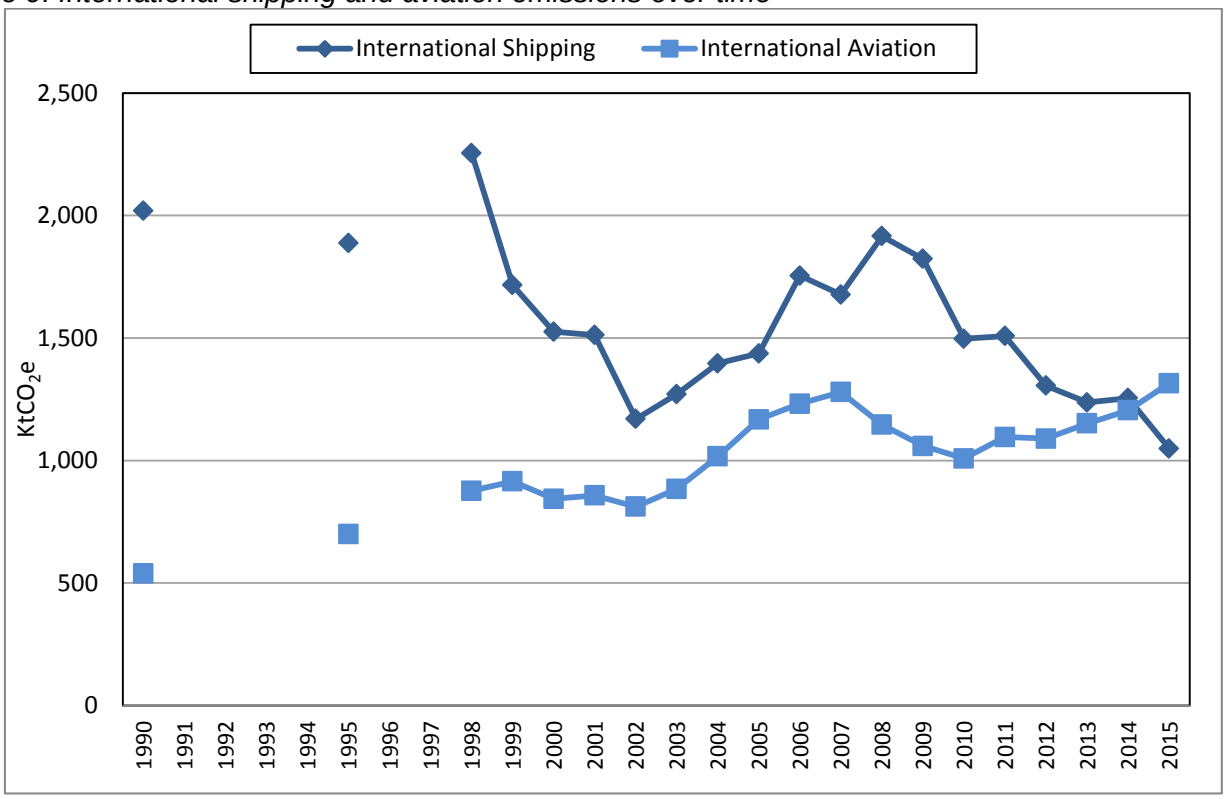
2.3.4 International aviation and shipping

Emissions from international aviation and shipping were 2.4 Mt CO_2e in 2015, a drop of -3.9% on the previous year, and -7.6% below 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

[12] Scottish Transport Statistics Table 8.1

shipping emissions and the rising pattern of aviation emissions. In 2015 international aviation generated more emissions than international shipping for the first time since the emissions inventory was compiled.

Figure 9: International shipping and aviation emissions over time

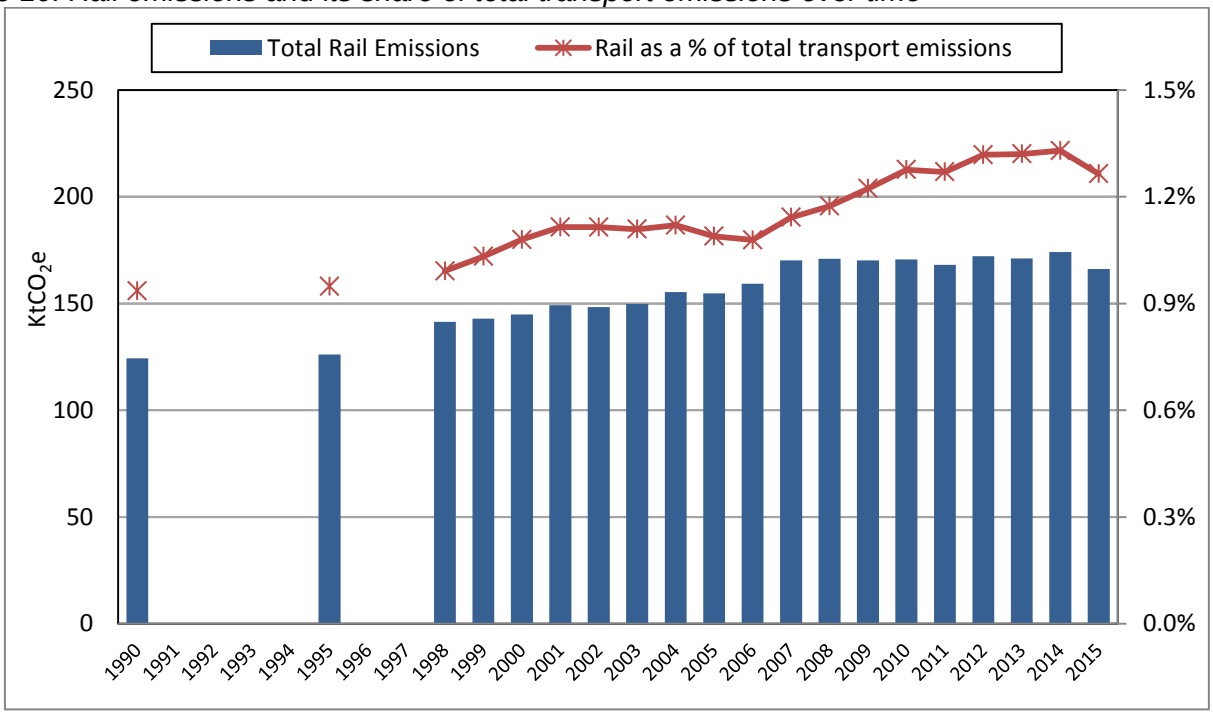


Source: National Atmospheric Emissions Inventory

2.3.5 Rail

Rail accounted for 0.17 Mt CO_2e in 2015; -4.5% below the previous year, but 33.7% above the 1990 level. In the ten years to 2015/16, passenger kilometres on Scotrail services increased by 32.9%, and scheduled train route kilometres increased 20.2%[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 both 2014 and 2015, having generally fallen since 2007. Between 2005 and 2015, car kilometres in Scotland rose from 22.1 million to 34.7 million[14], while emissions fell from 6.2 Mt CO_2e to 5.7 Mt CO_2e. Despite this improved fuel efficiency, in 2015 cars still accounted for 59.3% of road emissions and 43.2% of total transport emissions in Scotland. These are the highest proportions of any mode of transport.

2.4.2 Heavy Goods Vehicles

At 18.1%, HGVs accounted for the second largest proportion of road emissions in 2015. This is 12.3% of total transport emissions. At 1.7 Mt CO_2e, HGV emissions were 2.2% higher than the previous year, but -3.5% below the 1990 figure. Between 2005 and 2015 HGV kilometres in Scotland fell by -5.0%.

2.4.3 Light Goods Vehicles

LGV emissions were 69.2% higher in 2015 than in 1990. In 2015 they accounted for 1.6 Mt CO_2e, 4.6% more than the previous year. This is 16.9% of road emissions and 12.3% of total transport emissions. In the decade to 2015, light goods vehicle kilometres in Scotland rose 27.8%, from 5.5 million to 7.0 million.

2.4.4 Buses and coaches

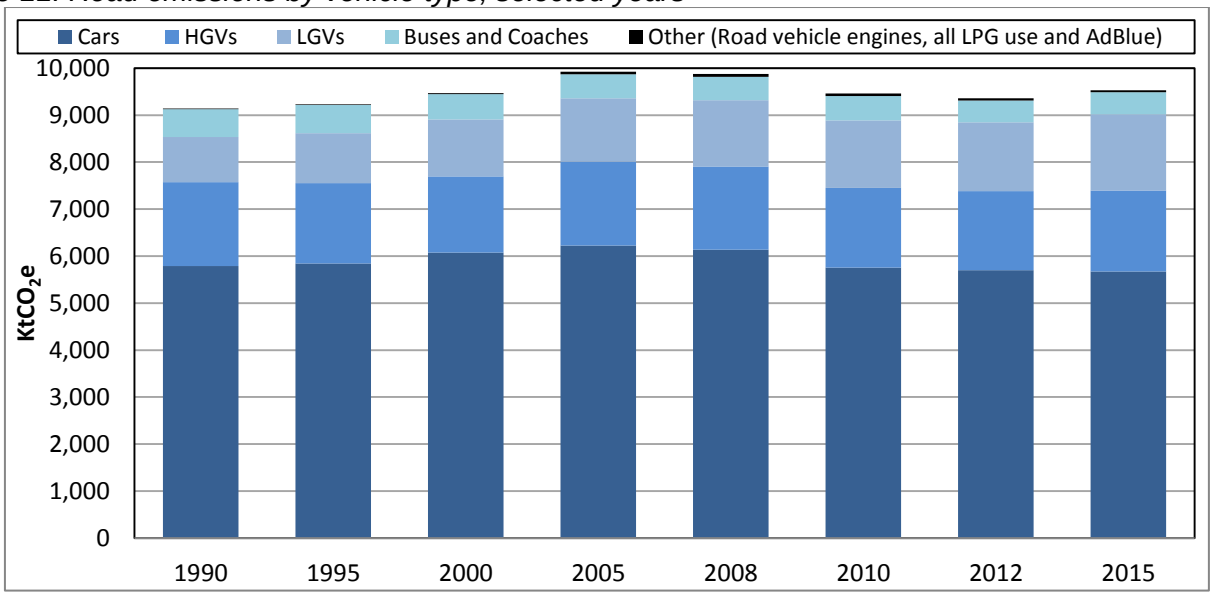
Buses and coaches accounted for under 0.5 Mt CO_2e in 2015, a drop of -3.0% on the previous year. Bus emissions have gently declined since 1990, and in 2015 stand -21.7% below this 1990 figure. Between 2005 and 2015, published public service vehicle kilometres fell -12.3%[15].

2.4.5 Motorcycles

Motorcycles emitted 0.033 Mt CO_2e in 2015. This is only 0.3% of road emissions and 0.1% 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.

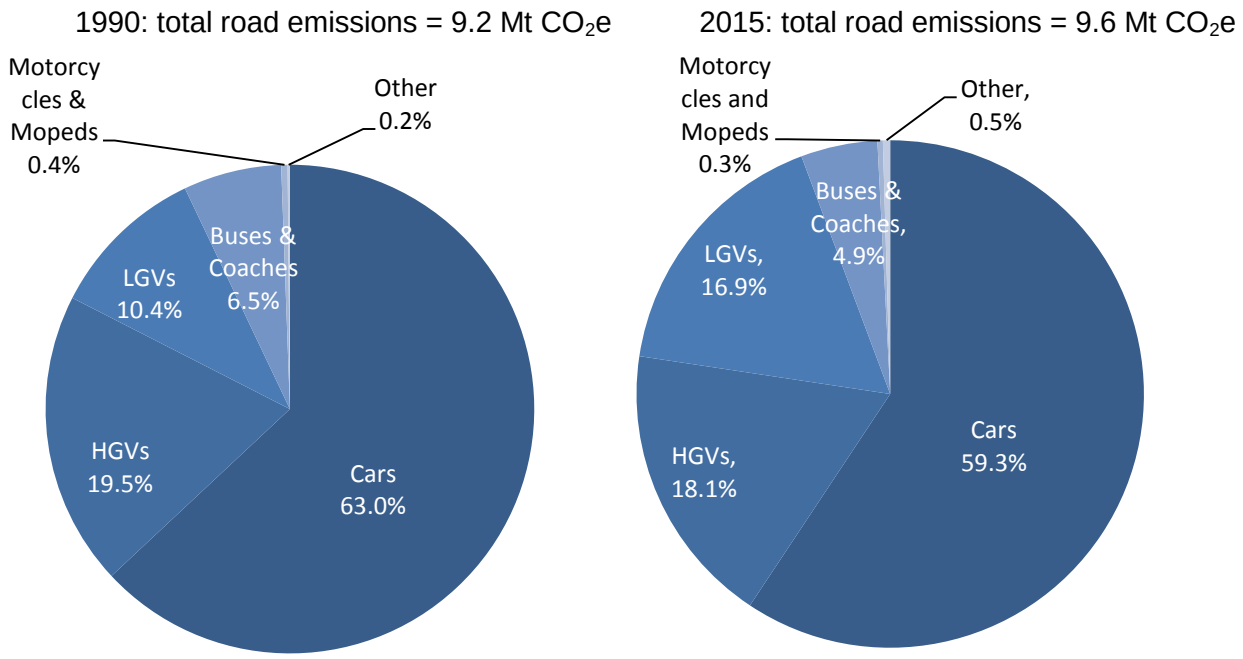
Figure 11: Road emissions by vehicle type, selected years



Source: National Atmospheric Emissions Inventory

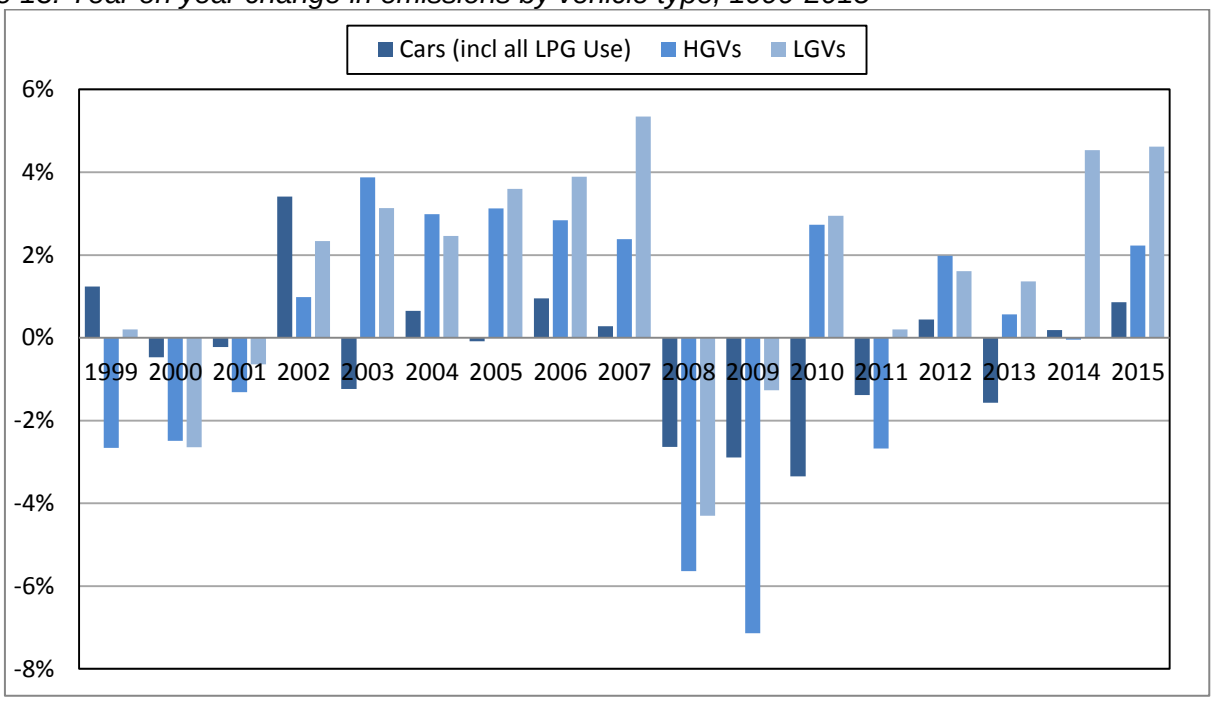
[14] Unless otherwise referenced, all kilometres quoted in section 2.4 are from Scottish Transport Statistics Table 5.3.
[15] Scottish Transport Statistics Table 2.3a. Note that these may not match the internal kilometres quoted in the special focus box. The emissions inventory is also not clear on the 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 12: Share of road emissions by vehicle type, 1990 and 2015



Source: National Atmospheric Emissions Inventory

Figure 13: Year on year change in emissions by vehicle type, 1999-2015



Source: National Atmospheric Emissions Inventory

2.5 Road emissions by type of road

2.5.1 Rural

At 4.8 Mt CO_2e in 2015, rural road emissions were 2.7% above the previous year, and 2.5% above 1990. Rural emissions accounted for 50.0% of road emissions.

2.5.2 Urban

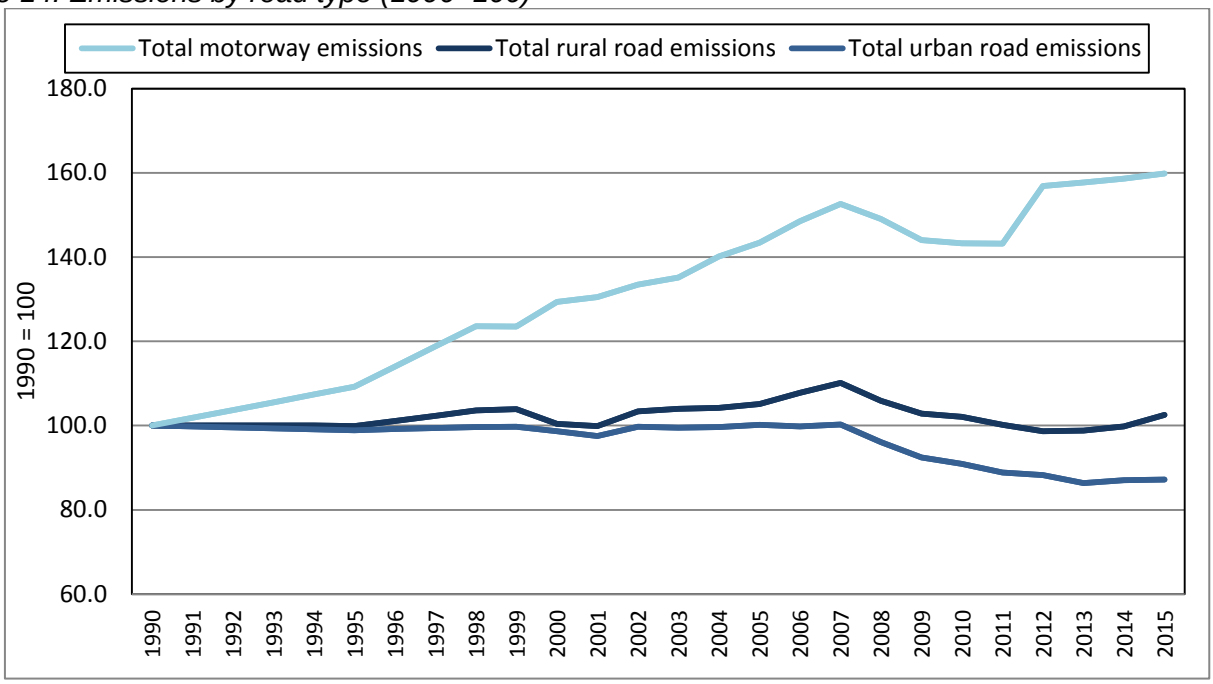
At 3.0 Mt CO_2e in 2015, urban road emissions are 0.1% above the previous year, but -12.8% below 1990. Urban emissions accounted for 31.2% of road emissions in 2015, down from 37.1% in 1990.

2.5.3 Motorways

At 1.8 Mt CO_2e in 2015, motorways emissions are at their highest level on record, 59.8% higher than 1990. Motorways contribute the smallest proportion of road emissions, at 18.8%, up from 12.2% in 1990.

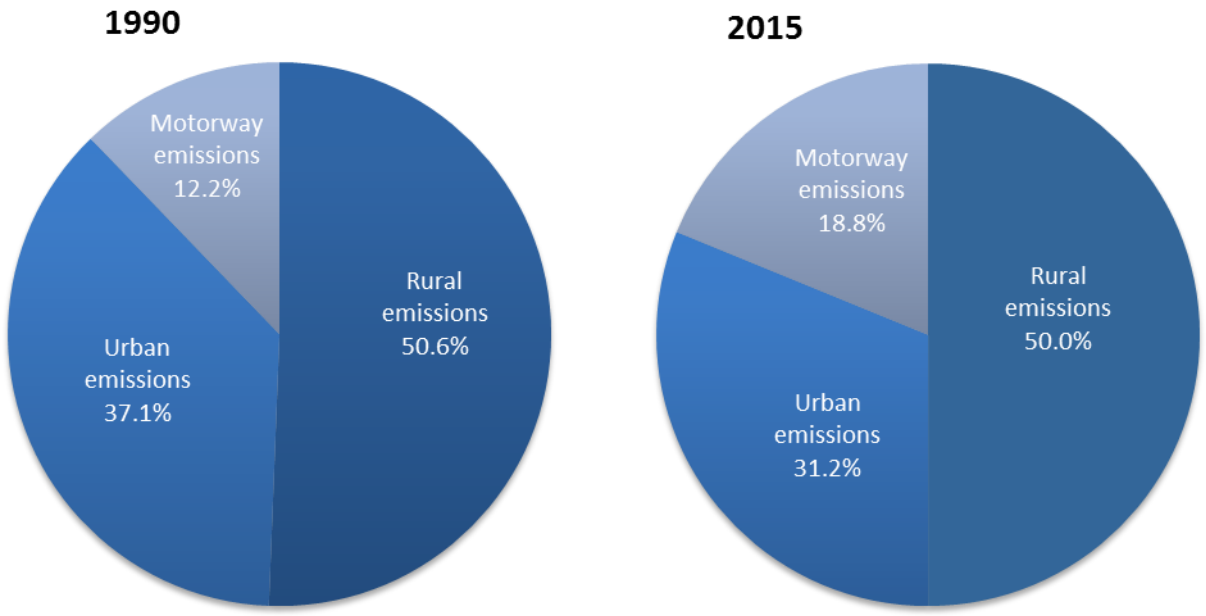
Figure 14 shows an index of emissions from different types of road since 1990.

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



Source: National Atmospheric Emissions Inventory

Figure 15: Share of road emissions by road type



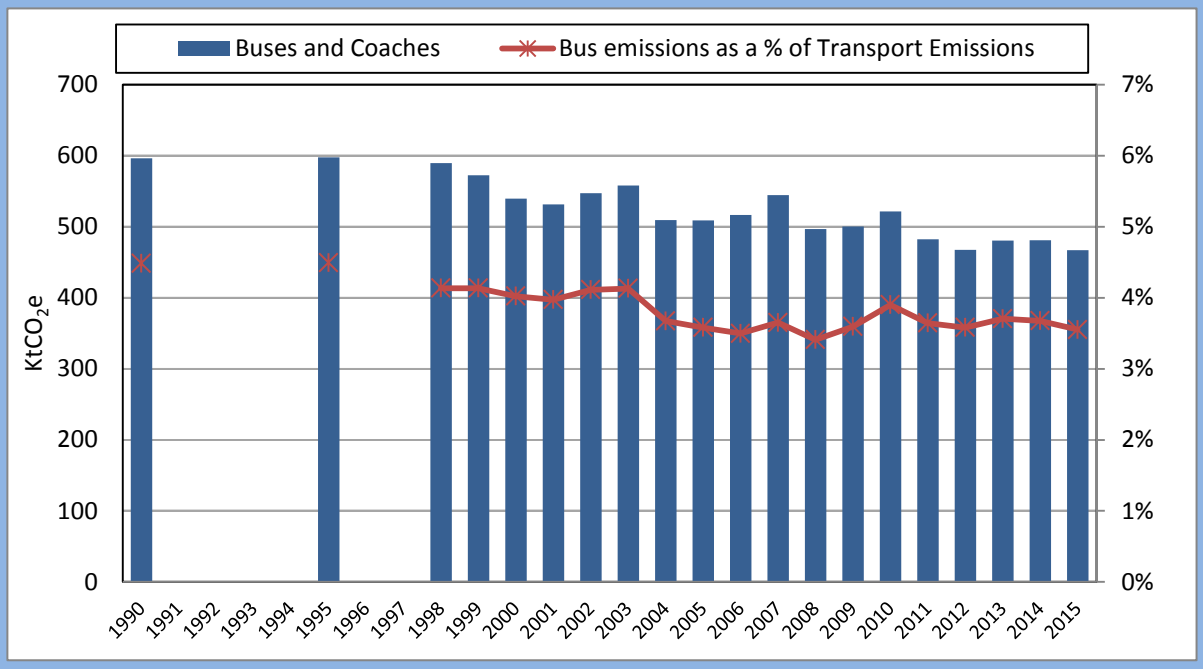
Source: National Atmospheric Emissions Inventory

[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. Low Emissions Buses Special Focus

This section examines the bus and coach industry in Scotland from the perspective of its emissions over time, and the policies The Scottish Government have put in place to reduce emissions.

Buses and coaches have historically contributed to less than 5% of total transport emissions in Scotland, a proportion which has fallen since 1990. Total emissions have also fallen in this period, as illustrated in the graph below.



Source: National Atmospheric Emissions Inventory

The Scottish Government has two key policies in place regarding the decarbonisation of bus and coach travel. The first is the Green Bus Fund, a capital grant awarded to bus operators for up to 80% of the additional cost of purchasing a low emissions bus relative to its diesel equivalent. The second is the Bus Service Operators' Grant (BSOG) Low Carbon Vehicle (LCV) incentive, currently paid at a rate of £0.101 per kilometre to qualifying buses. This is in addition to standard BSOG paid to all bus services at a rate of £0.144 per kilometre.

<u>Green Bus Fund</u>

Since its inception in 2010 the Green Bus Fund has aided the purchase of 362 buses on the Scottish network, across seven funding rounds. To qualify for funding, the bus being purchased must satisfy "…a more than 15% improvement on well-to-wheel greenhouse gas emissions as compared to an equivalent diesel Euro V bus of the same passenger capacity and which can achieve the Euro VI emission standard." Euro V and Euro VI are emissions standards for vehicles sold in the European Economic Area. They set limits for the emissions per kilometre travelled for gases which affect air quality, including nitrous oxides (NOx) and particulate matter (PM). The standards do not set limits for carbon dioxide, which is a greenhouse gas.

The number of buses purchased through each of the seven rounds of the Green Bus Fund is shown in the table below. It does not show a corresponding year because some buses purchased were not introduced until a later financial year.

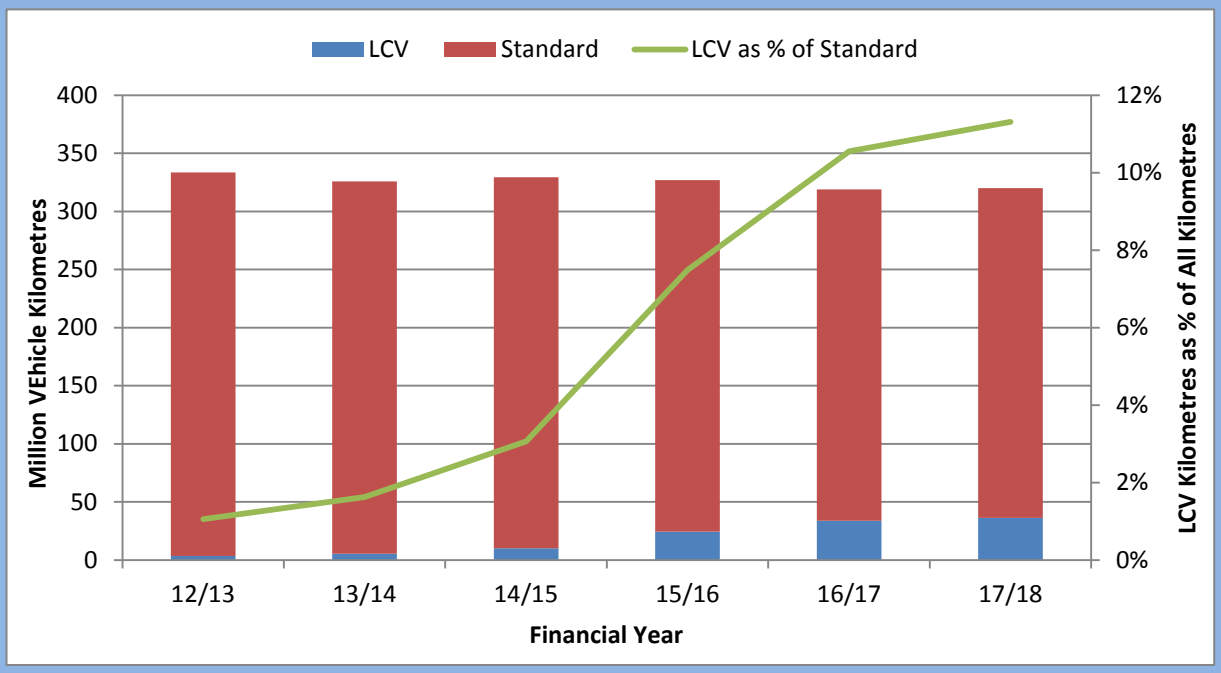
Scottish Green Bus Fund Round	1	2	3	4	5	6	7
Buses Purchased	48	22	24	32	143	46	47

Source: Transport Scotland

The Green Bus Fund is technology neutral to incentivise the development of new technologies in the future, and to not show bias in favour of existing emissions reducing technology. In practice this means that some qualifying buses are more efficient versions of their diesel equivalents. The most emissions reducing buses are those which include alternative drivetrains, and the Green Bus Fund has helped finance a number of hybrid and electric buses since its inception. However, some low emissions buses on Scotland's roads have not been funded through the Green Bus Fund. The hydrogen bus project in Aberdeen was funded with other government grants and private funding, and Lothian Buses have recently introduced the first all-electric buses to operate in Edinburgh, which were privately funded.

Bus Service Operators' Grant Low Carbon Vehicle Incentive

Operators have also purchased some low emissions buses out-with the Green Bus Fund. While their purchase was not supported, these buses do qualify for the low carbon vehicle incentive under the Bus Service Operators' Grant (BSOG). The qualifying standard is slightly different for this compared to the Green Bus Fund. The guidance states a qualifying bus is "a vehicle that produces at least 30% fewer greenhouse gases that a current Euro III equivalent diesel bus of the same total passenger capacity". Again, this is on a well-to-wheel basis. However, the standard is not as stringent as the green bus fund. There are a number of buses which qualify for this incentive which operators can afford to purchase and operate without the help of the Green Bus Fund. The graph below shows the growth in kilometres travelled by Low Carbon Vehicles relative to total commercial bus kilometres.



Source: Transport Scotland

As shown in the graph, there has been rapid growth in the number of kilometres travelled by qualifying buses, though this growth has slowed between 2016/17 and 2017/18. This is potentially because the LCV rate was reduced at the beginning of this financial year, but may also be the result of fewer low emissions buses coming onto the network.

Future Policy

One criticism of the current LCV incentive is that it does not compensate based on the extent to which a vehicle reduces emissions. Therefore a zero emissions bus receives no more support than a bus which just meets the emissions standard to qualify. The Scottish Government wishes to continue to incentivise the purchase and operation of progressively lower emitting buses, and is currently working with the industry to review policy in light of ever changing technologies.

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 2015, Scottish transport accounted for 9.0% of UK transport emissions excluding international aviation and shipping, and 8.2% including them.
- Scotland's share of UK emissions from buses and coaches, rural roads and domestic aviation were higher in 2015 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 -1.1% in Scotland between 1990 and 2015, while they rose 10.1% in the UK.
- However, removing international aviation and shipping shows a 0.4% rise in Scotland and a -1.5% 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

	2015 Emissions			2014-2015 % Changes		1990-2015 % Change	
Emissions are given in kt CO_2e	Scotland	UK	Scotland as % of UK	Scotland	UK	Scotland	UK
Transport incl. IAS	13,145	160,901	8.2%	0.4%	0.8%	-1.1%	10.1%
Transport excl. IAS	10,781	120,022	9.0%	1.4%	1.9%	0.4%	-1.5%
Road Transport	9,562	111,521	8.6%	1.5%	2.1%	4.1%	0.9%
of which:							
Cars	5,673	69,117	8.2%	0.9%	1.2%	-2.0%	-4.4%
HGVs	1,727	19,647	8.8%	2.2%	4.5%	-3.5%	-4.0%
LGVs	1,618	18,040	9.0%	4.6%	4.2%	69.2%	55.0%
Bus and coach	467	3,680	12.7%	-3.0%	-4.0%	-21.7%	-29.9%
Motorcycles	33	518	6.4%	-0.7%	0.6%	-2.0%	-32.9%
Rural	4,751	44,176	10.8%	2.7%	2.9%	2.5%	5.1%
Urban	2,964	40,543	7.3%	0.1%	0.4%	-12.8%	-17.1%
Motorway	1,789	26,109	6.9%	0.7%	3.5%	59.8%	35.3%
Rail Transport	166	1,912	8.7%	-4.5%	-6.5%	33.7%	-2.5%
Domestic Aviation	623	2,975	20.9%	-0.1%	-0.6%	-22.6%	-44.8%
Total Aviation	2,034	36,979	5.5%	6.0%	1.3%	46.1%	74.4%
Domestic Maritime	334	3,045	11.0%	3.5%	3.5%	-42.4%	-17.4%
Total Maritime	1,382	10,490	13.2%	-12.4%	-11.0%	-46.8%	-15.5%

Source: National Atmospheric Emissions Inventory

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

- In Scotland in 2015, total transport emissions including IAS were -1.1% 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

Emissions are given in kt CO_2e			Road	Rail	Domestic Aviation [17]	Total Aviation incl. IAS	Domestic Maritime	Total Maritime incl. IS	Total excl. IAS	Total incl. IAS
SCOTLAND	Emissions	2015	9,562	166	719	2,034	334	1,382	10,781	13,145
	% Change	2014-15	1.5%	-4.5%	0.6%	6.0%	3.5%	-12.4%	1.4%	0.4%
		1990-2015	4.1%	33.7%	-15.7%	46.1%	-42.4%	-46.8%	0.4%	-1.1%
ENGLAND	Emissions	2015	92,415	1,617	2,524	34,435	2,363	7,535	98,919	136,001
	% Change	2014-15	2.1%	-6.8%	0.0%	1.0%	2.9%	-11.4%	1.9%	0.9%
		1990-2015	-0.5%	-7.3%	-42.4%	78.6%	-13.4%	-8.1%	-2.8%	11.4%
WALES	Emissions	2015	5,658	91	61	128	234	1,078	6,044	6,956
	% Change	2014-15	1.9%	-6.3%	-3.1%	3.4%	9.0%	-6.9%	2.0%	0.4%
		1990-2015	1.4%	31.7%	-65.5%	-49.2%	-13.7%	-8.7%	-0.8%	-1.8%
N.IRELAND	Emissions	2015	3,885	38	240	381	115	960	4,278	5,264
	% Change	2014-15	1.9%	-1.4%	3.2%	4.1%	5.6%	-8.8%	2.1%	-0.1%
		1990-2015	32.1%	52.9%	3.4%	33.7%	5.7%	-5.8%	29.4%	23.3%

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[18].

- Coach is the least emitting means of travel per passenger kilometre, followed by rail.
- The most emitting mode of travel is domestic aviation, at 141 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] Including aircraft support vehicles

[18] *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	% Change 2012-2017
Road	Average petrol car	134	131	128	127	128	124	-7.4%
	Average diesel car	124	121	123	121	122	119	-3.7%
	Average petrol hybrid car	89	87	89	85	88	79	-11.4%
	Average petrol motorbike	119	119	120	120	120	117	-2.0%
	Average bus	112	112	109	109	102	103	-8.4%
	Average coach	29	29	29	29	29	28	-3.3%
Rail	National rail	58	49	47	45	49	47	-19.6%
	Light rail and tram	68	60	62	55	54	44	-34.2%
Ferry (Large RoPax)	Average foot and car passengers	116	116	116	116	116	116	0.0%
Aviation	Average domestic flights	180	173	155	158	147	141	-21.4%
	Average short haul international	104	102	88	90	89	85	-18.0%
	Average long haul international	119	120	111	105	101	104	-12.1%

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 2016 at this stage. However, there are some indicators of transport emissions available for Scotland.

- Scottish road vehicle kilometres travelled: In 2016 kilometres travelled were higher than at any point in the 10 years prior.
- Sales of plug-in vehicle grant eligible cars in Scotland: 2016 sales are 5.3% higher than 2015.
- 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 2016 UK transport emissions: An estimate published earlier than the NAEI shows UK transport emissions excluding international aviation and shipping rising by 0.9% in 2016 on the previous year.
- UK domestic transport fuel consumption: tracks total transport fuel sales. In 2016 this indicator rose 2.4% on the previous year.
- Scottish GVA: The 0.6% growth seen in the year to Q1 2017 is slower than in previous years.
- Scottish forecourt pump prices July 2016 – July 2017: prices of both petrol and diesel increased by 2.23% and 2.40% 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 2016

No.	Indicator	2015	2016	Average growth p.a.	Growth
				(2003-2016)	(2015-2016)
1	Road vehicle kilometres travelled (million vehicle kilometres)	45.0	46.1	0.8%	2.4%
2	Sales of Plug in Grant cars in Scotland	1,298	1,367	-	5.3%
3	Aircraft movements	480,070	481,334	1.7%	0.3%
4	UK transport emissions (excl. IAS) ($MtCO_2e$)	118.8	119.8	-0.4%	0.9%
5	UK domestic road fuel consumption by transport (million tonnes)	35.738	36.600	-0.5%	2.4%
6	Average CO2/km of petrol cars registered for the first time	127.9	123.8	*2003 Data Unavailable*	-3.2%
7	Average CO2/km of diesel cars registered for the first time	122.0	119.2	*2003 Data Unavailable*	-2.3%

					Growth
8	Scottish year-on-year GVA growth (to Q1 2017)	-	-	-	0.6%
9	Scottish year-on-year change in a) petrol and b) diesel prices (July 16 - July 17) - NOMINAL				a) 2.2% b) 2.4%

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. Emissions Impact of Transport Interventions

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 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[19]
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[20]

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, due to be published in early 2018, will provide 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: 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[21] 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 and ULEVs over conventionally fuelled cars this measure is expected to contribute to the UK's carbon emissions targets"[22].
- 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.

[19] This was the assumed opening date at the time of the environmental statement.
[20] Impact from operational emissions
[21] Alternative fuel vehicles include hybrids, bioethanol and liquid petroleum gas.
[22] *Policy paper: Vehicle Excise Duty*, HMRC, 2015.

- 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.

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