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# Carbon Account for Transport No. 8: 2016 Edition

# Carbon Account for Transport

## No. 8: 2016 Edition

This document provides an annual update of the Carbon Account for Transport (CAT), first published in August 2009. Future updates will be released as new data become available.

**Contents**

## Executive Summary

The CAT provides a carbon balance sheet for Scotland, and presents the impact of all Scottish transport policies and projects: .... *expected to have a significant impact on carbon, whether positive or negative* (National Transport Strategy page 46). Based on greenhouse gas emissions estimates up to and including 2014, the main findings in this latest report are:

- In 2014 Scottish emissions from all sectors amounted to 46.7 mega-tonnes of carbon dioxide equivalent ($MtCO_2e$). Transport's share, including emissions from international aviation and shipping (IAS) was 12.9 $MtCO_2e$. Transport accounts for 28% of Scotland's total emissions.

- Transport emissions including IAS have fallen for seven consecutive years and by 2.0 $MtCO_2e$ since peak figure of 14.9 $MtCO_2e$ recorded in 2007. However, the fall in emissions between 2013 and 2014 is less than 0.01%, so is best described as unchanged between 2013 and 2014.

- Road transport emissions account for 73% of all transport emissions and cars account for 59% of road emissions. Emissions from cars account for 44% of all transport emissions with emissions from goods vehicles (combined light and heavy) accounting for a further 25% of the total.

- Looking at the entire period 1990-2014:

  Total transport emissions (12.9 $MtCO_2e$) remain below their 1990 level of 13.3 $MtCO_2e$.

  At 5.7 $MtCO_2e$, emissions from cars are marginally below their 1990 level of 5.8 $MtCO_2e$

  Emissions from aviation have risen by 38% since 1990 to stand at 1.9 $MtCO_2e$ with goods vehicle emissions up 17% at 3.2 $MtCO_2e$.

  The significant rise in emissions from goods vehicles (from 2.7 $MtCO_2e$ to 3.2 MtCO2e in 2014) is largely a result of the increase in emissions from Light Good Vehicles prior to 2007 with HGV emissions accounting for the bulk of the increase from 2009.

- The specific infrastructure projects outlined in the CAT add an estimated net 0.05 MtCO2e to total transport emissions in 2027 – equivalent to 0.4% of current transport emissions.

# Chapter 1: Introduction

This is the eighth edition of the Carbon Account for Transport. It follows the same structure as previous reports, and for the third year running it is accompanied by an infographic to highlight some of the key information contained within. This year's edition contains a detailed examination of the uptake in electric and plug in hybrid vehicles in Scotland (between sections 2.5 and 2.6).

## 1.1 Policy Context

The *Government Economic Strategy*[1] states that the purpose of the Scottish Government is to:

*"… create a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth."* (The Government Economic Strategy 2015, p4).

In support of the Strategy, the Climate Change (Scotland) Act 2009[2] creates the statutory framework for greenhouse gas emissions reductions in Scotland requiring annual emissions targets and an interim emissions target for 2020 of 40.72 $MtCO2_e$, on the way to an 80% emissions reduction target for 2050. To help ensure the delivery of these targets, the Act also requires Scottish Ministers to set batches of annual targets for Scottish emissions in the period 2010 to 2050.

The most recent report on the climate change targets is *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2013-2027: The Second Report on Proposals and Policies*[3] (RPP2). This document sets out a possible pathway and options for delivering the necessary reductions out to 2027. The latest batch of annual targets covering the period 2028-32 were set in a statutory instrument in October 2016[4].

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1 http://www.gov.scot/Resource/0047/00472389.pdf
2 http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/climatechangeact
3 The Second Report on Proposals and Policies
4 http://www.legislation.gov.uk/ssi/2016/328/pdfs/ssi_20160328_en.pdf

Delivering both the interim and final emissions reduction target will be challenging. Reducing emissions from transport will require a combination of both reserved and devolved policies to ensure the sector makes its fair contribution to achieving each target. The 2020s will be particularly critical in setting road transport on a pathway towards low carbon solutions.

## 1.2 Purpose of the Carbon Account for Transport

The *National Transport Strategy* and its recent refresh (NTS)[5] identify three key strategic outcomes for transport in Scotland:

- Improve journey times and connections
- Reduce emissions
- Improve quality, accessibility and affordability

The ‘reduce emissions’ outcome in the NTS includes a commitment to publish a carbon balance sheet for transport with the expectation that:

*“This will present the impact of all Scottish transport policies and projects that are expected to have a significant impact on carbon, whether positive or negative.”(National Transport Strategy, p46)*

This commitment is met by the regular publication of the *Carbon Account for Transport* (CAT). The CAT provides updates on the following information:

- Official Scottish transport emissions data from 1990 to 2014
- Emissions efficiency estimates for passenger vehicles
- Key leading transport emissions indicators
- Scottish transport infrastructure projects likely to have a significant impact upon emissions

[5] National Transport Strategy

- Assessments of likely impact of Scottish, UK and EU wide regulatory and fiscal measures

Each of the above components can be used to monitor progress towards reducing transport emissions and support the development of actions to further reduce emissions in order to meet the targets in the Climate Change (Scotland) Act 2009.

The CAT is not a decision making tool at either the individual project or policy level. Neither is its function to reject policies that increase emissions. Its purpose is to present relevant data and analysis to inform the Scottish Government and Transport Scotland's consideration of future transport options. Scottish Transport Appraisal Guidance (STAG)[6] is the tool for appraising new transport policies and projects, in which environmental impact is one of five criteria considered alongside economy, safety, integration and accessibility and social inclusion.

The CAT continues to provide an estimate of the net impact of all devolved transport infrastructure interventions that fall within the competence of the Scottish Government or other Scottish public bodies that are likely to have a material impact on emissions. Details of the methodology and the results from the current assessment are set out in section 3.4.

In achieving its objectives, the CAT constitutes an important element of a wider framework adopted across the Scottish Government to monitor the rate of emissions reduction.

[6] http://www.transportscotland.gov.uk/stag/home

# Chapter 2: Historical emissions analysis

## 2.1 Background and data sources

All of the emissions data presented in this chapter is from the *Greenhouse Gas Inventory for England, Scotland, Wales and Northern Ireland: 1990-2014*[7] (GHGI), unless otherwise stated. Further to the information presented in this report, data referring to emissions from other sectors in Scotland is published in the Official Statistics release *Scottish Greenhouse Gas Emissions 2014*[8] The GHGI is compiled on an annual basis and a complete time series of all greenhouse gases dating back to 1990 is updated in each publication. This is to account for improvements in data and advances in calculation methodology. Revisions to the GHGI have led to a significant increase in the base year Scottish emissions figure for 1990 which has consequently impacted the absolute emissions reduction required to meet climate change targets. The greenhouse gases associated with transport recorded by GHGI are carbon dioxide ($CO_2$), nitrous oxide ($N_2O$) and methane ($CH_4$)[9]. Emissions levels are presented in mega-tonnes of carbon dioxide equivalent ($MtCO_2e$), a common unit which converts the mass of other gases to a mass of $CO_2$ which has the equivalent environmental impact.

The transport category within the GHGI covers emissions from road, aviation, rail and maritime transport. While domestic aviation and shipping emissions are recorded in the GHGI, emissions associated with international aviation and shipping (IAS) were not originally reported. However, indicative assessments of emissions from IAS have been included in the datasets since 2009. Furthermore, in line with the Scottish Government's commitment to include IAS emissions in the targets set by the Climate Change (Scotland) Act 2009, references to aviation and maritime emissions refer to both domestic and international combined, unless otherwise stated.

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[7] Greenhouse Gas Inventory for England, Scotland, Wales and Northern Ireland: 1990-2014, AEA Technology; http://naei.defra.gov.uk/reports/

[8] "Scottish Greenhouse Gas Emissions 2014" Official Statistics – published in June 2016: http://www.gov.scot/Publications/2016/06/2307

[9] While not relevant to the transport sector, the full inventory includes the three other greenhouse gases - Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs) and Sulphur hexafluoride ($SF_6$).

In line with the methodology used to report against the Climate Change (Scotland) Act, the transport emissions reported in this section only cover emissions at the point of use (tailpipe emissions). Consequently, no lifecycle or displaced impacts, such as the emissions generated by the electricity used on electrified railways, are included.

As well as including 2014 emissions data for the first time, the 2014 publication also updates emission estimates for all previous years, incorporating methodological changes and updates. As the emissions inventory contains no data for the periods 1991 to 1994, and from 1996 to 1997 inclusive gaps have been added to some graphs to more accurately show the rate of change over the entire time period.

**2.2. Total emissions trends for Scotland and the Scottish transport sector**

In 2014 total Scottish emissions from all sectors amounted to 46.7 $MtCO_2e$[10]. This total represents a 4.4 $MtCO_2e$ or 8.6% reduction from the 2013 figure. Compared to the 1990 base year Scotland has reduced its total emissions by 39.6%.

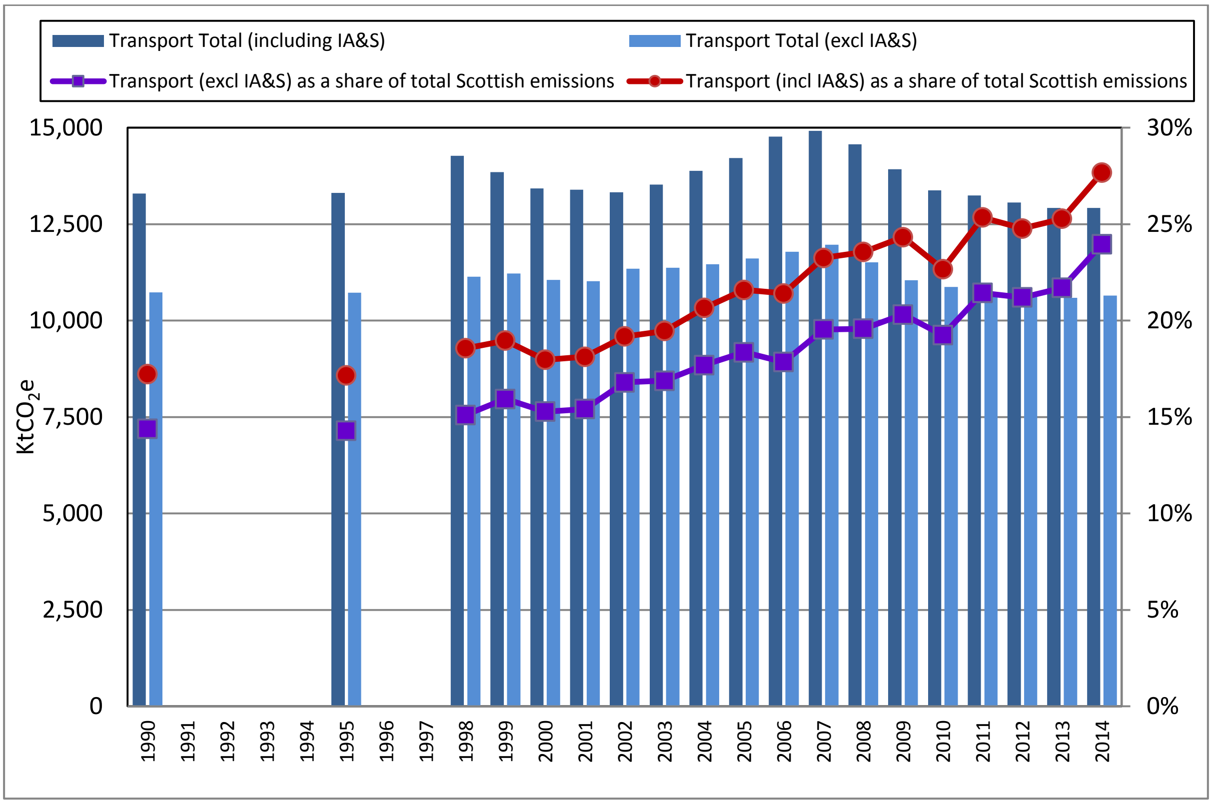
Transport's share of total emissions is 12.9 $MtCO_2e$. After almost continual increases in transport emissions from 1990, they peaked in 2007 at 14.9 $MtCO_2e$. Transport emissions have since fallen year on year and are now below their 1990 base year level of 13.2 $MtCO_2e$ and 13.3% below the 2007 peak.

The run in emissions reductions has been as a result of a number of factors. Principal among them was the consequences from the recession that began in 2008, and the slow recovery which followed. Further to this, investment in public transport infrastructure, improvements in fuel efficiency, government emissions policies, land-use planning and high global oil prices helped to cut transport emissions. However, global oil prices peaked in 2014 and began to fall significantly afterwards, which may have resulted in an increase in demand for fuel and travel.

[10] This calculation uses the unadjusted Scottish emissions total for 2014- i.e. excluding the impact of the EU Emissions Trading System (ETS). Including the ETS would lower Scotland's net emissions total and it is this adjusted total that is used in assessing Scotland's performance under the Climate Change (Scotland) Act.

With IAS emissions excluded, the transport sector accounts for 24% of all Scottish emissions. Including IAS, this proportion rises to just below 28%. Figure 1 illustrates the growing relative importance of transport emissions in Scotland's emissions total.

**Figure 1: Total emissions from transport and transport emissions as a percentage of total Scottish emissions, 1990-2014**




*Source: Greenhouse Gas Inventory, NAEI, 2016, Transport Scotland. Total emissions calculation excludes the impact of the EU Emissions Trading System.*

## 2.3 Emissions analysis by transport sector

### 2.3.1 Road Transport

Road transport emissions include all private, public and commercial road vehicles. This category accounts for 9.4 $MtCO_2e$, or 73% of transport emissions in 2014. This is marginally higher than the 2013 figure.

Figure 2 shows that road emissions followed a generally rising trend from 1990 to peak at 10.3 $MtCO_2e$ 2007. Since then, road emissions have fallen for five out of the seven years to 2014. Total road kilometres in 2014 were 2.8% higher than they were in 2007, implying an increase in fuel efficiency for road vehicles. Nonetheless, road emissions were almost 3% higher in 2014 than in 1990.

**Figure 2: Road transport emissions and road transport emissions as a share of total transport emissions, 1990-2014**

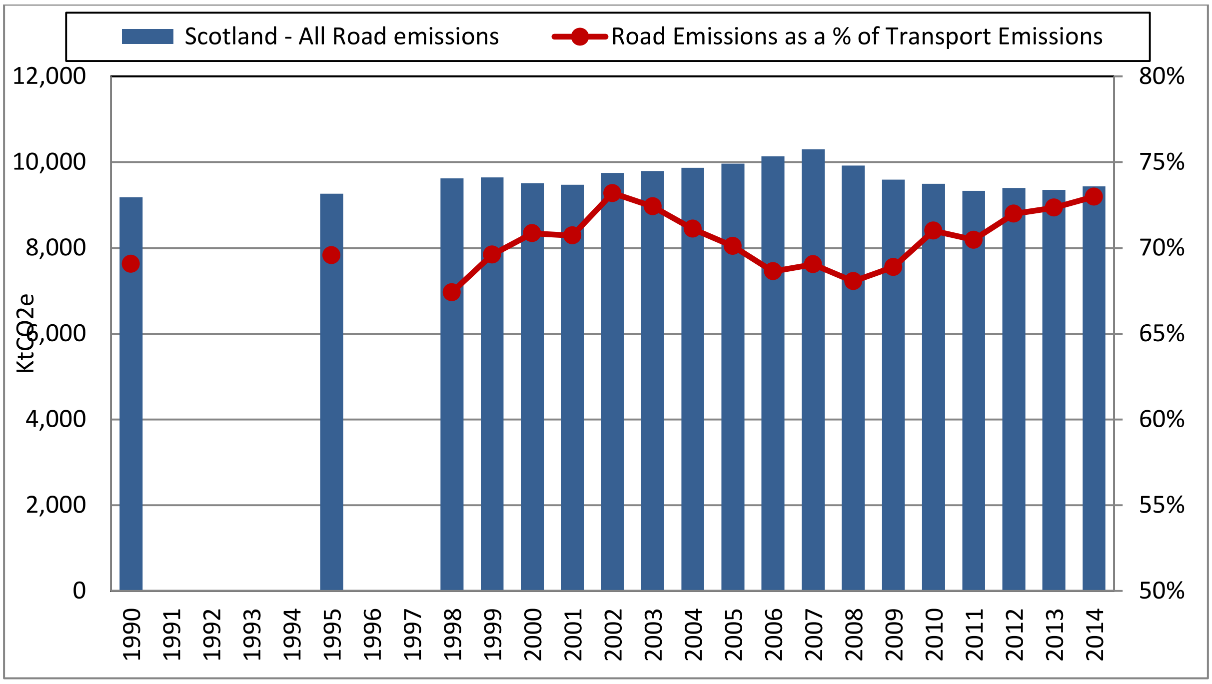



Figure 3 shows the growth in goods vehicle emissions relative to those of cars. While the share of road emissions from cars has fallen marginally between 1990 and 2014, total goods vehicle emissions have risen from just under 30% to just over 34% in the same period, with an increasing prominence for emissions from LGVs.

As well as reflecting improvements in fuel efficiency, car emissions have also been affected by a shift in fuel preferences. Diesel engines are more fuel efficient than their petrol equivalents, and so the increased proportion of the fleet fuelled by diesel since 1999 (as shown in figure 4) has resulted in a reduction in GHG emissions.

**Figure 3: Distribution of road transport emissions by mode – selected years**

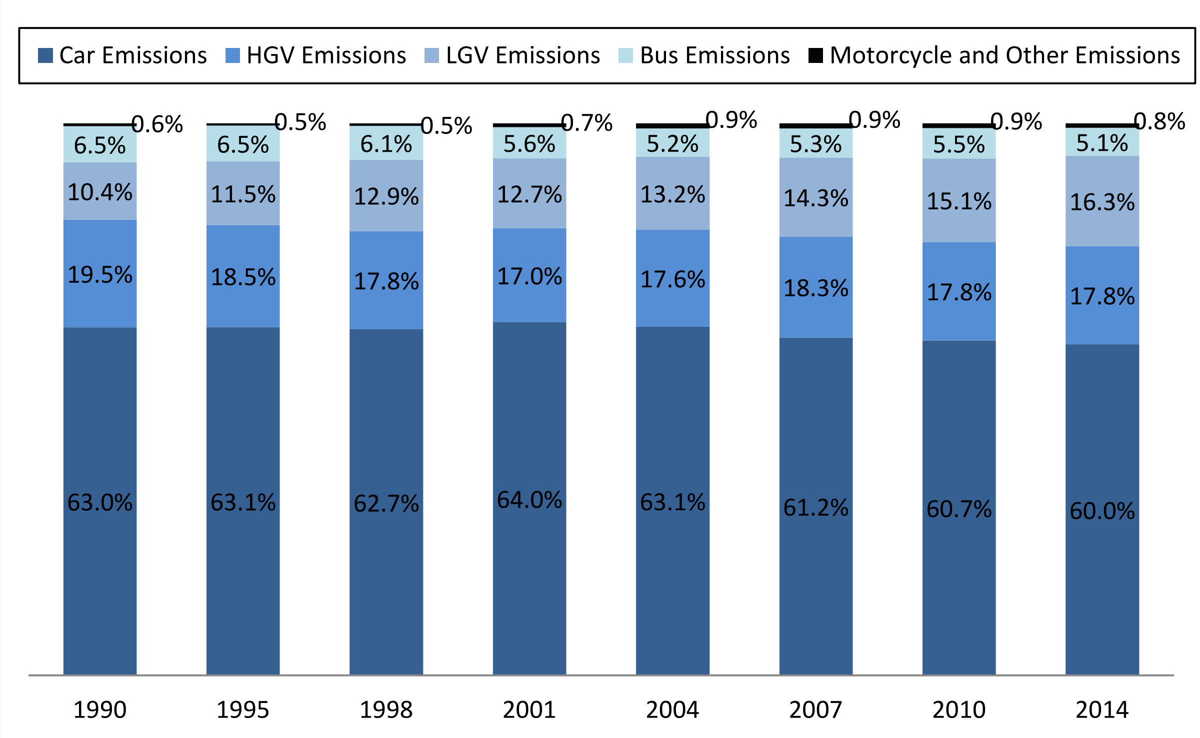
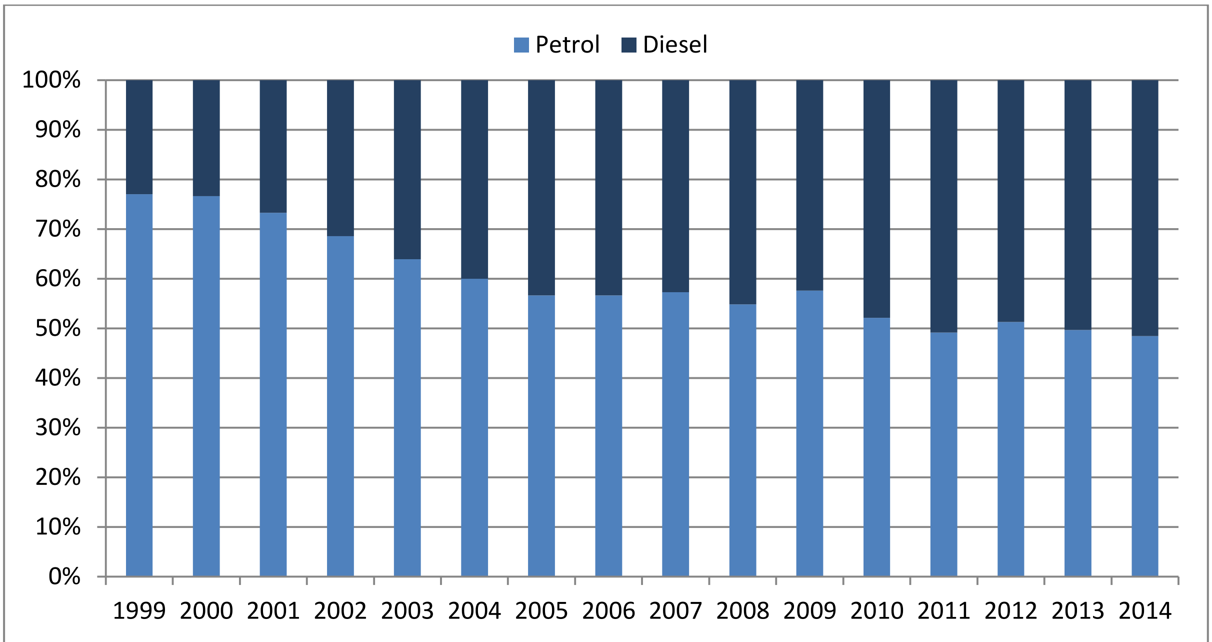



**Figure 4: Distribution of new Scottish registrations between petrol and diesel, 1999-2014 – all vehicle body types**

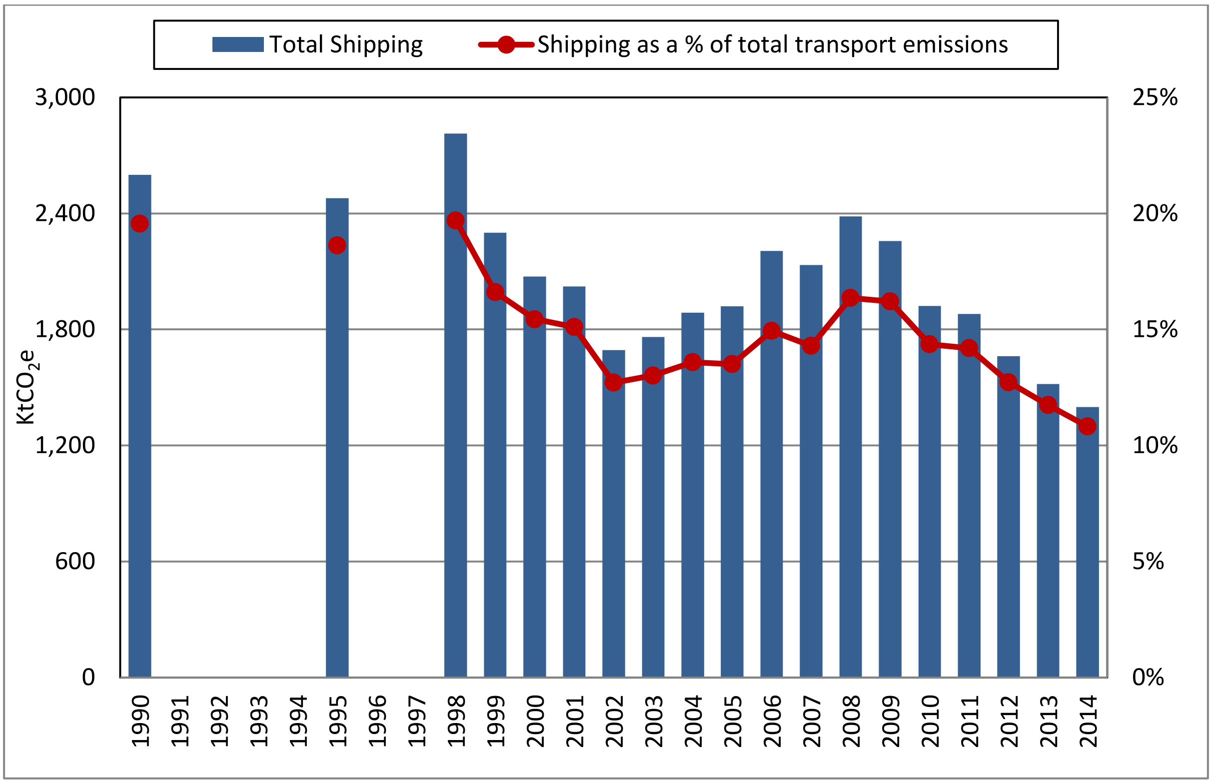



Should the split in new registrations between diesel and petrol settle around a 50:50 split, this year on year reduction in total emissions from switching to diesel will not continue. Further analysis of road transport emissions is undertaken in sections 2.4 and 2.5.

### 2.3.2 Maritime Transport

Emissions from maritime transport[11] in 2014 are estimated to be 1.4 $MtCO_2e$ or 11% of total transport emissions. Figure 5 shows that emissions from this sector have been volatile, due at least in part to methodological and GHG reporting changes.

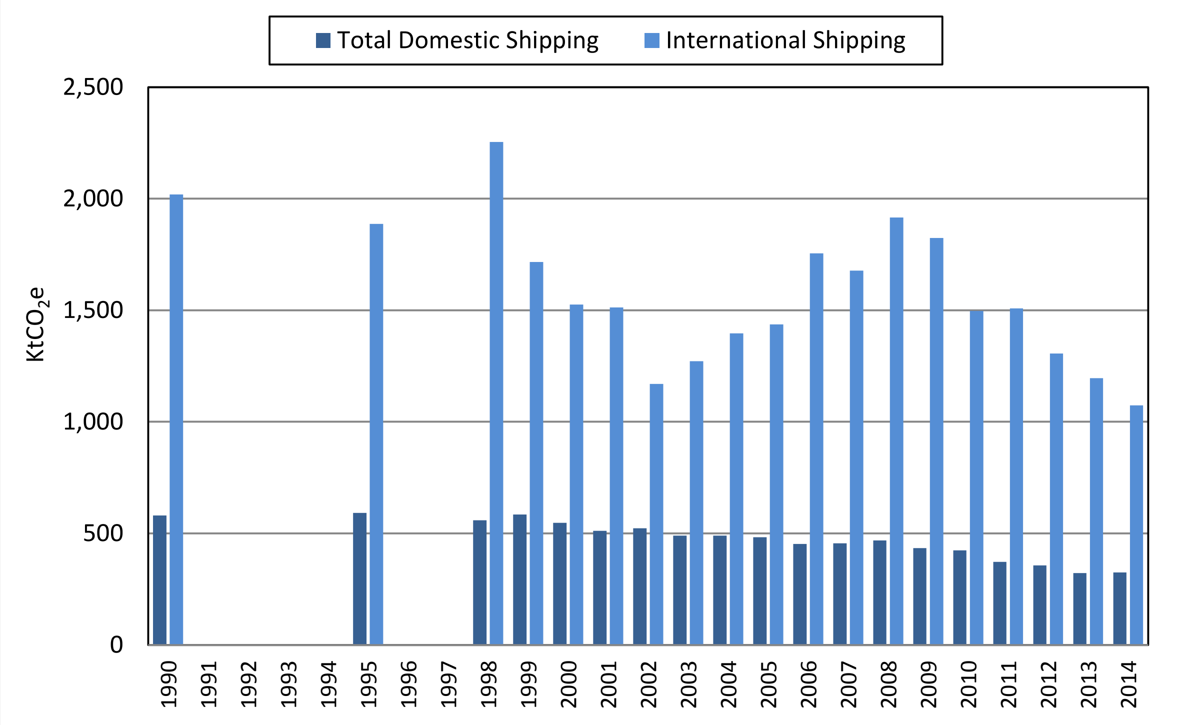
**Figure 5: Maritime transport emissions and maritime transport emissions as a share of total transport emissions, 1990-2014**




More recently, maritime emissions peaked at 2.4 $MtCO_2e$ in 2008 before falling to a new low in 2014, 46% below the 1990 figure. The volatility in the series can be attributed to the performance of international shipping sector (IS), which historically account for more than 70% of all maritime emissions, as indicated in figure 6. This figure also shows domestic maritime emissions decreasing over time.

[11] Includes national navigation and international shipping

**Figure 6: Comparison between domestic and international shipping emissions**




2.3.3 Aviation

In 2014 aviation emissions stood at 1.9 $MtCO_2e$. This represents an increase of less than 0.1 $MtCO_2e$ over 2013, but they now stand 38% above the equivalent 1990 figure, and account for 15% of all transport emissions. Figure 7 shows an increasing trend in emissions from 1990 to 2007, peaking at 2.3 $MtCO_2e$ before the recent recession led to lower annual emissions until 2010. There has subsequently been a slow increase in aviation emissions.

Figure 8 shows that from 1998 to 2004 emissions from domestic and international aviation were very similar. The series have since diverged. In 2014 international aviation emissions are estimated to account for 63% of total Scottish aviation emissions, almost the reverse of the proportion in 1990 when it was domestic aviation emissions that accounted for 61% of aviation's total. Between 2013 and 2014 domestic aviation emissions are estimated to have continued to decline (by 4.0%) with emissions from international aviation rising by 5.5%.

**Figure 7: Aviation transport emissions and aviation transport emissions as a share of total transport emissions, 1990-2014**

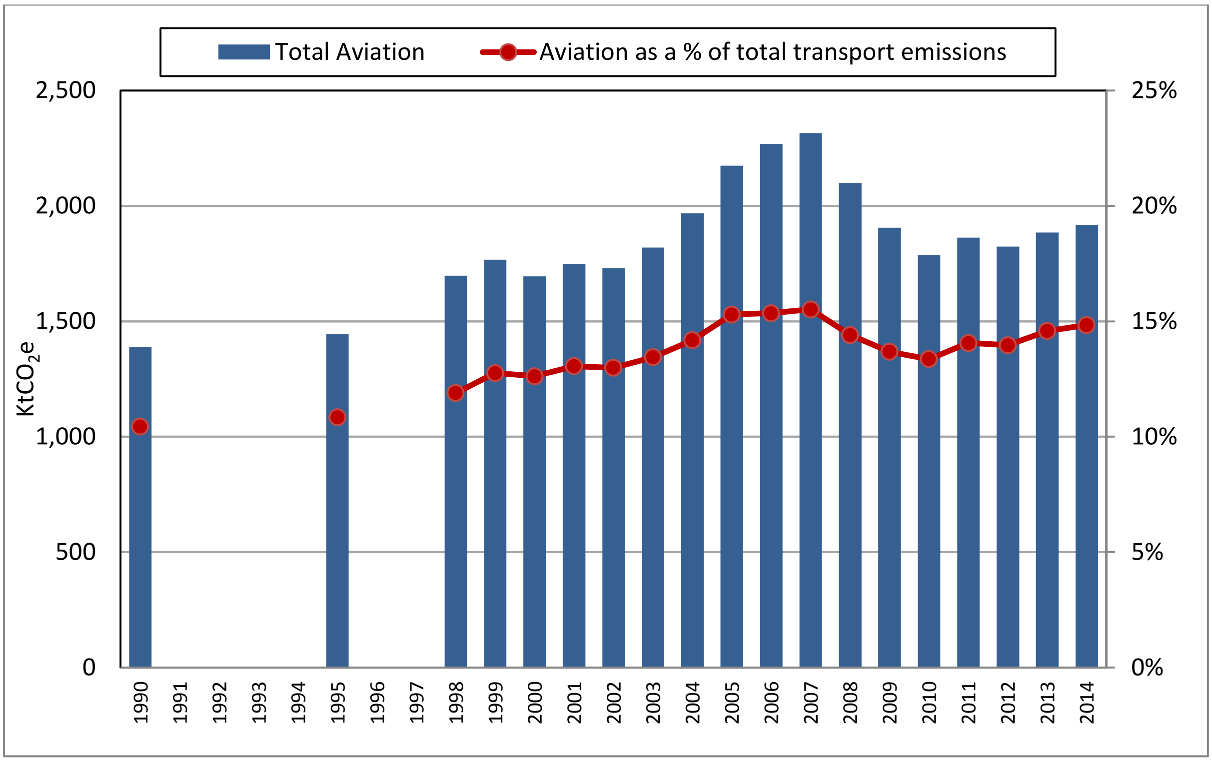
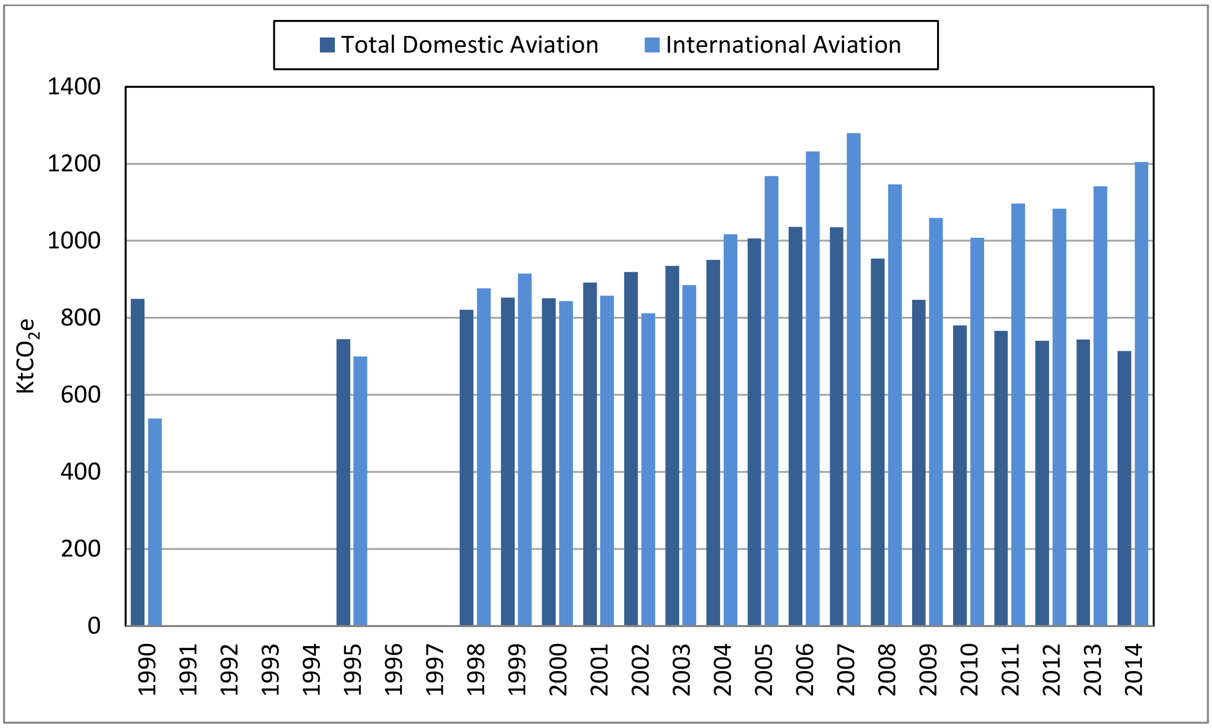



**Figure 8: Comparison between domestic and international aviation emissions**



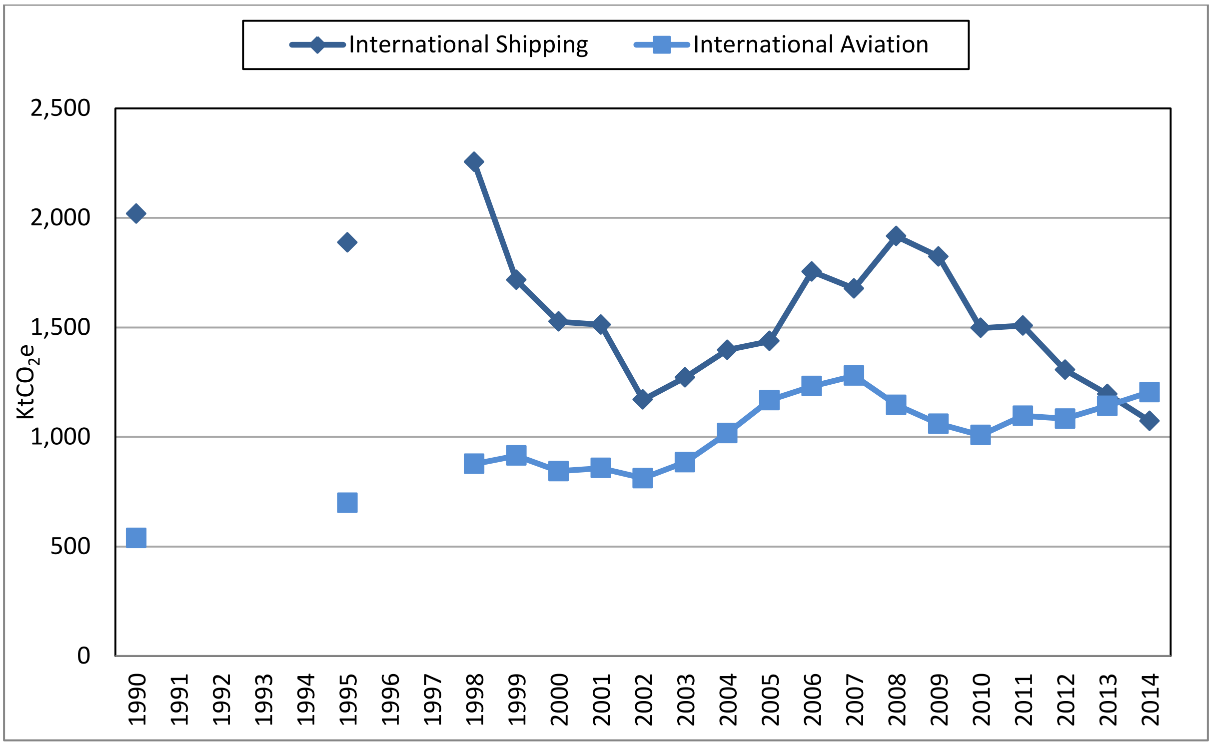
### 2.3.4 International Aviation and Shipping

After peaking in 2008 at 3.1 $MtCO_2e$, emissions from IAS were 0.8 $MtCO_2e$ lower in 2014 at 2.3 $MtCO_2e$. The 2014 figure is marginally lower than the 2013 figure (by approximately 0.06 $MtCO_2e$) and 11% below the 1990 figure. Between 2007 and 2010 the number of international flights from Scotland fell by 13.9% and emissions from international aviation fell by 21.2%. In the four years since 2010, international flight departures have risen by 18% and international aviation emissions are up by almost 19.5% or 0.2 $MtCO_2e$.

The estimates for IS emissions fell by 10% in 2014 to just below 1.1 $MtCO_2e$. This 2014 figure is the lowest figure since 2008 and 0.95 $MtCO_2e$ below the 1990 base year estimate.

The split in emissions between the two modes has changed over time with the share of the total coming from aviation rising from 21% in 1990 to almost 53% in 2014.

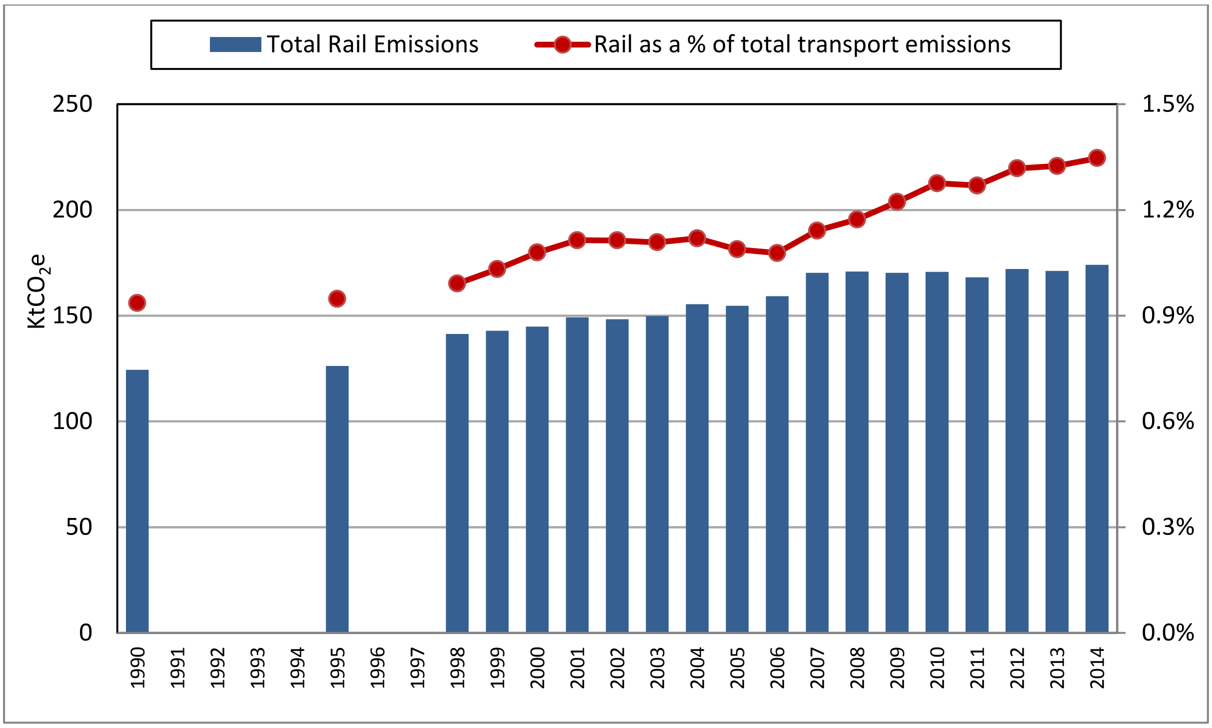
**Figure 9: International maritime and aviation emissions, 1990-2014**



2.3.5 Rail

Rail emissions in 2014 remain under 0.2 $MtCO_2e$, which is 1.35% of all transport emissions in Scotland. However, this is 40.0% above the 1990 figure. Total passenger kilometres travelled by rail have increased by 50% for the period 2003-04 to 2014-15[12] and scheduled train kilometres have increased by 22% over the same period.

**Figure 10: Rail transport emissions and rail transport emissions as a share of total transport emissions, 1990 - 2014**




## 2.4 Road emissions by vehicle type[13]

*2.4.1 Cars*

Emissions from cars have fallen from a peak of 6.3 $MtCO_2e$ in 2007 to an estimated 5.7 $MtCO_2e$ in 2014. Over the period 2002-2014, car kilometres have risen from 33.1 billion kms to 34.4 billion kms while emissions over the same period have fallen by from 6.3 $MtCO_2e$ to 5.7 $MtCO_2e$. Despite this fall, car emissions continue to account

[12] Source: Scottish Transport Statistics, No 34, 2015 Edition, Table 7.1
[13] For a full definition of exact vehicle types see: DfT vehicle definitions

for the greatest proportion of road transport emissions at 60% and almost 44% of all transport emissions in Scotland.

*2.4.2 Heavy Goods Vehicles*

HGV emissions make up the second largest proportion of road emissions at 1.68 $MtCO_2e$ in 2014. HGV emissions fell slowly between 1990 and 2001 before growing again, peaking at 1.88 Mt $CO_2e$ in 2007. HGV emissions have fluctuated around 1.7 $MtCO_2e$ since 2009.

*2.4.3 Light Goods Vehicles*

There has been a 61% increase in LGV emissions since 1990. At 1.54 $MtCO_2e$ in 2014, LGV emissions account for 16% of road emissions and 12% of total transport emissions. Emissions increased by over 4% between 2013 and 2014 in line with the steady year on year increase in vehicle kilometres of this group.

*2.4.4 Buses*

Emissions from buses have been flat since 2011 at just under 0.5 $MtCO_2e$; 0.1 $MtCO_2e$ (19%) below the 1990 figure. Vehicle kilometres were stable between 2013 and 2014 but there was a 2.4% drop in passenger journeys.

*2.4.5 Motorcycles*

Motorcycle emissions only accounted for 0.034 $MtCO_2e$ - 0.36% of road emissions and 0.26% of total transport emissions. Emissions from motorcycles have always been so small so as not to significantly impact on total Scottish transport emissions.

Figures 11, 12 and 13 illustrate the changes in road emissions by vehicle type, the share of each vehicle type in total road emissions and the year in year change in car, HGV and LGV emissions respectively.

Figure 11 shows that increasing goods vehicles emissions largely drove the increase in road emissions to 2007. The decline in emissions since then can be mainly attributed to cars. The change in shares between vehicle types between 1990 and 2014 can be seen in Figure 12.

Figure 13 shows that whereas previously changes in emissions tended to move in the same direction within a particular year this relationship seems to be less apparent in more recent years.  The growth in van kilometres compared to other modes appears to generate the strongest recent trend.

**Figure 11: Breakdown of road emissions by vehicle type, selected years**

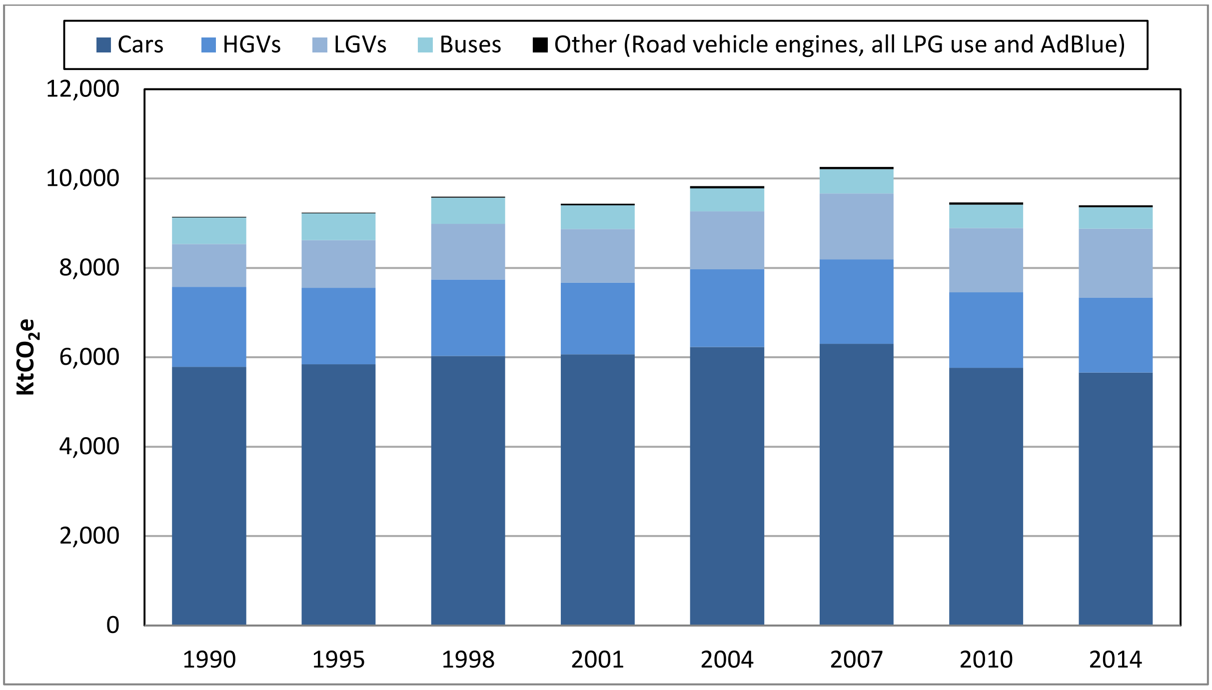
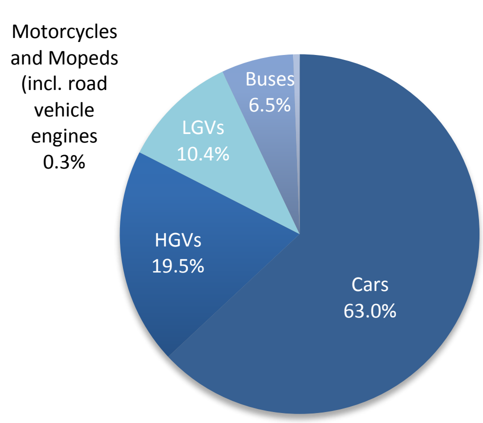



**Figure 12: Share of road emissions by vehicle type in 1990 and 2014**

1990–total emissions 9.2 $MtCO_2e$




2014–total emissions 9.4 $MtCO_2e$

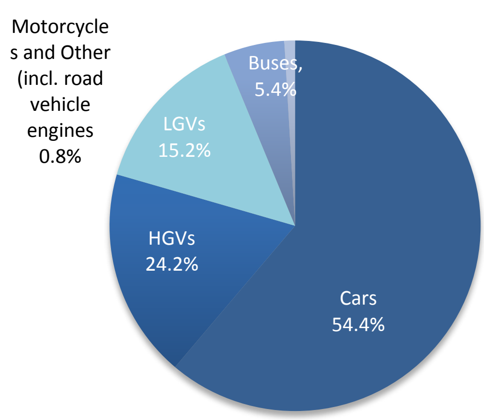
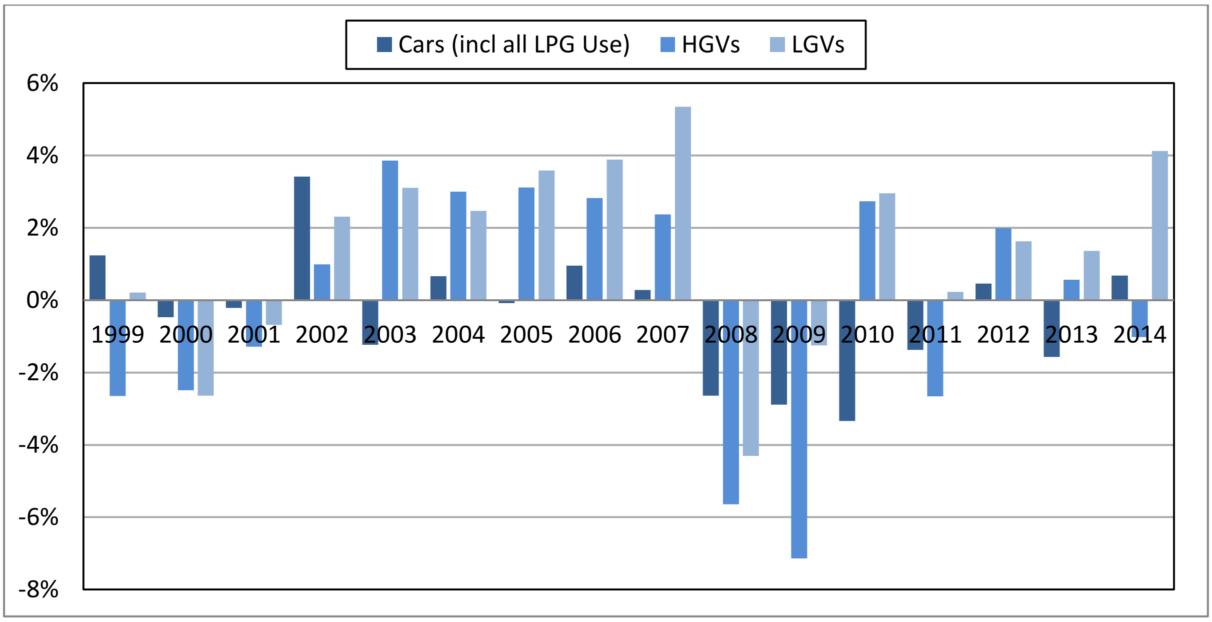


**Figure 13: Year on year change in car, HGV and LGV emissions 1999-2014**




## 2.5 Road emissions by road type[14]

### *2.5.1 Rural*

2014 halted the downward trend in rural that began after 2007. This 2014 emissions estimate of 4.6 $MtCO_2e$ is the same at the 1990 estimate. Rural emissions account for 49% of total road emissions.

### *2.5.2 Urban*

At just under 3 $MtCO_2e$ in 2014, urban emissions are 12% below their 1990 level of 3.4 $MtCO_2e$, an emissions figure that was last recorded in 2007. Emissions from urban traffic account for just under 32% of road emissions.

### *2.5.3 Motorway*

At 1.8 $MtCO_2e$ or 19%, emissions from motorway traffic account for the smallest proportion of 2014 road emissions. However, they are currently at their highest annual figure since 1990. Emissions from motorway traffic have increased by 59% over the 1990 figure (Figure 14).

[14] Rural areas are defined as major and minor roads outside urban areas. Urban areas are defined as having a population of more than 10,000 people. Motorways are a separate classification.

**Figure 14: Emissions by road type (Index=1990 for each road type)**

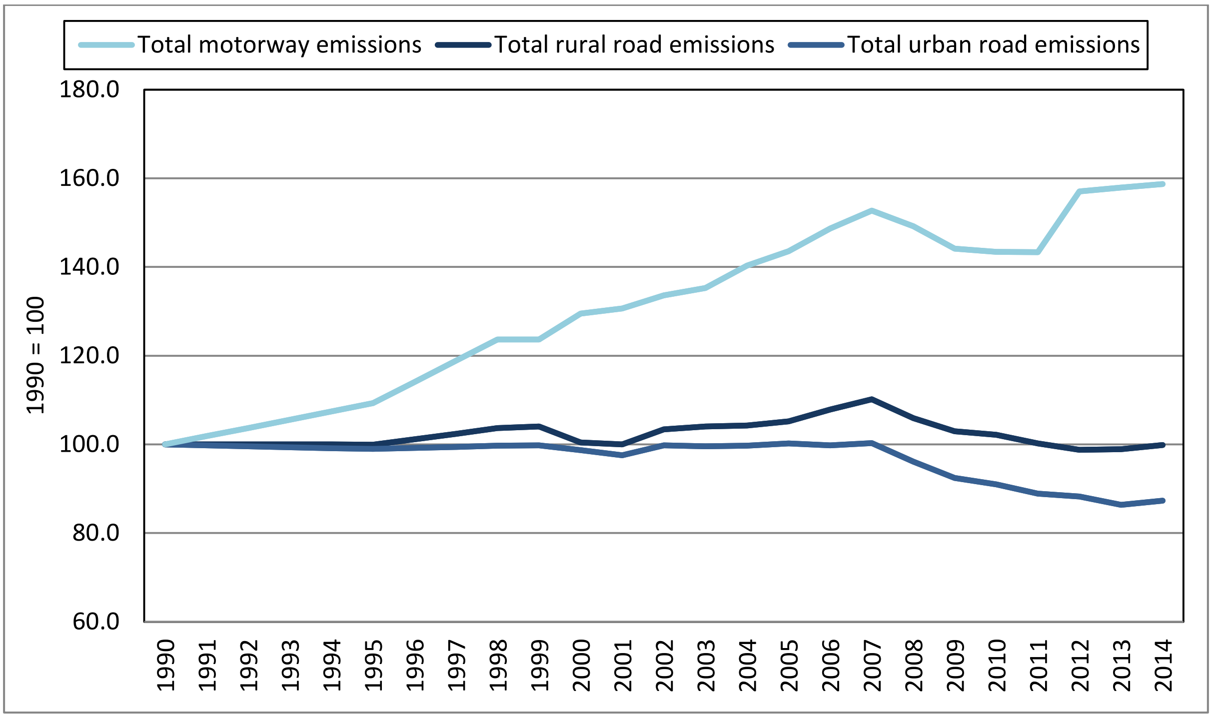
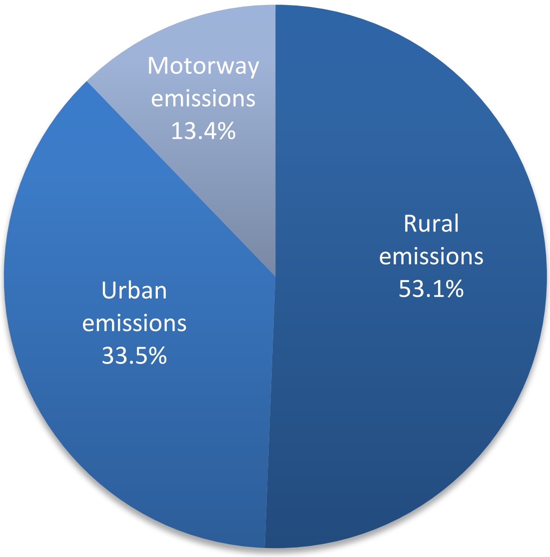
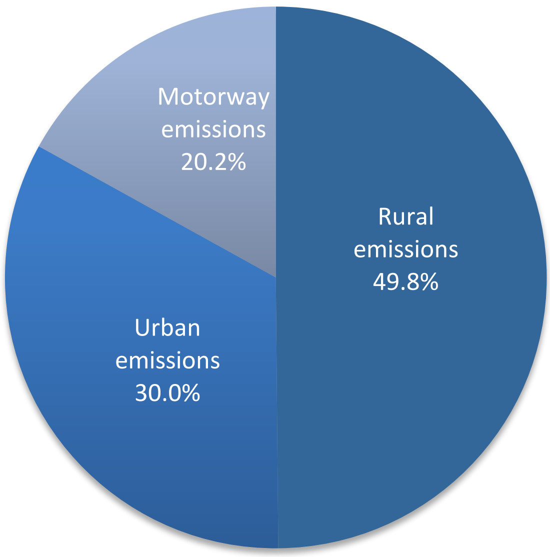



**Figure 15: Share of road emissions by road type**




1990 Share by road type




2014 Share by road type

**Analysis of Low Emission Car and Van Sector**

Given that road vehicles and cars and vans in particular generate the greatest proportion of carbon emissions (73%), it is impossible to meet the ambitious targets in the Climate Change Act without a fundamental transformation in how such vehicles are powered.

There are now a range of vehicles on the market which use a variety of technologies to produce lower, or in some cases zero emissions. Of these, this section of the report will focus on two: Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs).

Plug-in Hybrid Electric Vehicles have two engines; one of which is an electric engine powered by a battery, and another which is a conventional internal combustion engine (ICE). The vehicle can run on one alone, or both can operate together to drive it. PHEVs differ from other forms of hybrid in that the battery which powers the electric motor is charged from an external power source in addition to any electricity generated through the internal combustion engine.

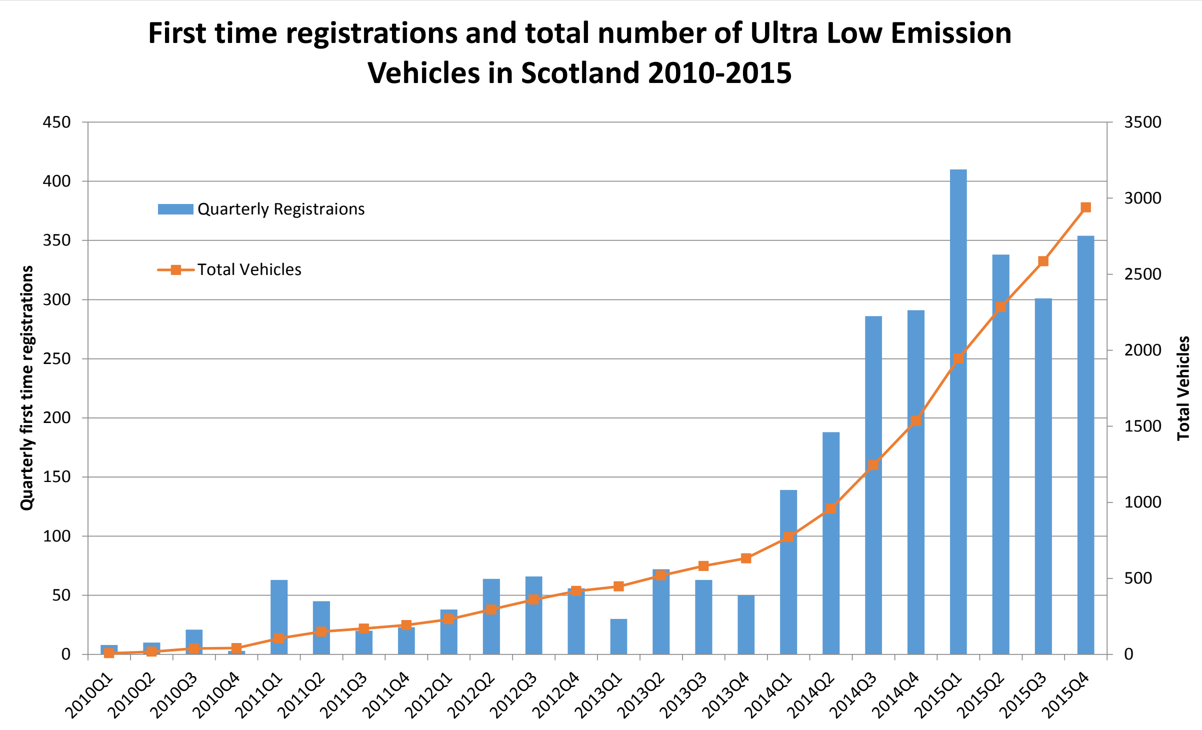
The result in emissions terms is that PHEVs generate lower carbon emissions than their ICE driven counterparts, especially over short journeys which can solely use the electric (i.e. zero emissions) powertrain.

BEVs are solely powered by a rechargeable battery, which can be recharged from an external power source. Such vehicles generate no emissions whatsoever during their operation. A key issue with currently available BEVs is the range capacity of the battery (typically around 100 miles although range is dependent on factors such as driving style and temperature). While this is not an issue for the overwhelming majority of current trips, for longer trips drivers become more reliant on publically available charging points. Research has shown that “range anxiety” is a significant factor for those considering buying a BEV, even if they very rarely make journeys beyond the range of the current battery.

The graph below shows the number of hybrid electric, and electricity powered vehicles registered in Scotland since 2010.

**Incentives to drive a PHEV or BEV**

There are currently a number of incentives and advantages available to assist with the purchase and running of PHEV and BEV cars and vans. The Plug-in Vehicle Grant offers drivers up to 35% of the cost of a new BEV or PHEV, up to a limit of £2,500 or £4,500 dependent on the model. Grants are also available to assist in the purchase of a van covering up to 20% of the cost with an upper cash limit of £8,000.




Source Department for Transport: The Department for Transport uses the term 'ultra-low emission vehicles' to refer to vehicles with significantly lower levels of tailpipe emissions than conventional vehicles. In practice, the term currently refers to electric, plug-in hybrid and hydrogen fuel-cell vehicles. For the purposes of this indicator, vehicles with fully electric powertrains, and cars with tail-pipe emissions below 75 g/km of $CO_2$ have been included at this stage.

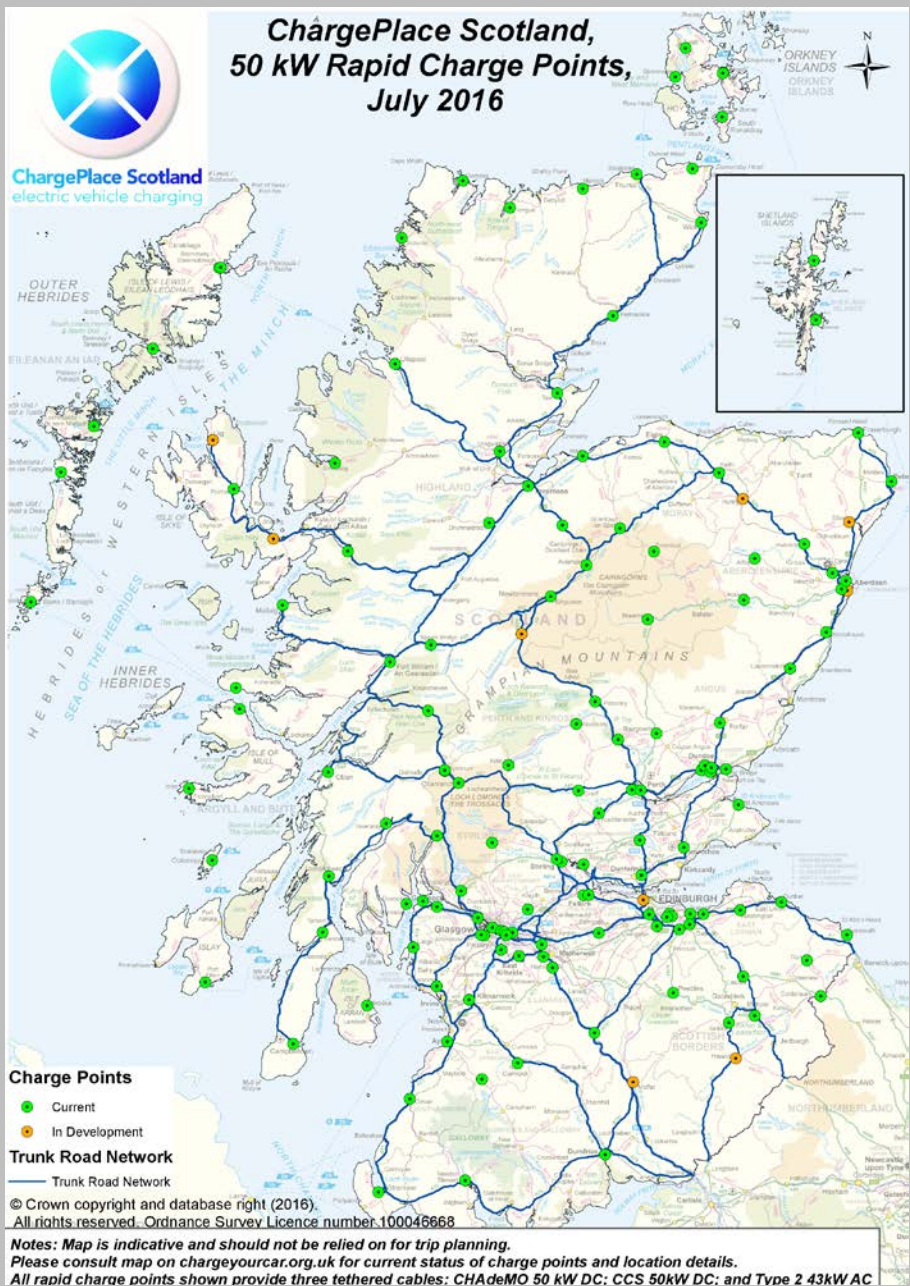
Sales have been boosted in Scotland by the provision of interest-free loans for BEV and PHEVs scheme, which are enabling individuals and businesses to make the switch. Furthermore, plug-in vehicles are currently exempt from VED, although this will change in 2017, as well as being exempt from schemes such as the London Congestion Charge. Company car tax is also lower for low emission vehicles.

The cost of running a BEV can be lower than that of a conventional ICE car 2-3p per mile compared to 16p per mile and the servicing and maintenance costs can be lower too.

**Re-charging Infrastructure**

The Scottish Government’s Second Report on Proposals and Policies (RPP2) states the intention to have a charging infrastructure in place in Scottish cities by 2020. The ChargePlace Scotland network of publically available EV charging infrastructure has expanded to over 600 points, equating to over 1200 charging bays. This includes over 150 ‘rapid’ charge points, one of the most comprehensive networks in Europe.

The map shows the distribution of these “rapid” charge points across Scotland (as at July 2016).




**Popular Plug In Vehicles**

Across the UK the most popular plug-in vehicle in the UK is the Mitsubishi Outlander PHEV, with approximately 25,000 units on the road in 2016. The most popular BEV in the UK is the Nissan Leaf, which is also the world’s most popular all-electric vehicle, with approximately 240,000 units sold since its introduction to market in 2010.

More manufacturers and more models are expected to be released onto the UK market in the next couple of years increasing the options for consumers.

## 2.6 Comparison of key Scottish and UK transport emission statistics

Table 1 sets out a number of comparisons between UK and Scottish emissions by broad sector or category, and over both the short and longer term.

**Table 1: Comparison of Scottish and UK GHG emissions**

| | Scottish emissions 2014 (ktCO2e) | Scottish emissions as a % of UK emissions 2014 | Change in Scottish emissions (2013-14) | Change in UK emissions (2013-14) | Change in Scottish emissions (1990-2014) | Change in UK emissions (1990-2014) |
|---|---|---|---|---|---|---|
| All Transport | 12,924 | 8.2% | 0.0% | 0.4% | -2.8% | 8.4% |
| All Transport (excl. IAS) | 10,646 | 9.0% | 0.5% | 1.1% | -0.8% | -3.3% |
| | | | | | | |
| Road Transport | 9,434 | 8.6% | 0.9% | 1.4% | 2.7% | -1.2% |
| *of which*: | | | | | | |
| Cars | 5,658 | 8.3% | 0.7% | 0.8% | -2.3% | -5.1% |
| HGVs | 1,675 | 9.0% | -1.0% | 1.4% | -6.3% | -9.1% |
| LGVs | 1,542 | 8.9% | 4.1% | 4.0% | 61.2% | 48.1% |
| Bus and coach | 480 | 12.5% | -0.1% | -0.7% | -19.5% | -27.0% |
| Motorcycles | 34 | 6.5% | 4.5% | 3.9% | -2.3% | -32.4% |
| | | | | | | |
| Rural | 4,629 | 10.8% | 1.0% | 2.1% | -0.1% | 2.4% |
| Urban | 2,969 | 7.3% | 1.0% | 1.0% | -12.7% | -17.2% |
| Motorway | 1,776 | 7.1% | 0.5% | 0.8% | 58.7% | 29.7% |
| | | | | | | |
| Rail Transport | 174 | 7.9% | 1.7% | 1.3% | 40.0% | 4.2% |
| | | | | | | |
| Aviation Transport | 622 | 20.7% | -5.0% | -8.6% | -22.2% | -44.2% |
| Aviation Transport (incl. IA) | 1,918 | 5.3% | 1.7% | -0.1% | 38.2% | 72.1% |
| Maritime Transport | 325 | 11.0% | 0.8% | 0.1% | -44.0% | -19.6% |
| Maritime Transport (incl. IS) | 1,398 | 13.3% | -7.9% | -7.0% | -46.2% | -15.2% |

- In 2014 Scottish transport emissions, including IAS, accounted for an estimated 8.2% of total UK transport emissions and 9.0% of emissions if IAS is excluded.
- The share of emissions from buses, traffic on rural roads, domestic and international maritime combined and from domestic aviation are disproportionately greater in Scotland than in the UK as a whole, with the opposite holding true for motorway emissions and international aviation. The shares in other categories are broadly similar to the overall picture.
- Between the 1990 base year and 2014, transport emissions in Scotland have fallen by 2.8% whereas for the UK as a whole they have risen by 8.4%.

Without the inclusion of IAS the improvement for the UK as a whole (-3.3%) is greater than for Scotland alone (-0.8%)

- Over time, all sub-categories of Scottish transport emissions have tended to change broadly in line with the equivalent UK series.
- A number of sub categories (vans, motorway emissions, rail, bus and coach and international aviation) have seen sharp rises in emissions over the period 1990-2014 but in absolute terms it is only for vans and international aviation where the increase has been particularly significant.
- Total Scottish (Domestic and International) aviation emissions account for 5.3% of the total UK aviation emissions, but 20.7% of total UK domestic aviation emissions. This is to be expected given the relative importance of international aviation traffic (and emissions) in England in particular relative to Scotland.
- Emissions from domestic maritime transport in Scotland fell by 7.9% between 2013 and 2014, a similar but slightly greater reduction than the UK figure over the same period (7.0%). With IS included, maritime emissions in Scotland and for the UK are notably below their respective 1990 figures.

Breaking down the UK estimates to the four home countries sheds a little more light on Scotland's performance relative to England, Wales and Northern Ireland.

- Compared with the 1990 base year, the Scottish aggregate emissions total (incl. IAS) shows a decrease of 2.8%. This is less of a reduction than in Wales but better than the outcome in both England and in N. Ireland where emissions have risen over the same period.
- Between 2013 and 2014 all four countries saw small increases in emissions, excluding International Aviation and Shipping.

**Table 2: Comparison of Scottish, English Welsh and Northern Irish GHG emissions from transport 1990 – 2014 and 2013 – 2014**

| | | | Road | Rail | Aviation | Aviation (incl.IA) | Maritime | Maritime (incl. IS) | All Transport | All Transport (incl. IAS) |
|---|---|---|---|---|---|---|---|---|---|---|
| SCOTLAND | Emissions | 2014 | 9,434 | 174 | 714 | 1,918 | 325 | 1,398 | 10,646 | 12,924 |
| | Change in emissions | 2013-14 | 0.9% | 1.7% | -4.0% | 1.7% | 0.8% | -7.9% | 0.5% | 0.0% |
| | | 1990-2014 | 2.7% | 40.0% | -16.0% | 38.2% | -44.0% | -46.2% | -0.8% | -2.8% |
| ENGLAND | Emissions | 2014 | 90,361 | 1,734 | 2,537 | 34,082 | 2,312 | 7,620 | 96,944 | 133,798 |
| | Change in emissions | 2013-14 | 1.4% | 1.3% | -7.2% | -0.1% | 0.4% | -5.5% | 1.1% | 0.6% |
| | | 1990-2014 | -2.7% | -0.5% | -42.2% | 76.8% | -15.1% | -7.0% | -4.7% | 9.6% |
| WALES | Emissions | 2014 | 5,547 | 97 | 63 | 125 | 216 | 1,023 | 5,923 | 6,792 |
| | Change in emissions | 2013-14 | 1.7% | 1.3% | -11.6% | -11.3% | -4.2% | -15.0% | 1.3% | -1.5% |
| | | 1990-2014 | -0.6% | 40.5% | -63.9% | -50.5% | -20.0% | -13.3% | -2.8% | -4.1% |
| N.IRELAND | Emissions | 2014 | 3,955 | 39 | 233 | 340 | 110 | 133 | 4,338 | 4,467 |
| | Change in emissions | 2013-14 | 1.2% | 2.2% | -11.0% | -7.7% | 1.0% | 0.6% | 0.5% | 0.5% |
| | | 1990-2014 | 33.6% | 55.1% | 0.6% | 6.1% | 0.7% | 12.0% | 30.4% | 30.4% |

## 2.7 Efficiency of passenger vehicles

Measuring the efficiency of passenger vehicles in terms of the $CO_2$e per passenger kilometre (ppkm)[15] provides another useful lens for considering transport emissions.

According to UK Company Reporting Guidelines[16], on average a UK coach generates the least emissions per passenger kilometre at 29g $CO_2$e/ppkm, followed by rail at 49g $CO_2$e/ppkm. The average diesel and petrol car produces emissions of 122g $CO_2$e/ppkm and 128g $CO_2$e/ppkm respectively; emissions levels per kilometre which are only exceeded by domestic flights at 147g $CO_2$e/ppkm.

Table 5 also shows that, over time, almost all modes are seeing improvements in emissions per passenger kilometre, with rail and aviation seeing double digit

[15] Emissions per passenger kilometre are calculated as the distance a vehicle travels and its fuel efficiency divided by the number of occupants travelling that distance.

[16] 2015 Government GHG Conversion Factors for Company Reporting https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2016 (Advanced user set).

improvements in performance. Since 1999 average car occupancy has fallen by 11.2%[17], which has acted as a drag on the improved efficiency of the internal combustion engine in terms of emissions per passenger kilometre.

**Table 3: $CO_2$e emissions per passenger kilometre by mode[18]**

| Sector | Mode and fuel | gCO₂e/ppkm | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | 2016 | % Change 2012-2016 |
| Road | Average petrol car | 134 | 131 | 128 | 127 | 128 | -4.3% |
| | Average diesel car | 124 | 121 | 123 | 121 | 122 | -1.4% |
| | Average petrol hybrid car | 89 | 87 | 89 | 85 | 88 | -0.6% |
| | Average petrol motorbike | 119 | 119 | 120 | 120 | 120 | 0.7% |
| | Average bus | 112 | 112 | 109 | 109 | 102 | -9.1% |
| | Average coach | 29 | 29 | 29 | 29 | 29 | -0.2% |
| Rail | National rail | 58 | 49 | 47 | 45 | 49 | -16.0% |
| | Light rail and tram | 68 | 60 | 62 | 55 | 54 | -20.6% |
| Ferry (Large RoPax) | Average foot and car passengers | 116 | 116 | 116 | 116 | 116 | 0.0% |
| Aviation | Average domestic flights | 180 | 173 | 155 | 158 | 147 | -18.1% |
| | Average short haul international | 104 | 102 | 88 | 90 | 89 | -14.2% |
| | Average long haul international | 119 | 120 | 111 | 105 | 101 | -14.7% |

*Source: Government Conversion factors for company reporting (advanced users workbook), available at https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2016*

## 2.8 Leading indicators

Data on Scottish greenhouse gas emissions emerges around 18 months after the end of the year in question.  Unfortunately, there are not a large number of Scottish lead indicators that throw much light on performance in the period after the latest emissions data to the present date, but those that are available, including UK series, are reported and discussed below.

- *Scottish road vehicle kilometres travelled*: This indicator tracks vehicle kilometres travelled by all vehicle types on all roads. Road emissions are

[17] Source: *Transport and Travel in Scotland 2015*, available at http://www.transport.gov.scot/report/j450918-00.htm Table TD9.
[18] All car figures assume the average car occupancy rate published in *Transport and Travel in Scotland 2015* for each respective year regardless of engine type. Bus and coach figures assume an average vehicle occupancy rate based on Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting.

directly related to the kilometres travelled. From 2007 to 2011 total kilometres travelled annually in Scotland declined slowly.  Since then, they have increased marginally year on year and in 2015 surpassed the previous peak in 2007.

- *Sales of Plug in Grant eligible cars*: This indicator includes electric and hybrid vehicle and produce less GHG emissions per kilometre travelled. An increase in the proportion of such vehicles on the road will reduce average transport emissions. It is calculated from the number of newly registered cars that received the Plug-in Grant.  The latest data shows that 2015 saw a sharp increase in sales of 56% over 2015, and this trend has continued into 2016. However, alternatively fuelled vehicles still represent a very small proportion of total registered vehicles in Scotland (0.6%) and proportion of total vehicle kilometres travelled.

- *Aviation movements*: Emissions from international aviation in particular have grown rapidly over the past 20 years. This indicator tracks the total number of aviation movements at Scottish airports (take-off and landing), which shows a small decrease of approximately 0.6% between 2014 and 2015.

- *2015 UK provisional emissions estimates*:  Provisional UK emissions data for 2015 has been published, while the Scottish emissions inventory for 2015 will not be available until June 2017.  The provisional UK transport estimate shows a small increase in emissions of 1.4%. This is the second consecutive year of growth in this indicator, continuing the reversal on a downward trend in emissions that began after 2007.  There is currently no estimate available for 2015 emissions from International Aviation and Shipping. Though there tends to be a strong correlation between emissions movements at the UK and Scottish levels, there is no guarantee of this, particularly when international emissions figures are unavailable and form a significant proportion of Scottish transport emissions.

- *UK domestic transport fuel consumption*: This indicator tracks total transport fuel sales and shows that total sales in 2015 increased by 2.1% on the previous year. Improved fuel efficiency will reduce emissions per kilometre travelled, but if overall road kilometres are rising along with fuel consumption emissions from road transport are likely to increase.
- *Average CO2/km of cars registered for first time:* As internal combustion engines becomes more fuel efficient and an increasing proportion of cars use alternative fuels, the average emissions of a newly registered car will fall. Table 4 shows falling emissions per kilometre for both petrol and diesel engines between 2014 and 2015.
- *Scottish GDP: Q2 2015 to Q2 2016:* over the year to the end of the second quarter of 2016 Scottish GDP grew by 0.7%. This indicates that growth is slowing in comparison to previous years. Because economic performance and emissions remain strongly linked, slower GDP growth is likely to result in slower emissions growth.
- *Scottish forecourt pump prices October 2015 to October 2016:* prices of both petrol and diesel increased in the above period by 4.9% and 4.7% respectively which is likely to have a marginally negative impact on sales figures.

Together, the available indicators suggest that achieving reductions in Scottish transport emissions is becoming more challenging, with a number of these key leading indicators suggesting a possible increase in emissions. As cars become a smaller share of total transport emissions so the aggregate impact of the measures to reduce emissions from car declines and other sectors such as goods vehicles and aviation become relatively more important to the overall position in transport.

### Table 4: Trends in leading transport indicators

| Indicator | 2014 | 2015 | Average growth p.a. | Growth |
|---|---|---|---|---|
| | | | (2003-2015) | (2014-2015) |
| Road vehicle kilometres travelled (million vehicle kilometres) | 44.5 | 45.0 | 0.6% | 1.3% |
| Sales of Plug in Grant eligible cars (Scotland) | 834 | 1298 | - | 55.6% |
| Aircraft movements | 482,878 | 480,070 | 1.4% | -0.6% |
| UK transport emissions (excl. IAS) ($MtCO_2e$) | 116.6 | 118.3 | -0.6% | 1.4% |
| UK domestic transport fuel consumption (million tonnes) | 35.001 | 35.738 | -0.9% | 2.1% |
| Average CO2/km of petrol cars registered for the first time | 128.4 | 126.7 | *2003 Data Unavailable* | -1.4% |
| Average CO2/km of diesel cars registered for the first time | 122.8 | 120.7 | *2003 Data Unavailable* | -1.7% |

| | | | | Growth |
|---|---|---|---|---|
| Scottish year-on-year GVA growth (to Q2 2016) | - | - | - | 0.7% |
| Scottish year-on-year change in a) petrol and b) diesel prices (October 15 - October 16) | | | | a) 4.9%<br>b) 4.7% |

# Chapter 3: Future emissions impact of transport interventions

## 3.1 Background

This chapter lists transport interventions, whether devolved or reserved to the UK/EU, which are firm commitments and are expected to have a direct and significant impact on Scottish transport emissions in the future. The interventions are separated between infrastructure projects, and fiscal and regulatory measures. The emissions impact estimates used here are sourced from the available project or policy documents, and have been rounded to the nearest kilo-tonne of carbon-dioxide equivalent ($ktCO_2e$) where appropriate.

This chapter also outlines the general methodological approach or background documents used to estimate the impact of infrastructure projects and fiscal/regulatory policies. As independently commissioned projects, the precise estimation methodology of each infrastructure project may differ significantly depending upon the type of intervention and the modelling approach adopted. Second, emissions estimates are frequently assessed in isolation, and therefore will not necessarily include the full interactions between measures, or take account of the impact of any future measures on the project. Finally, for many interventions there are likely to be a number of localised impacts which may not be captured or presented consistently between infrastructure appraisals. Where possible, the impacts presented are the net emissions impact at a Scottish level.

With such methodological variation, the emissions impact from each infrastructure project and related timescales are intended as an informative guide to the direction of change and an order of magnitude only. The basis of each fiscal estimate is not known beyond what is presented in the accompanying document(s). As a result the comparison, addition or netting off of emissions estimates between interventions or against the GHGI data is not statistically valid and may lead to incorrect conclusions being drawn**.**

## 3.2 Infrastructure projects

Undertaken by Transport Scotland and announced by The Minister for Transport, Infrastructure and Climate Change in December 2008, the Strategic Transport Projects Review (STPR) sets out investment priorities for the next twenty years and provides the basis on which Ministers can make informed decisions about future transport spending. The nature of this publication means that while some projects are now underway and others completed, many will be undertaken at a future date and thus as yet lack a designated timetable and a formal appraisal process. Individual projects from within STPR likely to have a significant emission impact will be included in the CAT commentary as and when they become committed schemes.

**Methodology for measuring environmental impacts**

Estimates of the environmental impacts from each infrastructure project are cited from the latest available project documents. In most cases this will be the emissions estimate contained in the project specific environmental statement. More recently announced projects will have no estimate because the formal appraisal process has not yet been undertaken. For reference, links to the project home page on Transport Scotland's website are also provided where they are available.

STAG recommends that greenhouse gas emissions from road traffic are calculated according to the methodology in the Design Manual for Roads and Bridges[19] (DMRB). First introduced in 1992 in England and Wales, and subsequently in the rest of the UK, it continues to provide a comprehensive manual system which accommodates current standards, advice notes and other published documents relating to trunk road works.

For emissions associated with the running of diesel and electric trains, STAG recommends the use of the Rail Emission Model Final Report[20] produced for the Strategic Rail Authority. This is available on the Department for Transport website,

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[19] Design Manual for Roads and Bridges (2009): Highways Agency Design Manual for Roads and Bridges (DMRB)
[20] Rail Emission Model (2001), AEA Technology Environment

and provides estimated emission factors and detailed data for individual diesel and electric train types.

There are no similar established guidelines for producing carbon estimates for other travel modes. Should such a need arise, the methodology used would be tailored specifically to the individual projects concerned. Similarly, when considering the predicted emissions impacts of infrastructure projects, the modelling procedures used can differ significantly between projects, particularly in how they account for secondary impacts such as land-use changes.

## Road

### M8, M74 and M73 Motorway Improvements Project

http://www.transportscotland.gov.uk/road/projects/m8m73m74

Following award of the contract to Scottish Roads Partnership (SRP) in February 2014, the M8, M73 and M74 Motorway Improvements Project is underway, and scheduled to open in Spring 2017. This project encompasses three individual sub-projects: M8 Baillieston to Newhouse, M74 Raith Interchange, and M8 M73 M74 Network Improvements.

SRP anticipate that the project will create in excess of 1,000 jobs in Scotland, with the motorway improvements project expected to reduce the journey time for the 100,000 vehicles that use the busiest sections of the M8 each day.

It is predicted that the scheme will lead to a reduction of more than 100 accidents per year, and more freely flowing traffic on strategic routes will reduce emissions associated with queuing traffic. This will also improve air quality and health.

#### M74 Raith Interchange

- Document: Environmental Statement (2007), Mouchel Fairhurst JV
- Anticipated construction completion: 2017

- Estimated emissions impact: +10kt$CO_2$e p.a. from 2017; +10kt$CO_2$e p.a. from 2020

The scheme is aligned with the M8 Baillieston to Newhouse works and the Associated Network Improvements**.** These are vital links in the trunk road network of Central Scotland and serve substantial existing developments as well as some of the most significant future development sites in Scotland.

Severe traffic problems exist at Raith Junction due to the interaction of heavy turning volumes from the A725 and the M74 at the signalised roundabout. This scheme aims to relieve traffic congestion at the junction creating free-flow conditions on the A725.

**M8 M73 M74 Network Improvements**

- Document: Environmental Statement, 2008 (Mouchel Fairhurst JV)
- Anticipated construction completion: 2017
- Estimated emissions impact: +2kt$CO_2$e p.a. by 2020

This scheme comprises capacity improvements on sections of the M73, M74 and M8 adjacent to Baillieston and Maryville interchanges as a result of changes to east-west traffic patterns following completion of the M74 and once improvements to the M8 are in place.

**M8 Baillieston to Newhouse**

- Document: Environmental Statement (2007), Mouchel Fairhurst JV
- Anticipated construction completion: 2017
- Estimated emissions impact: +30kt$CO_2$e p.a. from 2017; +30kt$CO_2$e p.a. from 2020

This project is to upgrade the existing A8 between Baillieston and Newhouse to dual three-lane motorway standard equivalent.

The DMRB was used to calculate the change in greenhouse gas emissions, therefore the assessment has included all traffic on the entire modelled network, in addition to links that were explicitly included in the local assessment. The increase in emissions is due to an increase in predicted traffic levels.

**A90 Aberdeen Western Peripheral Route (AWPR) and A90 Balmedie-Tipperty**

http://www.awpr.co.uk/

- AWPR Document: Assessment of Effects of Updated Traffic Model submitted for PLI (2008), which updates previous source of 2007 Environmental Statement, Jacobs
- Balmedie - Tipperty Document: Environmental Statement (2007), Grontmij / Natural Capital
- The A90 Aberdeen Western Peripheral Route and the A90 Balmedie to Tipperty projects were combined into a single scheme prior to being tendered.
- Anticipated construction completion: Construction of the scheme commenced in February 2015 following award of the contract to Aberdeen Roads Limited. The first section of the AWPR/B-T works to open to traffic included the Craibstone and Dyce Junctions in August 2016. This section was brought forward following requests from stakeholders and subsequent discussions with the contractor. The Balmedie to Tipperty section is scheduled to open by Spring 2017 with the remainder of the AWPR/B-T expected to open to traffic in winter 2017.
- Estimated emissions impact for AWPR: +8kt$CO_2$e p.a. from 2012; +10kt$CO_2$e p.a. from 2027. For Balmedie- Tipperty : +2kt$CO_2$e p.a. from 2010 (assumed opening year in environmental statement)

A peripheral route around Aberdeen will reduce the high volumes of traffic using the A90 in the centre of Aberdeen, and reduce the traffic congestion that the city experiences as a result of the volume of traffic using the A90 and its associated radial roads. The overall increase in the number of road vehicles, however, is expected to lead to an increase in carbon dioxide emissions.

The AWPR will provide substantial benefits across the whole of the North East of Scotland and will provide a boost to the economy; increase business and tourism opportunities; improve safety; cut congestion as well as increasing opportunities for improvements in public transport facilities.

This proposed dualling of the A90 between Balmedie and Tipperty will provide continuous dual carriageway between Aberdeen and Ellon, which will remove the bottleneck caused by the existing single carriageway. The local community has been pressing for this upgrade for a number of years. The increase in emissions through Balmedie -Tipperty is mainly due to the increase in the road sections that make up the total road network assessed.

**Forth Replacement Crossing**

- http://www.transportscotland.gov.uk/project/forth-replacement-crossing
  Document: Forth Replacement Crossing Environmental Statement (2009), Jacobs Arup
- Anticipated construction completion: 2017
- Estimated emissions impact: +20kt$CO_2$e p.a. in 2032

The Forth Replacement Crossing (FRC) is a major road infrastructure project being delivered by Transport Scotland. The project was driven by uncertainty over the future viability of the existing Forth Road Bridge, and is designed to safeguard this vital connection in Scotland's transport network. It comprises a new cable-stayed bridge across the Firth of Forth (the Queensferry Crossing), to the west of the existing Forth Road Bridge, and associated new and improved road infrastructure to the north and south of the bridge. The scheme will retain the existing Forth Road Bridge as a public transport corridor for use by buses, taxis and other specified users and for continued use by pedestrians and cyclists. The Queensferry Crossing will be used by all other traffic including private cars and heavy goods vehicles. Emergency vehicles will be able to use either bridge.

The FRC was identified as a key strategic investment project in Scotland's national transport network in the Strategic Transport Projects Review (STPR) undertaken by Transport Scotland in December 2008, and the National Planning Framework (NPF2) published by the Scottish Government in June 2009. There are eight specific transport planning objectives for the FRC which have underpinned the work on the project. These are to:

- maintain cross-Forth transport links for all modes to at least the level of service offered in 2006
- connect to the strategic transport network to aid optimisation of the network as a whole
- improve the reliability of journey times for all modes
- increase travel choices and improve integration across modes to encourage modal shift of people and goods
- improve accessibility and social inclusion
- minimise the impacts of maintenance on the effective operation of the transport network
- support sustainable development and economic growth
- minimise the impact on people, and the natural and cultural heritage of the Forth area.

Construction commenced in 2011 and the FRC will open in 2017.

**Dualling of A9**

- Document: Environmental Statement: not yet available
- Anticipated construction completion: 2025
- Estimated emissions impact: not yet available

This programme will address issues of driver frustration on the A9 caused by the limited guaranteed overtaking opportunities that current exist, resulting in improved connections between Perth and Inverness. Options for the proposed dual carriageway are currently being developed but it is likely that it will largely comprise on-line widening due to the environmental and physical constraints in the corridor.

It is too early to say how $CO_2$e emissions may change as a result of the scheme. Design development work is now underway and the emerging findings are that the dualling will increase emissions as a consequence of changes to vehicle speeds. Quantification of that impact across the programme is not yet available and a number of route options are still being assessed. Quantification will take place as part of the preparation of the Environmental Statements for the component projects.

**Dualling of A96**

Document: Environmental Statement: not yet available

- Anticipated construction completion: 2030
- Estimated emissions impact: not yet available

This programme will address issues of driver frustration on the A96 caused by the limited availability of overtaking opportunities. It will also address issues of community severance by introducing bypasses to communities along the route. Both objectives will serve to improve connectivity between Inverness and Aberdeen. Baseline information and constraints mapping collated to support future option development for the proposed dual carriageway. Route option development and assessment on the Hardmuir to Fochabers section underway with a preferred option for Inverness to Nairn (including Nairn Bypass) announced in October 2014.

Given the likelihood of extended lengths of dual carriageway to provide bypasses it is likely that $CO_2$e emissions will increase as a result of the scheme. However further work will be undertaken during the design development to understand changes to vehicle speeds and their consequences for emissions before and after the scheme is in place.

**Rail**

**Edinburgh-Glasgow (Rail) Improvements Programme**

http://www.transportscotland.gov.uk/project/egip

- Document: Edinburgh Glasgow Improvement Programme (EGIP) Appraisal and Analysis Model (2013), Transport Scotland.
- Anticipated construction completion: In phases through to 2028.

**Embodied emissions** (construction)**:**

| **Total impact (2013 – 2028) (kt$CO_2$e)** | |
|---|---|
| Phase 1 | +112 |
| Phase 1 + 2 | +123 |

**Operational emissions** [21]:

| **Average annual impact from 2017 (kt$CO_2$e)** | |
|---|---|
| Phase 1 | -28[22] |
| Phase 1 + 2 | -33 |

| **Total impact (kt$CO_2$e)** | **By 2025** | **By 2050** | **By 2078** |
|---|---|---|---|
| Phase 1 | -237 | -956 | -1760 |
| Phase 1 + 2 | -262 | -1095 | -2028 |

This intervention was identified early in the Strategic Transport Projects Review (STPR) and brought forward in a study that considered improvements to the capacity, frequency and journey time of rail services between Edinburgh and Glasgow.

The Edinburgh Glasgow Improvement Programme is expected to result in a significant reduction of carbon emissions through the electrification of approximately 260 km of single track and the move from diesel to electric trains.
The change in $CO_2$e emissions has been calculated in line with guidance from the Department for Energy and Climate Change. Previous estimates derived from the Network Modelling Framework (NMF) have been revised to account for reduced fuel consumption/increased fuel efficiency estimates for class 170 diesel trains (reducing

[21] To be consistent with the scope of this document, the average annual and total savings relate to emissions in the transport sector only and exclude increased emissions in the electricity sector associated with electrification. When including these emissions, the estimated net impact for Scotland remains at lower emissions over the long term.
[22] A negative impact indicates a carbon emission saving.

EGIP operational emission savings) and the latest changes to WebTag parameter values that have increased the calculated displaced car emissions (increasing EGIP operational emission savings).

Once the project is fully completed (phase 1 + 2) by 2028, the projected long term annual reduction of road emissions is approximately **3kt$CO_2$e**.

The programme achieves emissions reductions and also transfers emissions from non-traded (e.g. car emissions) sectors to traded sectors (e.g. electricity generation).

If both electricity emissions and those from embodied carbon are included, the total net impact of EGIP (phase 1 + 2) is **-1529 kt$CO_2$e** by 2078. Of this total, **-1847 kt$CO_2$e** arises from diesel savings from trains removed from the rail network, **+376** from the new electric trains added to the rail network and **-181 kt$CO_2$e** from cars removed from the road network. Table 5 demonstrates further breakdown of the expected emissions impact across the different sectors.

**Table 5: Change in emissions as a result of EGIP, by sector (kt$CO_2$e)**

| Budget Period | Operational | | | | Embodied** | |
|---|---|---|---|---|---|---|
| | Transport sector | | Non-transport sector* | | | |
| | Phase 1 | Phase 1 +2 | Phase 1 | Phase 1 + 2 | Phase 1 | Phase 1 + 2 |
| 2013 - 2017 | -17 | -19 | +12 | +12 | +92 | +92 |
| 2018 - 2022 | -133 | -146 | +90 | +90 | +20 | +20 |
| 2023 onwards | -1610 | -1863 | +240 | +274 | 0 | +11 |
| Total | -1760 | -2028 | +342 | +376 | +112 | +123 |

* Electricity production and distribution sector
** Primarily manufacturing and construction

**Aberdeen to Inverness**
www.aberdeeninverness.co.uk
www.transport.gov.scot/rail

- Document: Not yet available
- Environmental Statement: not yet available
- Anticipated construction completion: In phases through to 2030
- Estimated emissions impact: not yet available

This project will deliver significant journey time improvements and greater connectivity for both passenger and freight services operating on the Aberdeen to Inverness rail corridor.  It is too early to say how $CO_2$e emissions may change as a result of the improvement project.  Further work will be undertaken during the design development to understand the impact the increased frequency and additional services will have on emissions following their introduction.

**Highland Mainline**

- Document: Not yet available
- Environmental Statement: not yet available
- Anticipated construction completion: In phases through to 2025
- Estimated emissions impact: not yet available

This project will deliver significant journey time improvements and greater connectivity for both passenger and freight services operating between Inverness and the Central belt. It is too early to say how $CO_2$e emissions may change as a result of the improvement project.  Further work will be undertaken during the design development to understand the impact the increased frequency and additional services will have on emissions following their introduction.

**Shotts Electrification**

- Document: Not yet available
- Environmental Statement: not yet available
- Anticipated construction completion: By end of March 2019
- Estimated emissions impact: not yet available

Route clearance work is currently being undertaken in advance of the award of contract for the actual electrification works. The route is currently served by diesel multiple units (DMU). When construction works have been completed, a new fleet of electric multiple units (EMU) will be deployed. The route will also benefit from a reduction in journey times. The environmental and emissions impacts are not yet available.

**Table 6: Estimated net emissions impact of individual transport infrastructure projects**

| Project title | Published emissions estimate |
|---|---|
| M74 Raith Interchange | +10 kt$CO_2$e p.a. from 2020 |
| M8 M73 and M74 Network Improvements | +2 kt$CO_2$e p.a. by 2020 |
| M8 Baillieston-Newhouse | +30 kt$CO_2$e p.a. from 2020 |
| A90 Balmedie-Tipperty | +2 kt$CO_2$e p.a. from 2010* |
| A90 Aberdeen Western Peripheral Road | +10 kt$CO_2$e p.a. from 2027 |
| Forth Replacement Crossing | +20 kt$CO_2$e p.a. in 2032 |
| Edinburgh-Glasgow (Rail) Improvements Programme | -33 kt$CO_2$e from 2017** |

* This was the assumed opening date at the time of the environmental statement
** Impact from operational emissions
The emission estimates within this table are forecast changes in carbon dioxide emissions with the project compared to without the project in a given future assessment year. These estimates have been calculated using a variety of methodologies and, consequently, it is not statistically valid to aggregate the individual figures or directly compare them with one another.

## 3.3 Fiscal / regulatory measures

The current split between devolved and reserved powers means that the majority of fiscal and regulatory decisions that impact on Scottish transport emissions are taken at either the UK or EU level. However, the areas which Scottish Ministers have direct control over are still extremely important for emissions performance, particularly in respect of investment behavioural change and mode switching. These are vital component of long term emissions reductions because they involves the removal of key barriers that could affect the significant uptake of ultra-low or zero carbon vehicles by households and switching to more efficient and active modes of travel. Furthermore, The Scottish Parliament now has the power to legislate for a tax to replace the currently UK-wide Air Passenger Duty (APD) in Scotland. The new Air Departure Tax (ADT) is scheduled to come into effect from April 2018.

Published in June 2013, the Second Report on Proposals and Policies provides the most up to date and comprehensive analysis and assessment of these Scottish policies and the potential impact these measures can have on emissions out until 2027[23]. The impact of tightening EU car and van emissions standards and the Renewable Fuels Transport Obligation are also covered within the RPP's analysis.

With a narrower focus on road transport emissions, and particularly on the transition from reliance on fossil-fuelled vehicles towards plug-in cars and vans, *Switched on Scotland* [24] sets out the necessary steps and barriers to be overcome on the pathway to the almost complete decarbonisation of road transport. The recently published review of *Switched on Scotland* considers the progress made since the publication of the original document. [25] Following a period of consultation with partners across the public and private sectors, a refreshed plug-in vehicle action plan will be published by Spring 2017.

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[23] http://www.scotland.gov.uk/Publications/2013/06/6387/9
[24] Switched on Scotland
[25] Switched on Scotland 2016 Review

It is more difficult to ascertain the potential emissions impact in Scotland from UK and (other) EU fiscal or regulatory measures, not least because the impacts are analysed and estimated at a more aggregate level. That said, some Scottish estimates have been generated and where available these are recorded below alongside the description of the policy intervention.

The best and most readily available sources of information for the remaining aggregate UK emissions impacts include published Impact Assessments, associated documents accompanying the annual HM Treasury (HMT) Budget and Autumn Statement/Pre-Budget reports, HMRC notes and the House of Commons Library for more general topic background and briefing.

**Air Passenger Duty (APD)**

Key documents and analysis:

- House of Commons Library Note SN5094 Air Passenger Duty: recent debates and reform http://www.parliament.uk/briefing-papers/SN05094/air-passenger-duty-recent-debates-reform
- APD Budget 2016: tax-related documents
- Overview of Tax Legislation and Rates
- Transport Scotland assessment on impact on emissions of reducing APD by 50% (2014) http://www.transportscotland.gov.uk/report/j340458-01.htm
- Estimated initial annual emissions impact: 0.05 $MtCO_2e$ to 0.06 $MtCO_2e$ in Scotland

Air passenger duty (APD) is charged on all passenger flights from almost all UK airports[26]. The rate of tax varies according to passenger destination and the class of passenger travel. Between 2009 and 2014 APD was structured around four distance bands, but in 2014 it was simplified to just two bands. Flights to a country with a capital city more than 2000 miles from London are now charged at the Band B rate, a shorter capital to capital distance would fall into Band A. This change is estimated in increase annual UK emissions by 0.3 MtCO2e but is unlikely to have a material impact on Scottish emissions as very few direct flights from Scotland were affected by this simplification in banding structure.

[26] Flights from Highland and Island airports are excluded

In May 2015 children under 12 travelling in the lowest class of travel became exempt from APD, and from March 2016 children who are under the age of 16 years on the date of the flight, and in the lowest class of travel, also became exempt. Children 16 years and over, or travelling in any other class, are chargeable passengers and APD is due. For 1 April 2017 rates will increase in line with inflation.

With powers over rates of APD being devolved to Scotland a Transport Scotland publication in 2014 estimated that cutting Scottish APD by 50% could lead to an annual increase in Scottish emissions of 0.05 MtCO2e to 0.06 MtCO2e[27].

**Inclusion of aviation in EU ETS**

Key documents and analysis:

http://ec.europa.eu/clima/policies/transport/aviation/index_en.htm

http://www.parliament.uk/briefing-papers/SN05533

- Implementation date: 2010
- Estimated emissions impact: up to - 183 Mt$CO_2$e p.a. in 2020 across Europe relative to no cap

The Aviation Greenhouse Gas Emissions Trading Scheme Regulations 2010 came into force in the UK on 31 August 2010. The inclusion of aviation within the emissions trading system allowed the sector to take responsibility for its carbon emissions in the most cost effective way. While it is difficult to predict the exact impact of the scheme, particularly with the ongoing economic uncertainties, earlier estimates made by the Commission suggest that the aviation cap could reduce emissions in 2020 by up to 183 million tonnes $CO_2$e.

The International Civil Aviation Organization (ICAO) agreed in 2013 to develop a global market-based mechanism to address international aviation emissions by 2016 and apply it by 2020. To allow time for the international negotiations, the EU ETS requirements were suspended for flights in 2012 to and from non-European countries. In the period 2013-2016, only emissions from flights within the EEA fell under the EU ETS. The impact of this revision on the Commission's original

[27] Estimate of the Impact on Emissions of a Reduction in Air Passenger Duty in Scotland | Transport Scotland

assessment of emissions reductions is unclear but the revision is unlikely to have any material effect on Scottish aviation emissions as the majority of flights from Scotland are within the EAA.

The ICAO agreement reached in October 2016 foresees the establishment of a Global Market-Based Measure (GMBM), which will oblige airlines to offset the growth of their CO2 emissions post-2020. To do so, airlines will buy "emission units" generated by projects reducing CO2 emissions in other sectors of the economy (e.g. renewable energies). All EU Member States will join from the start.

**Fuel duty**

Latest documents and analysis:

Budget 2016: fuel duty

https://www.gov.uk/government/news/rural-fuel-price-cut-begins

Due to high oil prices, Budget 2011 cut the fuel duty by one penny per litre and since then all increases in fuel duty have been cancelled. Up until 2014, this cancellation has been estimated to add 0.5 $MtCO_2e$ per annum to the UK emissions total compared to where it would otherwise have been. It should be noted that this gross impact from the cancellation of the fuel duty rise does not take account of the fluctuations wholesale fuel prices and therefore pump prices had on demand and therefore emissions, or the continued freeze in duty announced since the March 2014 budget.

From 31 May 2015 the Rural Fuel Rebate allowed customers in certain rural post codes to benefit from a cut of 5 pence per litre in the fuel price. Thirteen of the seventeen named post codes eligible for this cut are in Scotland, eleven in Highland and two in Argyll and Bute. The introduction if the Rural Fuel Rebate is unlikely to lead to a noticeable increase in emissions.

**Reform to vehicle excise duty**

Latest documents and analysis:

https://www.gov.uk/government/publications/vehicle-excise-duty/vehicle-excise-duty

Overview of Tax Legislation and Rates

- Budget 2016 HMRC documentation
- Estimated emissions impact of 2010 change: -0.9 $MtCO_2e$ by 2020
- Estimated impact of 2017 proposal:- not quantified

In April 2010, the Government introduced a new first-year rate of VED. Under this system, all cars emitting up to 130 g $CO_2e$ per km paid no VED in the first year. Cars emitting over 165 g $CO_2e$ per km paid additional VED in the first year. In 2016 only cars over 150 g $CO_2e$/km will see an increase in in VED. Together, these changes are estimated to result in a cumulative reduction in UK emissions of 0.9 $MtCO_2e$ by 2020, relative to where they would otherwise have been.

In 2017 a new VED banding system will be introduced. First year rates for newly registered cars will depend on $CO_2$ emissions. Thereafter all but zero emitting vehicles will pay £140 with a 5 year supplement of £310 for cars costing over £40,000. This is likely to have an initially small but negative impact on the emissions outcome with all but zero rated cars in 2017 seeing an increase in VED over their existing equivalent makes and models. The reverse is true for more polluting cars as newer cars will see a reduced rate of VED.

**Company car tax**

Latest documents and analysis:

Overview of Tax Legislation and Rates

- Anticipated implementation date: Ongoing
- Estimated emissions impact: Not quantified

The UK Government’s June 2010 budget set out to reform company car tax and provide incentives to purchase the lowest emitting vehicles on the market. This has been reinforced in subsequent budgets to incentivise the purchase and manufacture of ultra-low emission vehicles in the UK. The 2013 Budget set out rates for company cars emitting 75g $CO_2e$ per km or less from 2016-17 onwards and provides a commitment that in 2017-18 there will be a 3 percentage point differential between the 0-50 and 51-75 g/km $CO_2e$ bands and between the 51-75 and 76-94 g/km $CO_2e$

bands. The 2014 budget further lifted the percentage of a company car list price that would be subject to tax for cars emitting more than 75 g $CO_2$e /km.

This policy aims to encourage the purchase of ULEVs and hence contribute to the objectives of reducing greenhouse gas emissions from road transport. However, given that the market is at an early stage of development it is not possible to precisely estimate the impact on ULEV sales or emissions savings. That said the savings are likely to be small to begin with.

Subsequent budgets have further lifted the percentage of the car list price to be taxed although the increase in the rates on the most efficient cars are higher than for the least efficient over the next few years.

**Fuel benefit charge (FBC)**

- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/294190/OOTLAR_19_March_2014__1_.pdf
- Estimated emissions impact: Not quantified

The provision of free fuel to company car drivers provides a perverse environmental incentive. The aim of the fuel benefit charge is to tax this benefit as though it were income. The figure on which the calculation is based rises each year and for cars currently stands at £22,100. The van fuel benefit charge – on which tax on free van fuel is payable – stands at £594. The Government has committed to pre-announcing the FBC multiplier one year in advance and has announced that the FBC multipliers will increase in line with inflation in 2016 and 2017.

Table 7 summarises the previous information. As with Table 6, these emissions estimates are not produced using a single, consistent methodology so are not directly comparable.

**Table 7: Net emissions impact estimates of fiscal / regulatory measures**

| Project title | Published emissions estimate |
|---|---|
| Air passenger duty | i) -0.3Mt$CO_2$e p.a from 2015-16 (UK)<br>ii) +0.05 Mt$CO_2$ep.a in Scotland from 50% cut in APD |
| Inclusion of aviation in EU ETS | -183Mt$CO_2$e* p.a. in 2020 (Europe) |
| Fuel Duty | +0.5 Mt$CO_2$e p.a. by 2013 from two freezes (UK)<br>Negligible impact from Rural Fuel Rebate |
| Reform of Vehicle Excise Duty[28] | -0.9 Mt$CO_2$e total savings by 2020 (UK)<br>2017 proposal – impact not quantified |
| Company car tax | Not quantified |
| Fuel benefit charge | Not quantified |

The emission estimates within this table are forecast increases or decreases in carbon dioxide emissions with the policy compared to without the policy in a given future assessment year. These estimates have been calculated using a variety of methodologies and, consequently, it is not statistically valid to aggregate the individual figures or directly compare them with one another.
* Estimate from before the introduction of 'Stop the Clock' – see relevant section in EU ETS above

## 3.4 Projected net emissions impact from Scottish projects

The Carbon Account for Transport collates information from a variety of sources and outputs with one of the key sources being the findings generated from the application of the Scottish Transport Appraisal Guidance (STAG) to transport proposals. Two key concepts in STAG are that an appraisal:

- should be applied proportionately but comprehensively. The whole process should be used and the level of detail required will be determined by the scale of the impacts of the transport issue being addressed.

- should not prioritise between options. Instead, it is an aid to decision makers in order to make more informed choices. STAG may provide an initial rationale for investment and it is important that the STAG outcomes are revisited as the Business Case for an intervention develops.

[28] The impacts from both VED and company car tax contribute to the delivery of the savings from the EU regulation on $CO_2$ from cars, as opposed to representing additional savings.

As such, a study undertaken using STAG is not required to provide an absolute prediction of all of the outcomes of an intervention.  Instead, it provides sufficient information to understand the relative impacts between different options. The individual results cannot therefore simply be summed to produce an aggregate impact.

While these assessments provide one of the key purposes of the CAT - to improve transparency - something further is needed to monitor progress towards the NTS strategic outcome of reduced transport emissions.  In 2010 a single model run of the Land-Use and Transport Integration in Scotland (LATIS) service was commissioned to estimate the net impact of all measures within the CAT that fall under the competence of the Scottish Government or other Scottish public body[29]. LATIS includes a strategic transport and land-use model covering all of Scotland and all motorised modes of transport so the use of LATIS to assess the carbon impacts of Scottish transport schemes ensures network consistency and takes full account of the potential displacement of developments between one area and another.  The modelling of this set of projects over the timescale of their introductions also provides a greater understanding of the full impact that Scottish interventions are having, or are expected to have, on underlying emissions from transport. The model is not a complete assessment of the likely impact as it does not include the impacts of those measures taken at a reserved level - for example changes to fuel duty or some of the demand side measures outlined in RPP2.

The updating of the baseline data within LATIS enabled a revised set of projections to be run ‘with’ and ‘without’ the identified infrastructure projects over which Scotland has direct control.  The latest available estimates from the revised projection are shown in Table 10.   The table shows that the combined impact of the projects generates a small increase in overall emissions, with the long-run impact estimated at an additional 50 kt$CO_2$e p.a. by 2027.  This is equivalent to an additional 0.4% on annual transport emissions in 2027 relative to where emissions would otherwise have been.

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[29] Including those measures whose expected emissions impacts has not been quantified on an individual basis, e.g. Freight Facilities Grant.

**Table 8: Projected net emissions impact of Scottish projects**[30]

| Year | Annual Change in Emissions ($ktCO_2e$) |
|---|---|
| 2017 | 30 |
| 2022 | 50 |
| 2027 | 50 |

## Chapter 4: Conclusions

The Scottish Government is committed to tackling climate change, and has put in place a framework to cut emissions in 2020 to 40.7 $MtCO_2e$ and by 80% by 2050 (compared to a 1990 baseline). RPP2 set out a pathway that would keep Scotland on the trajectory to achieve this emissions reduction and now we have inventory data beyond the RPP2 timeline it is possible for the first time to directly compare the actual estimate with that suggested in RPP2. Neither set of data are built in such a way as to allow a line by line comparison but setting the aggregate positions alongside each other will be a helpful way to monitor the level of progress achieved. In 2014 Scotland met its emission reduction target and transport's aggregate emissions 12.9 MtCO2e were in line with the projections in RPP2, also 12.9 MtCO2e.

Transport must play a significant role in meeting Scotland's national targets and RPP2 set out the wide range of work already underway to bring down transport emissions. Efforts include continued significant investment in public transport infrastructure and service delivery to encourage mode shift, initiatives to encourage active travel, improving the efficiency of freight movements and the demonstration and use of low carbon vehicles across the different motorised modes. Furthermore, there is strong support from the Scottish Government for those wider measures and initiatives to reduce emissions such as new tighter emissions standards and incentives to promote alternative fuels, including the continuation of the UK Renewable Transport Fuels Obligation (RTFO). Together, these can help make a long-lasting and permanent reduction in Scotland's transport emissions.

[30] The reduction in emissions within the non-traded sector that are a result of EGIP have been added to the modelled output, as these benefits sit outside the scope of the modelling framework.

Section 2 of the CAT set out the latest outturn emissions data available. It demonstrated that whilst transport continued to make up a quarter of Scotland's total emissions, transport emissions fell for a seventh straight year, albeit only marginally in the latest year.

Section 2 also demonstrates through a range of key indicators monitoring public transport use, continued encouraging movements towards more fuel efficient, less polluting transport behaviours. The challenge continues to be how best to increase the speed of mode-switching and take up of these new technologies and fuel sources in our every day travel.

Section 3 of the CAT explains the likely future impact from the infrastructure projects underway. While the emissions impacts from these projects are not measured on a like for like basis, and consequently cannot be compared against each other, it is clear that some interventions are expected to increase future emissions albeit by relatively small amounts. The STAG process is though about more than recording emissions impact so an appraisal may show that an infrastructure improvement is, on balance, the best way to achieve the overall Government Purpose. That said, it is still important to quantify and to minimise the emissions impacts of each project and identify other areas through which to reduce emissions.

Section 3 of the CAT also sets out the range of fiscal and regulatory measures, predominantly reserved, that have been committed to usually via the EU or UK Budget process. The move of the UK government away from full emissions impact assessments as part of the budget process has made tracking the magnitude of the impact of policy changes more difficult.

The primary purpose of the CAT remains bringing greater transparency to Scotland's transport emissions and, therefore, greater emissions accountability in transport policy. Whilst the underlying factors set out in Chapter 2 will continue to have a major influence on overall transport emissions, the CAT will continue to report the marginal impact that projects and policies are likely to have upon the overall emissions pathway.

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