Scotland's Cleaner Transport Future

Michelle Cottrell, Principal Planner, Jacobs
Calum Robertson, Principal Transport Planner, Jacobs

1 Introduction

Air pollution and climate change are amongst two of the most serious global threats facing us today. The transport sector is a major contributor as it continues to emit air pollutants and greenhouse gases (GHGs) which, although very different, are both harmful to human health and the environment. Increasing awareness together with potential EU infraction, legal challenge by ClientEarth and global agreements on action towards climate change has resulted in the Scottish Government developing and adopting a range of policies and measures. Two of the key ones are:

- *Cleaner Air for Scotland* (CAFS) strategy published in November 2015 which aims to provide the foundations for achieving the best possible air quality for Scotland; and
- *Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013 – 2027*, the Second Report on Proposals and Policies (RPP2) published in June 2013 which identifies next steps to be taken to deliver a 42% emission reduction by 2020 (from 1990 levels).

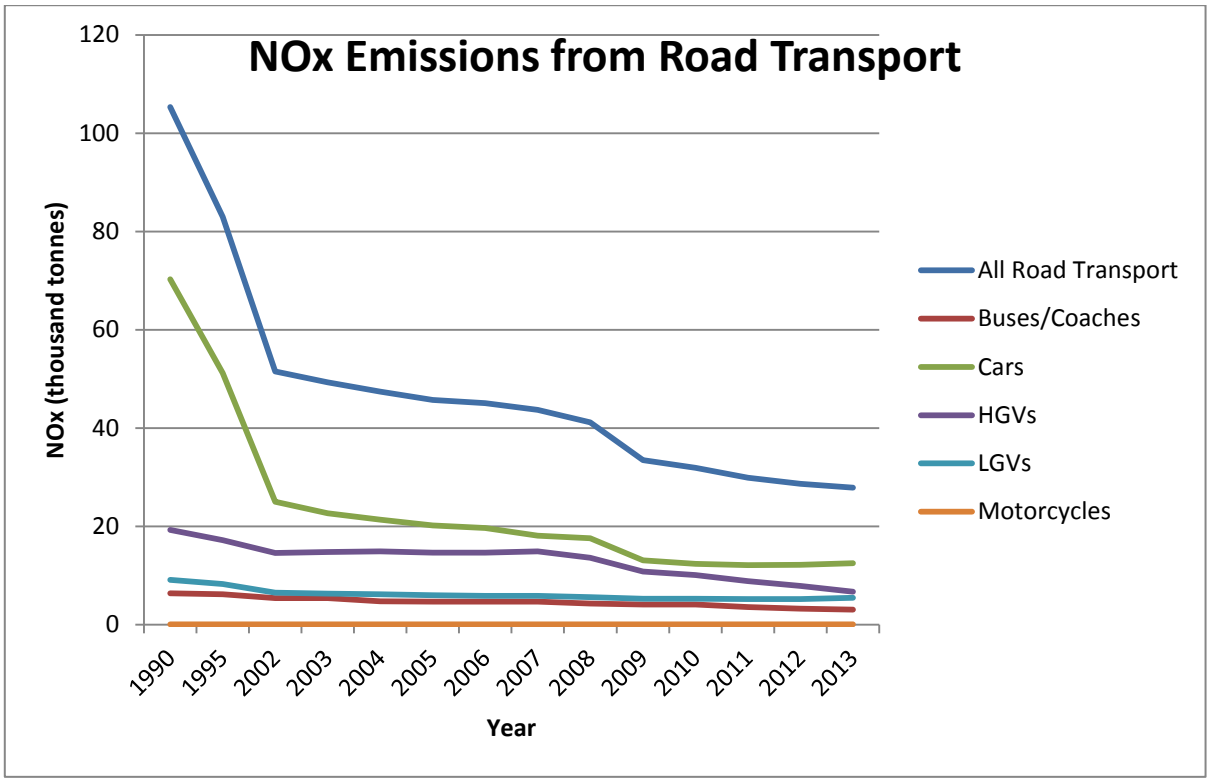
The policies and measures within these documents provide a solid basis for how Scotland intends to achieve a 'cleaner transport future'. Among other things, they provide information on ways to reduce air pollutants and GHGs from transport. However, a more integrated approach is required. We believe more needs to be done on charging, cutting pollution and GHGs and making streets more people-friendly. The CAFS strategy acknowledges this, taking a more long-term holistic approach to enhancing public realm, improving equitable access and integrating the environment.

This paper builds on recent work undertaken by Jacobs for Transport Scotland where we provided recommendations for the development of their National Low Emission Framework (NLEF) which is one action proposed to help deliver their CAFS strategy. Specifically, it explores some of the key actions set out within the CAFS strategy around transport, health and placemaking, and draws conclusions on their likely ability to help to 'clean' Scotland's transport future. Taking a broader view, this paper also touches on the synergies between delivering the CAFS strategy and meeting Scotland's carbon targets.

2 Background to this paper

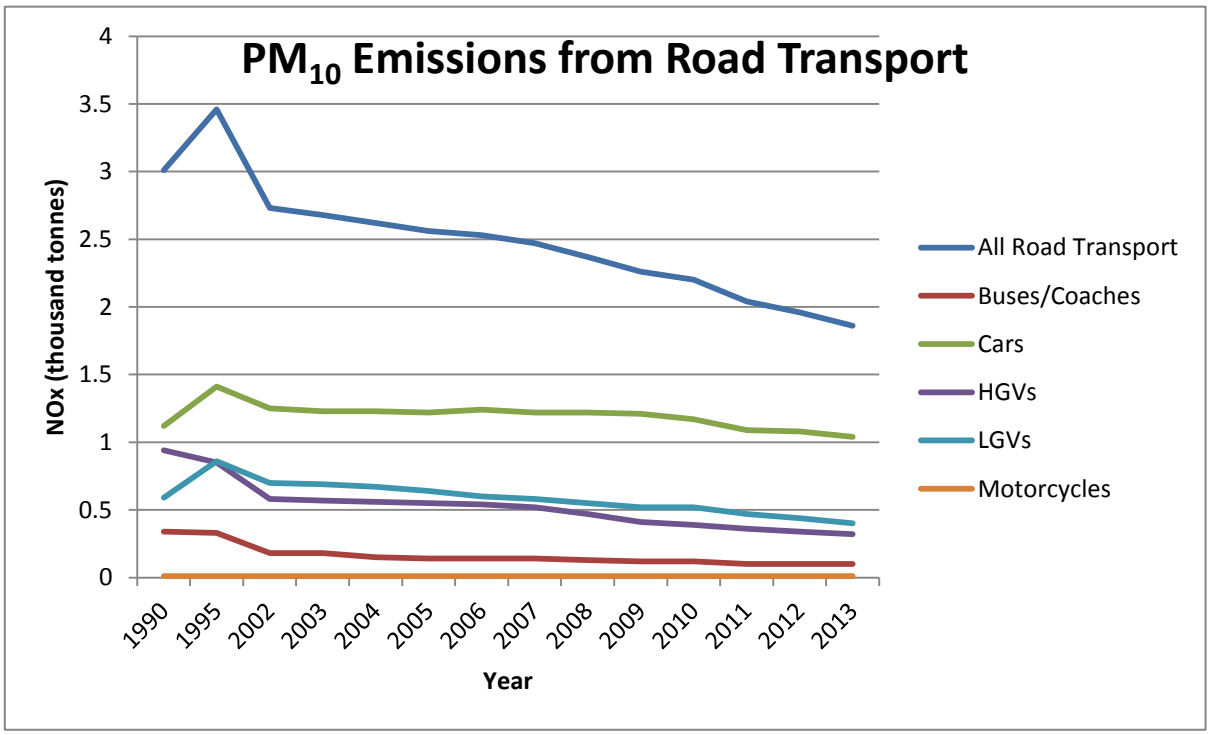
2.1 Transport sector impacts on human health and the environment

Figures 1 and 2 show emissions of air pollutants nitrogen oxides (NO_x) and particulate matter (PM_{10}) from road transport by mode. Figure 3 shows GHG carbon dioxide emissions (CO_2) from transport by mode. While these figures illustrate that good progress has been made over the past 20 or so years, in terms of limiting exhaust emissions of air pollutants and GHGs from road transport to near zero, significant improvement is still required. In 2013 the transport sector accounted for 40% of total NO_x emissions, 17% of total PM_{10} emissions and 24.4% of total Scottish CO_2 emissions (Transport Scotland, 2015a).



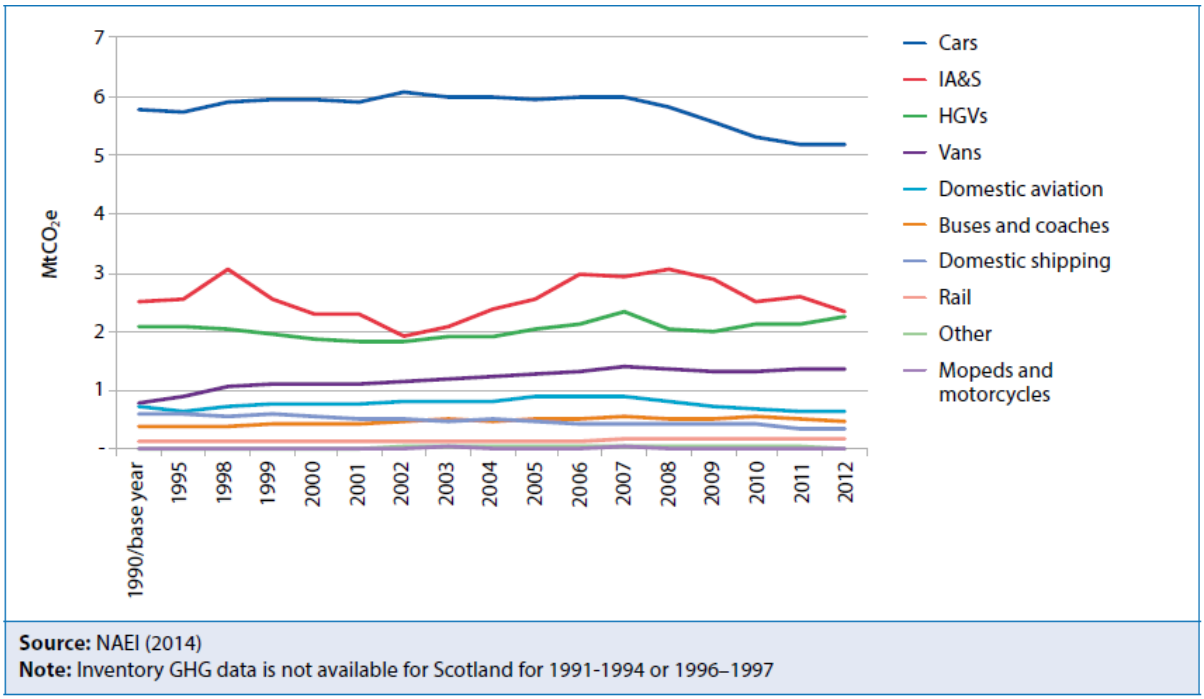
(Source: Transport Scotland, 2015b)

Figure 1: Nitrogen oxide emissions from vehicles in Scotland, by mode



(Source: Transport Scotland, 2015b)

Figure 2: Particulate matter emissions from vehicles in Scotland, by mode



Source: NAEI (2014)
Note: Inventory GHG data is not available for Scotland for 1991-1994 or 1996–1997

(Source: Committee on Climate Change, 2015)

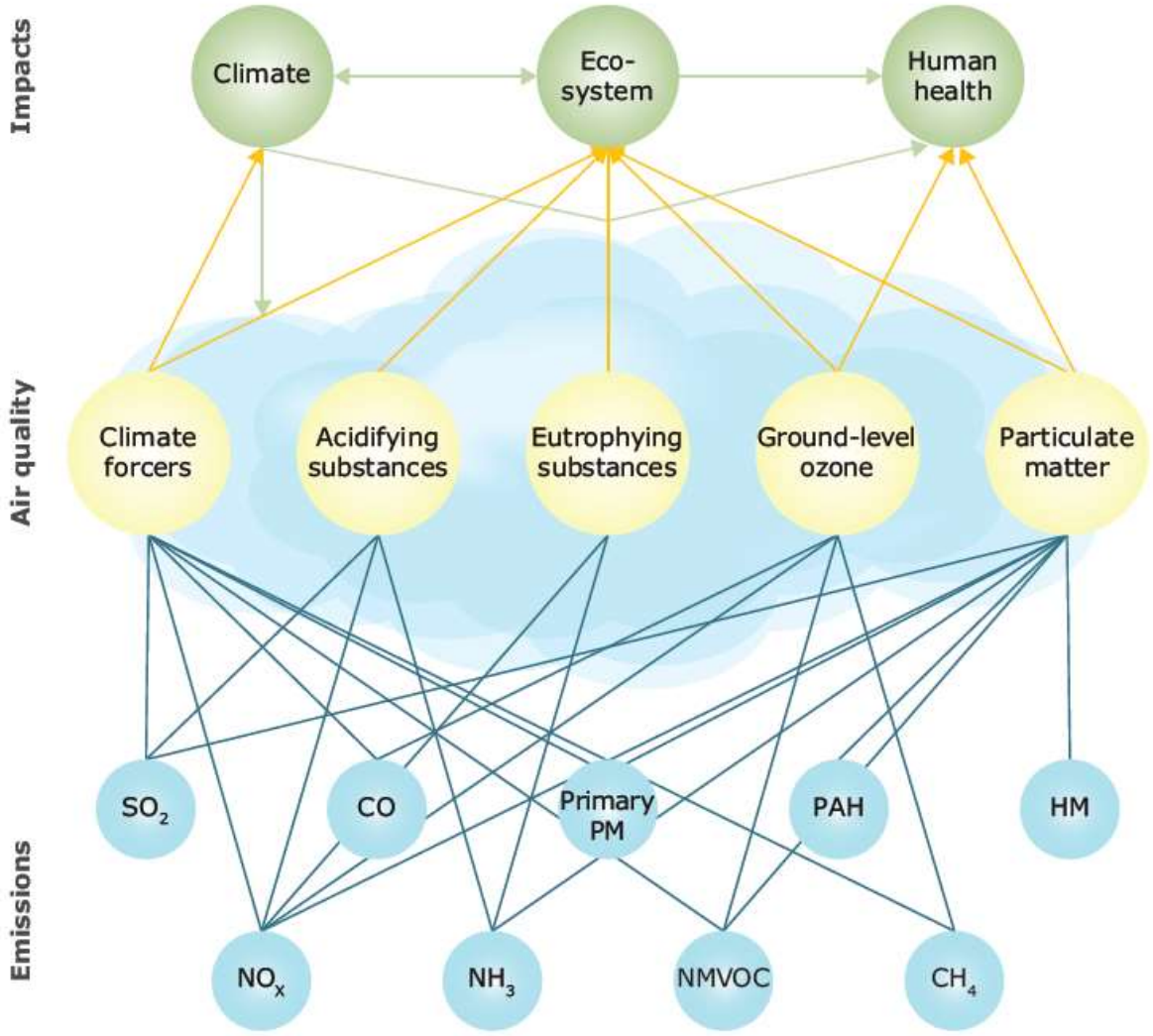
Figure 3: Carbon dioxide emissions from transport in Scotland, by mode (1990-2012)

Exposure to air pollutants such as NO_x[1], PM_{10} and $PM_{2.5}$ is linked to death and illness. Research funded by the British Heart Foundation Scotland has shown that air pollution can make existing heart conditions worse and can cause heart attacks and strokes among vulnerable people (Cant, 2016). "*In Scotland, in 2010 fine PM was associated with around 2,000 premature deaths and around 22,500 lost life-years across the population*" (The Scottish Government, 2015). Further, NO_x emissions lead to subsequent formation of ground-level ozone which together with secondary PM[2] contributes to the acidification and eutrophication of waters and soils harming the environment's historic buildings and biodiversity.

Of GHGs, CO_2 is the most significant which influences climate change and poses a threat to public health and the environment. CO_2 is the main product of fuel combustion in vehicle engines, along with water, and the burning of fuel generates air pollutants which contribute to increased mortality rates. The release of CO_2 into the atmosphere also affects our environment through sea level rise, impacts on agriculture, reduction of the ozone layer, increased extreme weather, spread of disease and ecosystem change.

Figure 4 provides an overview of the interactions between air pollutants and GHGs and their potential impacts.

[1] NO_x is made up of nitric oxide (NO) and nitrogen dioxide (NO_2)
[2] Secondary PM forms in the atmosphere following the release of precursor gases (mainly sulphur dioxide, NO_x, ammonia and some volatile organic compounds) (European Environment Agency, 2016a)



(Source: European Environment Agency, 2013, p. 3)

Figure 4: Interactions among air pollutants and greenhouse gases and their potential impacts

To date, cleaning up the transport sector has relied on tighter fuel and emission standards for road vehicles, investment in public transport infrastructure, improvements in fuel efficiency and government emissions policies; yet increased public and political attention around air pollution and climate change suggest this is not working well enough. Official air pollution forecasts continue to show high levels of air pollution across much of the central belt of Scotland (Williams, 2016) while the latest global climate change deal, agreed in January 2016 at Conference of Paris (COP) 21, demonstrated widespread consensus on the need for firm action on climate change.

2.2 Existing situation in Scotland

Scotland continues to fail to meet Scottish air quality objectives for nitrogen dioxide (NO_2) and / or PM_{10} concentrations in 31 (out of 32) Air Quality Management Areas (AQMAs) across 14 local authority areas[3]. Local authorities within Scotland with AQMAs have produced Air Quality Action Plans which identify actions for addressing poor air quality from road transport, including for example Low Emission Zones, Clean Air Zones and Intelligent Traffic Control. However, although some feasibility studies have been carried out e.g. for Aberdeen, Edinburgh and Glasgow, to date there are no Low Emission Zones in Scotland and pockets of poorer air quality remain in many Scottish towns and

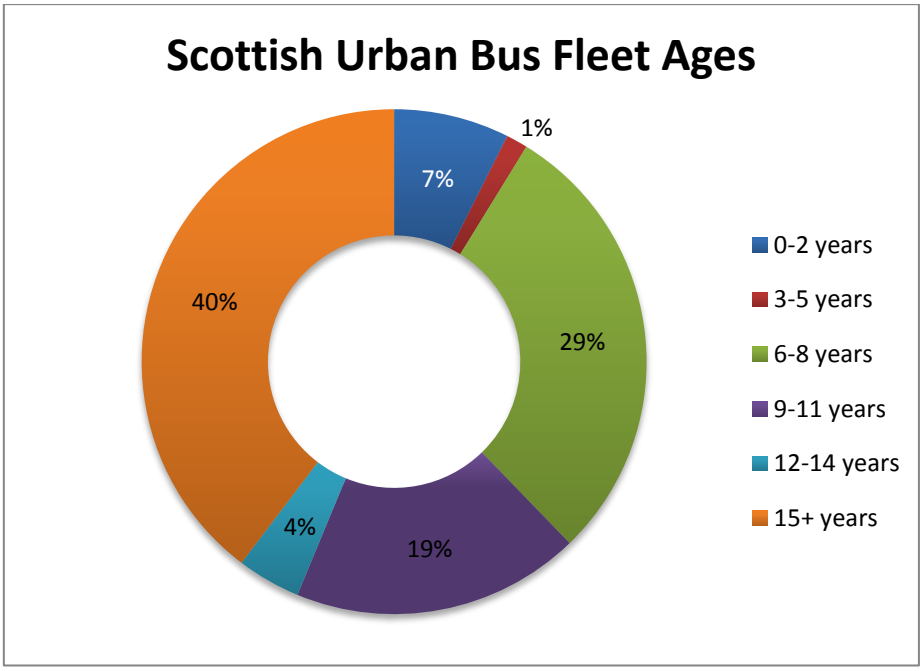
[3] The one AQMA not declared for exceeding air quality objectives for NO_2 and/or PM_{10} concentrations is declared for exceedances in the Scottish air quality objective for sulphur dioxide (SO_2)

cities. Some would argue that local authorities are lacking consistent support, tools, advice and targeted funding to aid the identification, appraisal and implementation of transport related air quality measures such as Low Emission Zones and Clean Air Zones[4].

Additionally, it is very difficult to project how transport will / can improve future air quality. As stated by European Environment Agency Executive Director Hans Bruyninckx "*measuring exhaust emissions from vehicles is a complex issue, and it's a topic that has been extensively discussed in the media over the past months*" (European Environment Agency, 2016a). In simple terms, projecting future exhaust emissions relies on a detailed understanding of traffic growth, changes to fleet (i.e. % heavy goods vehicles and so on), vehicle fuel (diesel, petrol, hydrogen, electric), engine size and the age or Euro Standard of those vehicles. It is also necessary to understand the emissions produced from the tail-pipe for each vehicle. These issues are coupled with unreliable official emissions testing in laboratories where vehicles can emit substantially higher emissions on the road than predicted through testing in laboratories (the Volkswagen emissions scandal is a well know example of this[5]).

Vehicle age is one significant contributing factor to how much pollution is emitted from the tailpipe, with older vehicles tending to emit more than newer vehicles as they will be of a lower Euro standard[6]. Scotland has an aging vehicle fleet with the average age of private vehicles 6.6 years, 6.3 years for goods vehicles (both an average increase of around 15% since 2004). The average age of public transport vehicles in Scotland is 8.2 years (a 4% increase since 2005) (Transport Scotland, 2015b).

Additionally, Jacobs research undertaken for Transport Scotland on the bus fleet age of the main urban bus companies in Scotland found that the fleet age varied significantly, with some firms routinely operating vehicles aged up to 15 years old that were of Euro 2 standard, as shown by Figure 5.



(Source: Jacobs, 2015)

Figure 5: Summary of bus fleet age (of information provided by bus operators surveyed)

[4] Feedback received by Transport Scotland from consultation undertaken during the development of the Cleaner Air for Scotland strategy suggested that local authorities would welcome consistent support to aid them in addressing air pollution.

[5] The Volkswagen emissions scandal centred around the fact many diesel VW cars were being sold with apparent software installed which could detect when they were being emissions tested, changing performance accordingly to improve emissions results to meet test targets. It was found that many of these vehicles did not, in reality, meet these targets during real world drive cycles.

[6] Vehicle Euro standard relates to the European Vehicles Emissions Standard Class system (Euro 1 to Euro 7) that defines the maximum emission levels allowed from vehicle classes, with limit levels decreasing as each new Class is introduced.

Our research identified that more work is needed by the Scottish Government to fully understand fleet make up. This may be by investment in Automatic Number Plate Recognition (ANPR) technology to accurately provide a variety of data on the national vehicle fleet, and local variations within this. It is only with this information that the true cost-effectiveness (effectiveness including health and air quality benefits) of Low Emission Zones and Clean Air Zones can be determined.

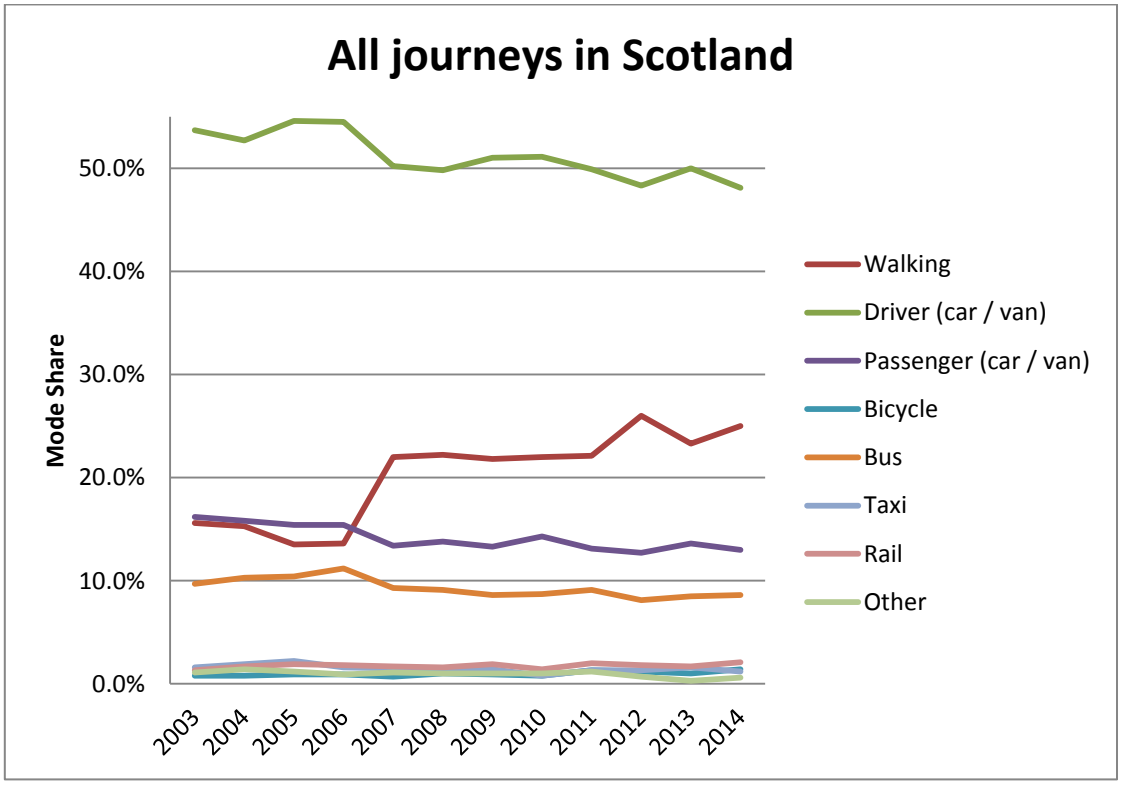
3 Current trends

3.1 Modes of travel

Active modes of travel (walking, cycling and use of public transport) can help to reduce air pollution and CO_2 emissions and therefore understanding current and projected trends in modes of travel can help to identify how transport will / can improve future air quality.

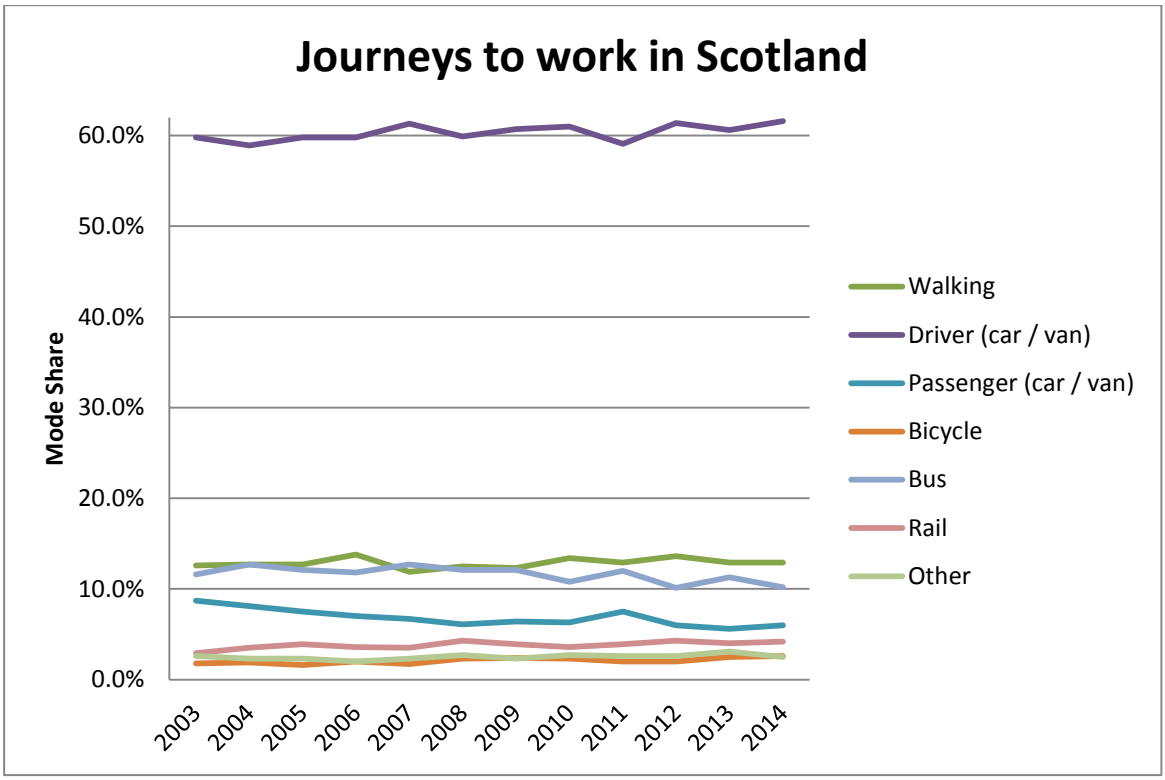
Statistics show a mixed picture in terms of travel trends across Scotland in recent years. While government policy has long been aimed at promoting the most sustainable forms of travel, such as walking, cycling, public transport and car sharing, the private car still dominates as the main mode of travel across Scotland.

Transport statistics tend to categorise journeys by purpose, with the main categories being 'all journeys', 'travel to work' and 'travel to school'. The majority of travel in Scotland is not work related (75%) but journeys to work are still very important when considering emissions as they tend to occur around the peak hours, when congestion is typically at its worst and local air quality is reduced. Figures 6 and 7 identify travel trends over the last 12 years and illustrate that, while some improvement has been made in terms of mode shift from private car to more sustainable modes such as public transport, walking and cycling, there is still a way to go.



(Source: Transport Scotland, 2015b)

Figure 6: Model of travel - all journeys



(Source: Transport Scotland, 2015b)

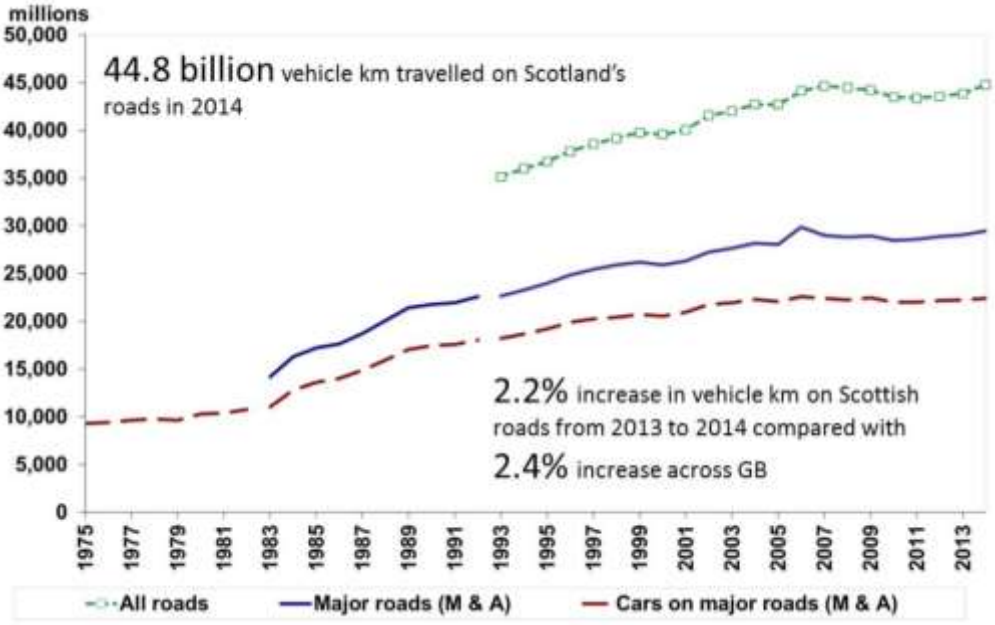
Figure 7: Model of travel – journeys to work

There has been a noticeable degree of change in mode share when considering 'all journeys' undertaken in Scotland, although conversely mode share for 'journeys to work' have remained very consistent over the same period. Travel by car has remained the predominant mode of travel for all journeys (although decreasing over the past 12 years) and journey to work (increasing to around 66% for car drivers and passengers in 2014 from 60% in 2003) (Transport Scotland, 2015b). Active modes of travel have also remained relatively consistent with the exception of walking for all journeys and cycling and rail for journeys to work.

Walking trips have seen an increase of 9.4% from 2003 to 2014 to a quarter of trips for all journeys, although the walking mode share for journeys to work has remained relatively static at around 12 to 13%. Additionally, whilst cycling and rail mode shares have remained fairly consistent for all journeys, for journeys to work these modes have enjoyed noticeable increases in share in recent years, albeit from a low base. Rail has increased its mode share from 2.9% in 2003 to 4.2% in 2014 and cycling has increased its mode share from 1.8% in 2003 to 2.6% in 2014.

Importantly however, the national statistics for all modes of travel tend to hide considerable local variations. Of note, the bicycle mode share varies widely across the country with the top five areas on Scotland for cycle to work mode share being Edinburgh (12.2%), Moray (10.3%), Argyll & Bute (9.1%), Stirling (8.7%) and then Clackmannanshire (8.4%) (Cycling Scotland, 2015).

Overall, although some progress has been made in reducing car mode share for all journeys, the dominance of the private car as the primary mode of transport to travel is an obvious and continuing trend. Further, regardless of any positive reduction in car mode share, statistics show that the number of all vehicle kilometres travelled across Scotland's road network has actually risen year on year since 1975, as shown in Figure 8. This is concerning when considering resultant vehicle emissions and subsequent pollution from these vehicles. To this end, encouraging active travel as a more favoured mode for travel is imperative at a national level (as well as regional and local) to help reduce such emissions.

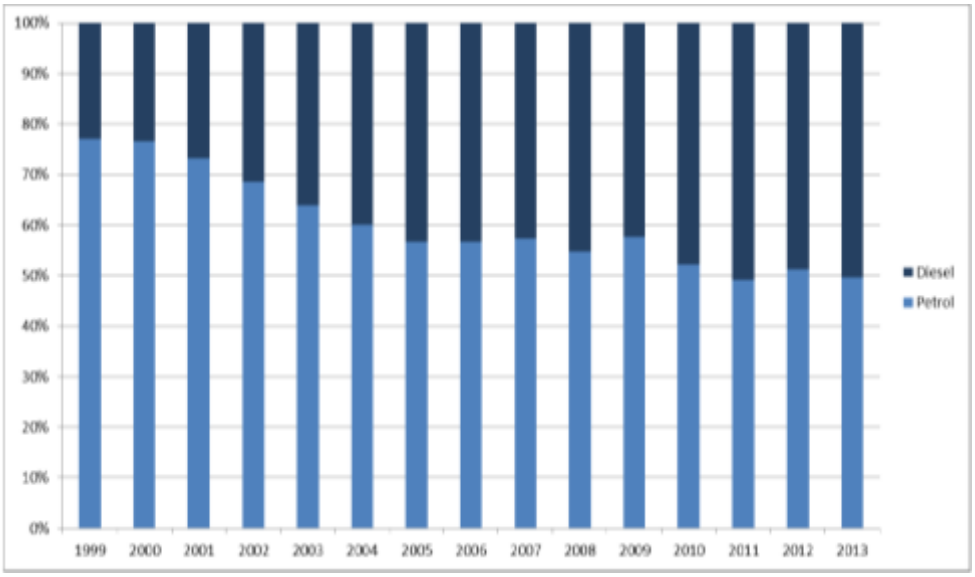


(Source: Transport Scotland, 2015b)

Figure 8: Vehicle distance trends on Scottish roads (vehicles km)

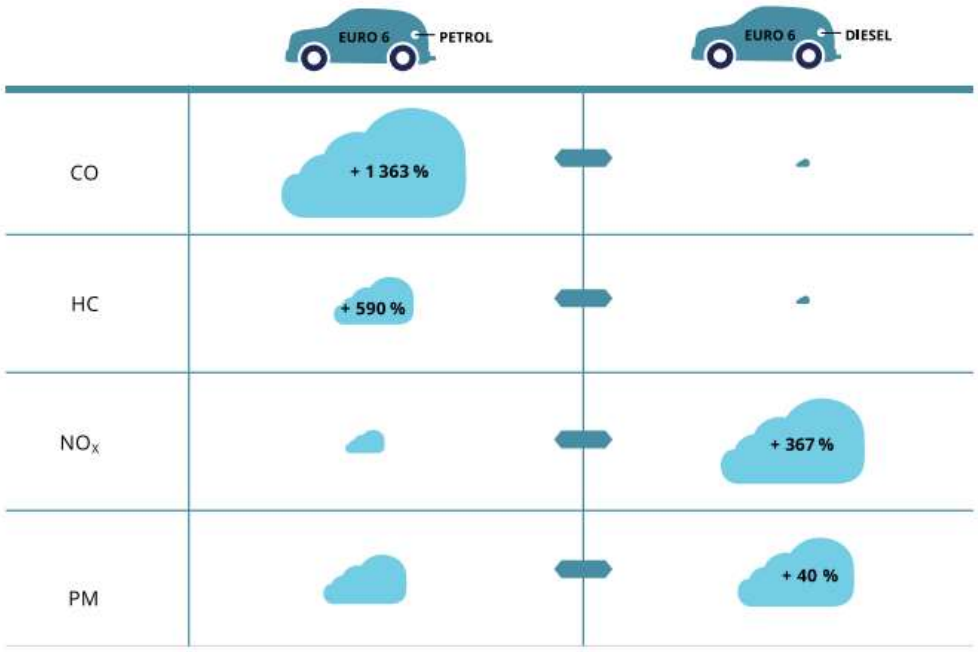
3.2 Emissions

As shown previously in Figures 1, 2 and 3, there have been overall reductions in emissions from road transport since 1990 to 2012/13. With overall decreases in the car mode share but corresponding increases in vehicle kilometres travelled by road it is likely that only engine technology is responsible for these overall reductions. Some of these will be as a result of tightening vehicle emissions regulations through the Euro class system but also some it of down to the fact there has been gradual increase in the proportion of the car fleet powered by diesel in recent years, as illustrated by Figure 9. Diesel cars typically emit less CO_2/km than their petrol equivalents, although they do tend to emit more NO_x and PM, as shown in Figure 10. The recent Volkswagen vehicle emissions scandal involving diesel powered vehicles may also have had an impact on this area.



(Source: Transport Scotland, 2015c)

Figure 9: Distribution of new Scottish registrations between petrol and diesel 1999-2012 – all vehicle types



(Source: based on www.fueleconomy.gov, found in European Environment Agency, 2016b)

Figure 10: Comparison of the relative amount of selected pollutants released by Euro 6 petrol and diesel cars

Some of the overall reduction in transport emissions may also be down to the recent increase in popularity of alternative fuelled vehicles (or ultra-low emission vehicles (ULEVs)), such as hybrid and electric. Hybrid cars typically emit around 30% less than their fossil fuelled equivalents (Transport Scotland, 2015) and electric cars clearly almost 100% less. As of December 2014, 1,344 of the 222,400 new cars registered in Scotland were electric (Department for Transport, 2015), a significant rise on previous years although it is recognised that, at present, this low proportion (around 0.05% of the whole car fleet) will likely be having little impact on emissions from cars at this time.

In terms of heavier vehicles travelling throughout Scotland, road is currently the most widely used method of moving freight in Scotland. In 2012, road freight accounted for 42% of total tonne kilometres, shipping for 30% and rail for 9% (Transport Scotland, 2015a). Figure 8 previously identified that the distance covered by all modes travel by road is increasing and Figure 3 shows corresponding increases in CO_2 emissions from Heavy Goods Vehicles (HGVs) and vans. It should be noted though that tightening emission standards for all vehicles do appear to be reflected in reductions of PM_{10} and NO_x emissions from freight vehicles, although it is concerning that NO_x emissions from HGVs are almost as high as those from cars, which represent a much larger share of the national fleet, as shown in Figure 1.

4 Achieving a cleaner transport future

Walking, cycling and public transport use has remained relatively stagnant for journeys to work over at least the last decade, and these remain secondary modes of travel to the car. There have been some increases in travel by alternative modes for all journeys but the distance travelled for all journeys by road has increased at the same time. Emission reductions have been limited overall and air quality is barely improving in many locations. It goes without saying that the Euro classification system should be, and is being to some degree, effective at reducing vehicle emissions per km, and increased uptake of ULEVs will continue to help as technology advances and becomes more cost effective. However, it is clear that the distance travelled by vehicles needs to be reduced and far more journeys need to be undertaken by active modes of travel. Active travel has a positive impact on the

environment (no emissions) and has a positive impact on people's health and wellbeing, contributing to increased physical activity levels across the population and tackling obesity[7]. In order to achieve this in the environment within which we live we must better integrate land use planning with active modes of transport, emphasising the importance of placemaking at the same time. We must also better integrate, and better provide for interchange, between these active modes and cleaner forms of public transport for longer journeys. This will require political backing from all levels of government but most importantly investment in the right infrastructure at a national level.

Investment in infrastructure at a national scale has been demonstrated through the UK 'city deal' funding strategy and comparable initiatives are underway elsewhere around the world. For example, in Australia the newly installed Turnbull Liberal government's cities agenda will see city deal funding models agreed between federal, state and local governments in relation to the delivery of major urban infrastructure projects, with success linked to multiple bottom line targets around job creation, housing delivery, emissions reduction and other economic measures (Dole, 2016). The Australian Prime Minister has announced that federal investment in infrastructure for growing areas such as western Sydney could be undertaken in accordance with 30-minute city urban design principles, where people can live, work and study within a half hour travel radius rather than just purely traffic or transit measures. London and Manchester have also demonstrated that success can be achieved at a regional level where there is significant political backing and investment in infrastructure.

The Scottish Government has recognised and acknowledged the importance of national scale measures in achieving a cleaner transport future. The CAFS strategy provides an integrated national approach which draws together actions relating to transport, health and placemaking to achieve the best possible air quality for Scotland. To this end, the CAFS strategy commits to carrying out a number of actions to properly enforce (i.e. beyond a 'duty') the legal requirements relating to air quality to achieve their vision that 'Scotland's air quality will be the best in Europe'. In achieving the vision of the CAFS strategy the Scottish Government are promising to protect and enhance health, wellbeing, environment, place making and sustainable economic growth.

The CAFS strategy rightly acknowledges that adopting a 'stick' approach to improving air quality (e.g. through Low Emission Zone or Clean Air Zones) will not, on its own, achieve the best possible air quality. The CAFS strategy is successful in making the all-important broader connection to health and placemaking, and this, together with the other interventions acknowledged by the Scottish Government in the CAFS strategy and other complementary strategies and policies[8], in our view, is the only way to achieve the Scottish Government's vision.

4.1 Transports role in improving air quality and human health in urban areas

Health problems such as obesity, diabetes, mental health and stress are becoming more prevalent in today's populations around the globe. These problems are inextricably linked to transport beyond just exposure to emissions of air pollution from road transport. Transport also plays a crucial role in the way in which people access jobs, education, shops, recreation, health and social services and travel to see friends and family. In addition to improving air quality to meet EU standards, if cities and towns can provide more varied and attractive transport modes they are likely to provide greater incentives for people to be more physically active ('carrot' approach) and thus improve health impacts such as obesity, heart disease, stroke, depression and type 2 diabetes.

[7] In Scotland in 2014, 65% of adults aged 16 and over were overweight, including 28% who were obese (The Scottish Government, 2015a)

[8] Complementary strategies and policies include, for example, Transport Scotland's National Transport Strategy and their Smarter Choices, Smarter Places initiative and the Scottish Government's Creating Places

The key question is how the Scottish Government will provide political backing and appropriate funding to achieve more varied and attractive modes of transport that are well connected to land use (in addition to supporting the implementation of Low Emission Zones and Clean Air Zones) to encourage people to shift from the private vehicle to more active modes of travel. Politically, it is easier to sell the benefits of Low Emission Zones and Clean Air Zones to the public and therefore demonstrate that action is being taken to improve air pollution. Their health benefits can be quantified in terms economic savings to the public health system (monetisation and life years lost) through use of the Department for Environment, Food and Rural Affairs (Defra's) health impact pathway approach[9] damage cost approach or unit abatement cost approach. Conversely, quantifying health benefits from mode shift and active travel is much harder and therefore justifying investment in placemaking and public realm improvements generally proves more challenging.

The CAFS strategy identifies some key actions towards how the Scottish Government aim to design places to minimise air pollution and its effects, however are they ambitious enough? Perhaps greater linkages to existing Scottish Government policies around designing streets, e.g. the Designing Streets Policy Statement for Scotland, would help to strengthen such actions. Transport for London provides a good example of how this could be achieved. Their Transport Action Plan sets out how they, and subsequently London boroughs, aim to achieve a 'whole-street' approach to improving air quality and the health of Londoners. Their whole-street approach involves making streets more inviting for walking and cycling and attractive to spend time in. It identifies five key indicators of a healthy street including physical activity, air quality, road traffic collisions, noise and access and severance. Each indicator is supported by a measure which is repeated in Table 1.

Table 1: Measuring healthy streets

Indicator	Measure
Physical activity	Percentage of trip stages walked or cycled
Air quality	NO_2 and PM on-street monitoring
Road traffic collisions	Reduction in killed or seriously injured casualties
Noise	Average rating of transport related noise
Access and severance	Access to opportunities and services (ATOS) score

(Source: Transport for London, 2014, p. 10)

London boroughs produce their own Local Implementation Plans (LIPs) in accordance with Transport for London's Transport Action Plan and Transport for London provide funding to local authorities to help implement the whole-street approach. In developing their own LIPs, London boroughs tend to adopt the whole-street approach where feasible. Some boroughs, for example Hackney, have proposed a Low Emission Neighbourhood which looks at how to adopt both stick and carrot approaches to improving air quality and human health.

Appropriate support and guidance at a national level in relation to placemaking is crucial to encouraging innovation and pro-active policy and design solutions from local authorities to improve the quality of urban life within their streets and places. It will ensure local authorities successfully "future-

[9] The health impact pathway approach can measure mortality associated with long-term exposure to $PM_{2.5}$, respiratory hospital admissions associated with acute exposure to PM_{10}, cardio-vascular hospital admissions associated with acute exposure to PM_{10}, respiratory hospital admissions associated with acute exposure to NO_2 and mortality associated with long-term exposure to NO_2.

proof" and "future-enhance" their local areas and take a whole-street, or a whole of environment, approach to improving air quality, and subsequently health, wellbeing, environment, place making and sustainable economic growth (as sought by the Scottish Government).

The Scotland's Way Ahead project that Jacobs has been involved in is a good example of how the Scottish Government might take a whole of environment approach to improving air pollution and addressing climate change. The project, which aims to highlight the benefits of low carbon infrastructure for Scotland and identify projects that could be developed in Scotland, includes a project example relating to adapting our cities for public transport and active travel and looks at re-engineering areas of Scottish cities to allow people to live and travel in low carbon ways (i.e. predominantly car free). In doing so, it is intending to connect public transport within and across cities, reducing air pollution (not just carbon) from private vehicles and making it easier and safer to travel on foot or by bike (WWF Scotland and Low Carbon Infrastructure Task Force, 2015).

Research undertaken by Jacobs for the project identified a number of measures that could be undertaken in combination in order to achieve a predominantly car free, active city. These included:

- Transformational change in the provision of cycling infrastructure;
- Significant restrictions on the use of private motorised vehicles in city centres e.g. close off some areas to private vehicles, reduce speed limits, introduce a congestion charge etc.;
- Implementing Ultra Low Emission Zones, Low Emission Zones, Clean Air Zones etc.;
- Improving cities for pedestrians in terms of safety, health and aesthetics; and
- Adopting a systems approach[10] to urban travel.

4.2 Transports role in improving air quality and human health outside urban areas

As Scotland has a relatively low population density, there will always be a need for some to travel long distances to access employment and services. This low population density makes provision of public transport for all a real challenge and so travel by private vehicle, for many, will remain critical to maintaining a prosperous economy and Scotland's peoples' quality of life. For this reason there must be a step change in the current effort to achieve reductions in vehicle emissions through ever tightening Euro standards and promotion of ULEVs; indeed the Committee on Climate Change estimates that plug-in hybrids and battery electric vehicles need to account for 9% of new car and van sales by 2020 and 60% by 2030 to make a significant contribution towards our emissions targets (Forster, 2016). This will require significant investment by government in charging infrastructure and subsidies to make technology more affordable, and at least comparable to a fossil fuelled alternative. Where public transport can be provided, every effort should be made to ensure this is by low emitting vehicles, with assistance from government where possible, i.e. grants to renew bus fleets with the least emitting vehicles available and investment in electric rail.

Additionally, Scotland's economy relies heavily on trade and movement of goods and so freight is likely to continue to make up a (not insignificant) share of movements within, to and from Scotland. Freight, be it by Light Goods Vehicles (LGVs), HGVs or indeed shipping and aviation, is a disproportionately high contributor of emissions. Tightening Euro engine standards will reduce road based emissions, provided distance travelled by freight remains steady or reduces, but will only do so if freight operators invest in renewing their fleets and in fuel efficient driver training. Additionally there needs to be a strengthened national approach to reducing freight by road; the Scottish Government's Freight Action Plan (2006) gives limited acknowledgement to this but their refreshed plan (2016) includes firmer objectives to promote freight modal shift to rail and water and improve the efficiency and sustainability of road transport, particularly in urban areas. Real effort needs to be focussed on

[10] A systems approach might include adopting a variety of travel modes, including rail and surface transport, support for car clubs or park and ride schemes

this area and in working with freight operators to ensure the objectives are met and emissions from freight are reduced.

5 Conclusions

It is widely acknowledged that the transport sector is still one of the major contributors to air pollution and climate change across Scotland (as well as many other parts of the world). Yet, transport is critical for our economy to function and grow successfully and therefore there is no easy fix to significantly reducing transport's apportionment to these two key issues. Further having regard to the varied geography of Scotland, a cleaner transport future for Scotland will vary across the country.

For Scotland to achieve the vision set out for it in the CAFS strategy – "*Scotland's air quality will be the best in Europe*" – while at the same time protect and enhance health, wellbeing, environment, placemaking and sustainable economic growth (the Scottish Government's mission), our paper suggests the following.

For urban areas, the stick approach of Clean Air Zones needs to be supported by greater emphasis on placemaking and successfully connecting transport and land use to encourage greater active travel. Funding also needs to be provided at a national level for schemes across all levels of government that promote or aim to increase active travel. The CAFS strategy goes some way to supporting this but could be bolder and go even further.

Outside of urban areas, where greater private car use will remain high and freight makes up a significant share of total travel movements, emphasis should be placed on tightening Euro engine standards, shifting towards ULEVs and a national approach to reducing freight by road.

Overall, the CAFS strategy is a great step forward from the Scottish Government in terms of tackling air pollution and climate change and, if successful, will encourage uptake of zero emission vehicles, achieve greater modal shift and influence the climate change agenda (on top of other initiatives that are already underway in this space).

6 Acknowledgements

The authors would like to thank the following for their approval to use data and support in reviewing and commenting on this paper:

Drew Hill, Transport Scotland

Keith Gowenlock, Jacobs

7 References

Transport Scotland. (2015a). National Transport Strategy Refresh – Transport Statistics – Change Since 2006. Accessed on 2 March 2016 from: http://www.transport.gov.scot/system/files/documents/reports/NTS%20Refresh%202015%20-%20Supporting%20Document%20-%20Transport%20Statistics%20-%201%20Dec%202015.pdf

Transport Scotland. (2015b). Scottish Transport Strategy Statistics No. 34: 2015 Edition. Accessed 21 March 2016 from http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j415388/j415388.pdf

Committee on Climate Change. (2015). Reducing emissions in Scotland – 2015 progress report. Accessed on 2 March 2016 from: https://www.theccc.org.uk/publication/reducing-emissions-in-scotland-2015-progress-report/

Cant, J. (2016). Time to clean up our act on air pollution. The Scotsman. Published Thursday 3 March 2016. Accessed on 30 March 2016 from: http://www.scotsman.com/news/time-to-clean-up-our-act-on-air-pollution-1-4041989

European Environment Agency. (2016a). Explaining vehicle emissions – why do laboratory and road measurements differ? Accessed on 30 March 2016 from: http://www.eea.europa.eu/downloads/ba9d713b964d4cf9ae55d1e5831801d1/1453884020/explaining-vehicle-emissions.pdf

European Environment Agency. (2013). Understanding pollutant emissions from Europe's cities. Highlights from the EU Air Implementation Pilot Projects. Luxembourg: Publications Office of the European Union, 2013.

Scottish Government. (2015). Cleaner Air for Scotland – The Road to a Healthier Future. Accessed on 2 March 2016 from: http://www.gov.scot/Resource/0048/00488493.pdf

Scottish Government. (2015a). Health of Scotland's population – Obesity. Accessed on 1 April 2016 from: http://www.gov.scot/Topics/Statistics/Browse/Health/TrendObesity

Williams, M. (2016). At-risk Scots warned to 'take it easy' as "dangerous air pollution" hits central belt. Herald Scotland. Published Thursday 17th March 2016. Accessed on 30 March 2016 from: http://www.heraldscotland.com/news/14348361.At_risk_Scots_warned_to__take_it_easy__as__dangerous_air_pollution__hits_central_belt/

Jacobs (2015). Low Emission Framework: Recommendations for a National Traffic Data Collection System, 2015

Cycling Scotland. (2015). Annual Cycling Monitoring Report CAPS Action 18: 2015 Edition. Accessed 28 March 2016 from http://www.cyclingscotland.org/wp-content/uploads/2015/03/Annual-Cycling-Monitoring-Report-2015-v2.0.pdf

Transport Scotland. (2015c). Carbon Account for Transport. No. 7: 2015 Edition. First published in 2009. Accessed on 2 March 2016 from: http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j408446/j408446.pdf

European Environment Agency. (2016b). *Explaining road transport emissions*. A non-technical guide. Luxembourg: Publications Office of the European Union, 2016.

Department for Transport. (2015). Vehicles statistics, all licensed vehicles and new registrations (VEH01), Cars (VEH02), Motorcycles (VEH03), light vans (VEH04), and others. Accessed on 2 March 2016 from: https://www.gov.uk/government/statistics/vehicle-licensing-statistics-2014

Dole, N. (2016). UK 'city deals' model to be adapted for Australia under Malcolm Turnbull's cities plan. Thursday 24 March 2016. Accessed on 30 March 2016 from: http://www.abc.net.au/news/2016-03-25/uk-city-model-to-be-adapted-for-australia/7276252

Transport for London. (2014). Improving the health of Londoners. Transport action plan.

WWF Scotland and Low Carbon Infrastructure Task Force. (2015). Adapting our cities for public transport and active travel. Accessed on 21 March 2016 from: https://scotlandswayahead.org.uk/projects/adaptingcities

Forster (2016). Market for electric cars failing to ignite, warns manufacturer. *Local Transport Today,* Issue 688, p.1.