Improving the Greenhouse Gas Inventories for Road Transport in Scotland, Wales and Northern Ireland

Task 23 of the UK / DA Inventory Improvement Programme

Report for DECC, Welsh Assembly Government, the Scottish Government and the Department of the Environment for Northern Ireland

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Executive Summary

The Greenhouse Gas Inventories for road transport in Scotland, Wales, Northern Ireland and England are currently calculated in the same way as for the UK's Greenhouse Gas Inventory (UK GHGI) by combining emission factors with activity data based on kilometres travelled within each Devolved Administration (DA). The inventories are not currently capturing any regional differences in the composition of the fleet and driving behaviour, nor any possible differences in fuels consumed, except for in Northern Ireland where local licensing data are used to reflect the specific nature of the Northern Ireland vehicle fleet.

This report describes the findings of a scoping study to consider the integration of more country-specific factors and assumptions in the DA inventories for road transport. Officials at each DA were initially contacted to gauge their opinions on where relevant information could be found and what transport or climate change policies were being developed that would benefit from more country-specific inventories that could be used to track progress. Subsequently, this study has considered a number of road transport activity trends and underlying factors that could be explored and used to reflect regional differences at DA level and therefore provide more accurate and sensitive DA road transport inventory estimates.

Particular consideration has been given to four specific transport features that influence emissions from road transport:

- vehicle fleet composition;
- speed;
- passenger car trip lengths; and
- use of alternative fuels.

Interrogation of detailed vehicle licensing data held by the Driver and Vehicle Licensing Agency (DVLA) and Department for Regional Development Northern Ireland (DRDNI) has provided an insight into the specific features of the vehicle fleet in each country, including:

- The proportion of diesel cars in the fleet is similar in England and Scotland, but is consistently slightly higher in Wales and much higher in Northern Ireland;
- Scotland and Wales have a slightly higher proportion of smaller engine-size petrol cars compared with England and the GB average while the size distribution of diesel cars is similar across all countries;
- Scotland has a newer petrol car fleet than England and Wales, while Wales appears to have an older diesel car fleet than England and Scotland;
- Northern Ireland also has a newer car fleet than the GB average which is already accounted for in the inventory;
- The van fleet in Scotland is newer than the GB average, while in Wales the van fleet is older;
- The fleet of rigid HGVs is older in Wales, but in England and Scotland they are similar;
- The proportion of cars running on LPG, hybrid electric or electric is very small in all countries. The proportion of registered LPG vehicles is slightly higher in Wales and lower in Scotland;
- The proportion of hybrid and electric cars is extremely small everywhere, but is higher in England than in Scotland and Wales.

The effect of using DA-specific fleet data in the calculation of GHG emissions in Scotland and Wales was quantified and compared with estimates currently derived using GB-average datasets. The analysis was not extended to Northern Ireland as country-specific fleet data for cars are already used in the Northern Ireland GHG inventory and no further Northern Ireland-specific datasets have been found.

The effect of each fleet characteristic on total road transport GHG emissions is shown in Table 1. Note that the effects of individual fleet characteristics are not additive; for example,

the effect of car engine size could be different if estimated against a baseline fleet which included DA-specific data on the diesel share of the car fleet. However, the results do give an indication of the magnitude of the effects of using DA-specific fleet data instead of the GB-average data currently used.

Table 1: Change in estimates of GHG emissions from road transport in 2008 when using country-specific data on characteristics of the vehicle fleet in Scotland and Wales compared with current estimates using GB-average fleet statistics.

Fleet characteristic	Scotland	Wales
% diesel cars	-0.02%	-0.1%
Car engine size	-0.7%	-1.0%
Age	-0.8%	+0.4%

Note: A negative number indicates emission estimates are reduced.

Although the effects are not additive, the results suggest that inventory estimates could be **0.5-1.5% lower** in Scotland and Wales if country-specific fleet data were used. This is a large enough difference to warrant further investigation, especially in light of sector targets at DA level for GHG reductions in this key source sector, such as the WAG 3% annual reduction targets for transport emissions.

It was not possible within the timescales of the project to obtain and analyse comparable vehicle speed data for each country to determine whether there were any statistically significant differences to average speeds assumed at GB level. A sensitivity analysis was therefore undertaken to illustrate the range of emissions that could be expected over the range of speeds that are currently used in the UK and DA GHG inventories. The results indicate that the differences in overall road transport carbon dioxide emissions are between 4-7% in each country when adopting the low and high speeds.

However, the study has not included any review or analysis of DA-specific speed data; it is unclear whether such data are available, derived on a comparable basis. Therefore the study has not included any assessment of variability in DA-specific road transport speed data that would impact on emission estimates. Further work would therefore be needed to explore any statistically significant impacts of using DA-specific speed data, depending on the requirements of the DAs to have an inventory that reflect policies that may lead to changes in speeds.

Trip lengths are used to estimate cold start emissions of nitrous oxide from petrol cars. No significant differences in passenger car trip lengths were found for Scotland and Wales compared with the GB average currently assumed in inventories, but trip lengths are shorter in Northern Ireland. Using Northern Ireland-specific data increases estimates of cold start emissions of nitrous oxide by only 0.4%. There may be more significant differences in the inventories for air quality pollutant emissions from using DA-specific trip length data.

No information has been found that provides data on the consumption of biofuels in the road transport fleet across the DAs. There are differences in the number of LPG vehicles licensed, but these are presently regarded as too insignificant to warrant any change in the method to allocate LPG emissions between countries.

Finally, the potential for accurately representing the effects of GHG reduction policies and measures introduced by each DA in the inventories has been considered, based on the current methodology used to derive DA road transport inventory estimates:

- Where a DA transport policy has a direct impact on vehicle kilometres or changes in the vehicle fleet mix, then the impacts of the policy WILL be reflected within the DA inventories.
- Where DA policies may lead to changes in factors such as driver behaviour, vehicle speeds or traffic flow, which may lead to a reduction in the fuel consumption per

vehicle kilometre, then the impacts of the policies will be reflected in the UK fuel sales data for the road transport fleet. In this event, a local policy action will affect national fuel use figures, and the effects will be smeared across the UK emission estimates, rather than explicitly within the DA inventory.

- In all cases, the impacts of a specific policy are not identifiable in isolation within the emissions inventory dataset. Tracking the impacts of a specific policy for the purposes of policy evaluation and development will therefore necessitate supplementary data gathering on behalf of DA transport policy teams. The impacts of other (UK or DA) policies and external factors will also affect road transport emissions.

The main study findings and recommendations are that:

- ✓ DA-specific fleet data and trip lengths should be incorporated as a method improvement for the DA inventory estimates, at the earliest opportunity;
- ✓ Further investigation on the use of speed data and further developments of the models for examination of policy interventions should also be considered,subject to the priorities of the DAs.

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1 Introduction

The Greenhouse Gas Inventories for road transport in Scotland, Wales, Northern Ireland and England (hereafter called the DA (Devolved Administration) Inventories) are calculated in the same way as for the UK's Greenhouse Gas Inventory (UK GHGI, see MacCarthy et al, 2010 and Sneddon et al, 2010). The inventory combines emission factors for different types of vehicles with annual kilometres travelled (vehicle km) by each vehicle type on different types of roads. For road transport, the greenhouse gases refer to emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) and emission factors are used for each of these pollutants and for fuel consumption (FC) which is converted to carbon dioxide on the basis of the carbon content of petrol and diesel fuels.

For fuel consumption and carbon dioxide emissions, the method uses functions which relate emission factor in grammes per kilometre to average speed of the vehicle on each type of road, average speed being used as an indicator of the traffic situation on different roads and how they affect emissions. For nitrous oxide, emission factor-speed relationships are not available owing to lack of measurements and sources provide only road type emission factors for three classes of roads: urban, rural and motorways. For methane, emission factor speed relationships are available for light duty vehicles, but only road type factors for heavy duty vehicles.

Emission factors are available for a range of different vehicle types, engine sizes, vehicle weights and fuels (petrol and diesel). They are further broken down by the European regulatory emission standard the vehicle complied with when manufactured and first registered. Although greenhouse gas emissions from road vehicles are not currently regulated, they are influenced by measures brought in to control air pollutant emissions which are subject to the Euro emission standards. Moreover, the fuel efficiencies and carbon dioxide emissions from new vehicles have been gradually improving over time as engine and vehicle technologies improve. The consequence of this is that emission factors of greenhouse gases depend on when the vehicle was first registered and hence in any one year on the age distribution of vehicles in the fleet, as well as fuel mix (petrol or diesel, in the case of passenger cars and vans) and vehicle sizes.

In the case of nitrous oxide, account is also taken of the excess emissions that occur from petrol cars when the vehicle starts a trip with its engine cold and the catalytic converter not functioning properly. The calculation of cold start emissions requires data on the average length of trips so the number of trip starts can be derived.

There is no reason to believe that emission factors for a given vehicle type should be any different across the DAs, but the DA inventories are not currently reflecting any regional differences in the composition of the fleet in terms of age distribution and fuel mix or in driving behaviour and traffic situations (reflected by average speeds) or trip lengths. At present, the assumptions made on all these parameters in the inventory are the same as for the UK across all the DAs with the exception of Northern Ireland where local licensing data have been used to define the fleet composition. The assumptions at UK level are largely based on information provided by the Department for Transport (DfT). This restricts the DA inventories' abilities in reflecting transport and climate change policies in each country.

In April 2010, a workshop was held at Defra offices in London with officials from DECC, DfT, representatives of each of the DAs and members of the inventory team to discuss the current methodologies used in the DA inventories and how they could be improved to make them more country-specific and able to be sensitive to DA-specific policies, either currently or in the future. The inventory needs and expectations of each DA were discussed, and the actions for the inventory agency were to:

- Explore availability and use of DVLA data for regional fleet information

- Consider adding UK-fuel unconstrained data to the inventory pivot table, to increase visibility of data
- Consider requests to increase transparency of DA road transport inventory by adding details of assumptions and data
- Provide feedback on where information and data are missing that would be useful

It was subsequently agreed that a scoping study should be carried out to consider the possibility of acquiring and using more country-specific features in the DA inventories. The study would identify a number of key areas where there might be regional differences in parameters affecting emissions in each country and which could be sensitive to DA policies. Particular emphasis would be given to differences in the composition of the vehicle fleet by interrogating DVLA licensing data at country-level for Scotland, Wales and England particularly in terms of age composition and therefore Euro standard mix, the fraction of diesel cars in the car fleet and variations in car engine size.

This report describes the findings of this scoping study, presenting results from analysis of data showing regional differences in the various parameters targeted for investigation and the effect these have on greenhouse gas emissions in each country in relation to current estimates based on UK-wide assumptions.

This is the first stage in the possible implementation of these data in the DA inventories and considers the practicalities of making these improvements. It is envisaged that after circulation of the report there will be dialogue with the DAs to discuss the outcome of the research and to agree an implementation plan for improvements to future DA inventories.

Section 2 of this report outlines the overall approach undertaken and the areas identified for analysis following feedback from DA officials to a series of questions.

The following sections present results from detailed analysis of data collected for each country relevant to the study, highlighting regional differences and the impact they have on emissions.

Sections 3-6 summarise for each DA country the effect that the use of potential country-specific data has or could have on emissions.

Section 7 considers the potential for capturing the effects of GHG reduction policies and measures introduced by each DA in the inventories in the context of the DA-specific transport trends and features considered in the study

The final section provides a summary and conclusions of the scoping study with recommendations on implementation of country-specific data into the greenhouse gas inventories.

The focus of the study was on greenhouse gas emissions. However, many of the findings are relevant to inventories for air pollutant emissions too, though for these pollutants there are some other factors expected to have regional differences such as ambient temperature which would need to be considered. This was outside the scope of the current study.

2 Overall Approach and Data Considered

From the discussions held at the meeting with DAs in April 2010 and from giving further consideration to the needs of the DAs not currently met by the DA inventories for road transport, the following areas were considered of particular relevance to the scoping study:

- Differences in fleet composition by age, fuel mix and car engine size
- Differences in average speeds driven
- Differences in car trip length
- Differences in the use of alternative fuels (LPG) and biofuels

Each DA was initially contacted to gauge their opinions on where the relevant information could best be found, what transport or climate change policies were being developed now or in the future that would benefit from more country-specific inventories and what emission models or data sources they were aware of that were currently being used to develop or evaluate these policies.

The following questions were asked of each DA:

1) *Are there any transport models used within your country which contain fleet composition, vehicle age distribution and fuel mix information that are specific to your region?*

2) *Is the average speed of vehicles in your country the same as the GB average on the same type of road, or do you have alternative speed data (modelled or measured by surveys) which suggest different traffic behaviour?*

3) *Do you have any data, perhaps from travel surveys on average trip length?*

4) *Do you currently have any emissions model which calculate GHG or air quality emissions for your region and can be considered for use in the DA inventory?*

5) *Do you have regional data on consumption of LPG and biofuels? For example, whether there is a higher/lower percentage of biofuels consumed or supplied in your country compared with the UK average, or programmes which require captive fleet running on biofuels?*

6) *Are there any specific road transport policies that you would like to capture in the DA GHGI, for instance, policy on biofuels, speed limits, fleet mix, or even future policy like implementation of Low Emission Zones (LEZ)?*

Officials from Scotland, Wales and Northern Ireland each made helpful responses to these questions and based on these responses the analysis described in the following sections was carried out. The general impression gathered from the responses was as follows:

a) <u>Fleet data</u>

The consensus in Scotland and Wales was that the best source of data would be from DVLA's vehicle registrations database. Licensing data for vehicles in Northern Ireland are already used in the DA inventory using information provided by the Department for Regional Development Northern Ireland (DRDNI).

Analysis of DVLA fleet data for Scotland, Wales and Northern Ireland is presented in Section 3.

b) Speed data

There was a general interest among all DAs in this area. All DAs collect speed data based on traffic count data, surveys, moving car methods and traffic models and all were willing to share it or do some further analysis or investigative work of their data. The problem was timescales and the burden it would place on them to provide the data in the format the DA inventory could use.

Some DAs also wanted to know about where the figures used in the UK inventory were sourced, as published in the National Inventory Report. These were either directly from various sources in DfT or were derived by the inventory team from DfT sources based on either models or measurements to provide the figures required for different road and area types in the inventory.

Part of the problem is that speeds vary with time-of-day and with general traffic situation and some published data may refer to only free-flowing traffic which is not representative of traffic all of the time. As the relationship between emission factor and average speed is not a linear one, it makes it difficult to know over what averaging period the average speed should be taken. One also has to take into account the road classifications used when comparing speed data from different sources as in some cases the available speed data were available for “road corridors” rather than by road types.

As well as the burden it would place on DA officials to further analyse their speed data, there was a view that it may not be possible to make valid comparisons between speed data in different countries and that any difference noted would unlikely be statistically different.

After reviewing the responses, our request for speed data from DAs was reconsidered and it was decided to approach the issue by undertaking some modelling tests to see how sensitive the emission estimates are to differences in speeds instead of asking each DA to spend time compiling an alternative data set. Since the speed data currently used in the UK and DA inventories are already based on averages over a range of speeds, it was decided to estimate emissions over ranges of speed applied to each main road type so that we could then gauge how important it would be to request and then use DA-specific speed data for the DA inventories. The procedures followed in this sensitivity test are described in Section 4.

c) Trip length

Information on average trip lengths for passenger cars was available or could be derived from related statistics for Scotland, Wales and Northern Ireland in travel surveys and statistics publications published by each DA. Analysis is described in Section 5.

d) Transport emission models

Scotland did have models that calculated overall emissions and projections, but these models used the same average speed-related emission factor and modelling approaches as currently used in the UK GHGI and DA inventories.

e) Fuels data

None of the countries had any specific data on consumption of alternative fuels and biofuels. The only figures available are the total sales figures for petrol and diesel, data which are also available for England, Scotland, Wales and Northern Ireland in the "*Digest of UK Energy Statistics*". These are not used in the DA inventories because previous work found that the figures as they relate to ***fuel consumption*** are distorted by cross-border issues (especially in Northern Ireland) and how fuels sold by some retailers such as supermarkets are attributed to one country (e.g. where the business is registered or has it central depot) regardless of where the supermarket ultimately sells the fuel.

Our particular interest in the context of the current study was whether there was any evidence that disproportionately higher or lower amounts of LPG or biofuels were sold or produced in each country for local consumption. This issue is considered further in Section 6

f) Transport policies

This was an area of considerable interest to the DAs. Scotland and Wales have transport or climate change strategies that they were keen the DA inventories could track. Details were provided for these strategies by the DAs and the means for tracking transport-related measures have been considered in the context of the inventory related issued addressed in this study in Section 7.

3 Analysis of DA Vehicle Licensing Data

The current fleet composition data used in the UK GHGI and the DA inventories are based on the annual DfT Licensing Statistics (DfT, 2009) for Great Britain (GB) and the annual Northern Ireland Transport Statistics produced by the Department for Regional Development (DRDNI, 2009). For this study, DfT has provided regional licensing statistics for England, Wales and Scotland between 1994 and 2009 (hereafter referred to as DVLA data) from their Licensing Agency database (DfT, 2010a). The DVLA data for each country have been analysed in terms of different characteristics of the fleet relevant to the inventory and compared against the corresponding figures for Great Britain used in the current DA inventories for Scotland, Wales and England. The figures for Northern Ireland are also shown by comparison. The significance of variations in the individual fleet characteristics for each country is then assessed in terms of the impacts it has on calculated emissions of the greenhouse gases for 2008.

3.1 Proportion of diesel cars in the fleet

Diesel cars are generally more fuel efficient and therefore emit less carbon dioxide per km than petrol cars.

The current DA inventories have taken into account that Northern Ireland has a higher proportion of diesel cars on the road compared with the rest of the UK whilst there is no variation assumed for England, Scotland and Wales in the DA inventories. It has been assumed that the mix of vehicles defined in Northern Ireland licensing statistics are a fair reflection of the vehicle mix on the roads in Northern Ireland.

A complication that arises when considering licensing data for cars concerns the place of registration of company cars. With privately-owned cars it may be reasonable to assume that the car spends most of its time on the road in the region where it is licensed. With company-owned cars, this may not be the case for two reasons. First, the car may be licensed in the region where the company has its registered addressed which may not be the same as where the user lives. Secondly, they are more likely to be used on the road for company purposes over a wider area of the country. A similar situation arises with hire cars. These factors may have a more significant impact when vehicle registrations are analysed over a smaller geographical area, but may not be too restrictive at the DA level.

Nevertheless, this is considered a point to bear in mind and hence the analysis on petrol/diesel car registrations in the DVLA database at DA-level was carried out in two ways.

1. The distinction between private- and company-owned cars was ignored and the proportion of all diesel cars registered in England, Scotland and Wales was used;
2. The proportion of diesel cars in each country was derived on the assumption that privately-owned cars remained in the country where registered so the proportion of cars that were diesel in the private car fleet was as the licensing data indicates, but the GB company-car fleet was equally distributed so that the proportion of cars that were diesel in the company-car fleet was the same as the GB average in all countries.

In fact, the two approaches led to similar results on the overall proportion of diesel cars in the fleet in each country, as shown in Table 3.1 for 2008. The analysis shows that there has been a slightly higher proportion of diesel cars in Wales compared with England and

Scotland consistently across the time-series between 1998 and 2008 while the levels in Scotland and England are very similar as can be seen in Figure 3.1; the values in Scotland were slightly higher than in England in the 1990s, but it appears that England has been converging with Scotland in more recent years.

Table 3.1 Proportion of diesel cars (including both private and company cars) registered with DVLA by region in 2008.

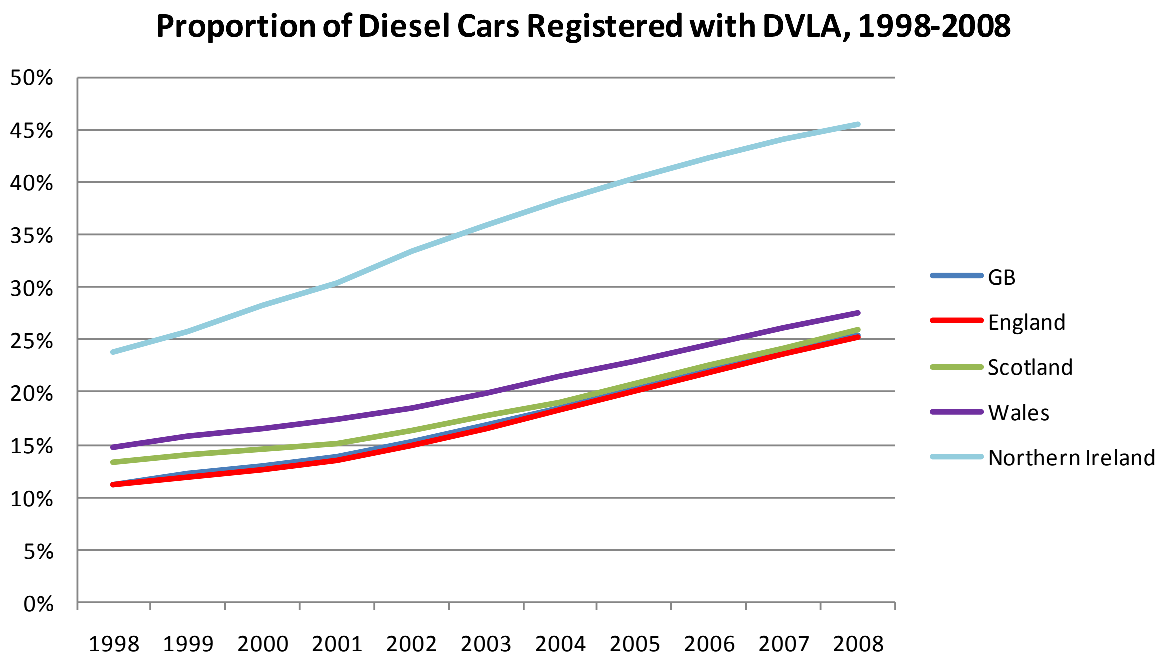
	GB (current assumption)	England	Scotland	Wales	Northern Ireland
% of diesel car registered in 2008					
a) % of all diesel cars registered	25.5%	25.2%	25.9%	27.6%	45.4%
b) % of diesel cars (DA private + GB company)		25.1%	26.4%	28.5%	N/A
% of company car	9%	9%	8%	6%	N/A
of which are diesel (%)	N/A	55%	47%	40%	N/A
Change in CO_2 emissions if using DA-specific data					
Petrol cars			-0.7%	-3.8%	
Diesel cars			1.4%	7.3%	
Total road transport			**-0.03%**	**-0.2%**	
Change in CH_4 emissions if using DA-specific data					
Petrol cars			-0.6%	-3.5%	
Diesel cars			1.4%	7.4%	
Total road transport			**-0.4%**	**-2.0%**	
Change in N_2O emissions if using DA-specific data					
Petrol cars			-0.5%	-3.3%	
Diesel cars			1.4%	7.5%	
Total road transport			**0.2%**	**0.8%**	
Change in GHG (GWP CO_2eq) emissions if using DA-specific data					
Total road transport			**-0.02%**	**-0.1%**	

Note: The values are shown in blue (or red) if they are smaller (or larger) than the GB values currently used in the inventory.

Northern Ireland has consistently shown much higher proportions of diesel cars in the fleet and this is already taken into account in the DA inventory.

Sensitivity tests were carried out to see what impact the differences in diesel car fleets in Scotland and Wales have on the greenhouse gas emissions calculated for these countries compared with current estimates which assume GB-average values on diesel car proportions. The results are shown in Table 3.1 as percentage change in emissions from petrol and diesel cars and for all road transport calculated for Scotland and Wales in 2008. Clearly, assuming higher proportions of diesel cars in the fleets increases the emissions from diesel cars and reduces emissions from petrol cars compared with current estimates, but overall the effect on GHG emissions from road transport is very small.

Figure 3.1 Proportion of diesel cars (including both private and company diesel cars) registered by DA regions from 1998 to 2008.



There is virtually no change in estimates of carbon dioxide emissions in Scotland and a 0.2% reduction in Wales. The changes are slightly larger for methane and nitrous oxide, but GHG emissions from road transport are dominated by carbon dioxide and the overall impact on total GHG emissions is a 0.02% decrease in Scotland and a 0.1% decrease in Wales.

3.2 Variation in petrol and diesel car engine sizes

Smaller engine cars are more fuel efficient than cars with larger engines and therefore emit less carbon dioxide.

The current inventory uses the proportion of cars by engine size varying each year from 2000 onwards based on the DfT's vehicle licensing data for Great Britain (DfT, 2009) and applies the same assumption to each DA country. In this section, the regional variation in proportions of cars by engine size based on the DVLA data for England, Scotland and Wales, and the likely impact on GHG emissions have been reviewed. The Northern Ireland Transport Statistics (DRDNI, 2009) have combined private and light goods vehicles licensed by engine size together and so it has not been possible to carry out the same analysis for Northern Ireland and so is not included in the comparisons below.

The DVLA data have shown that there has been a growing trend in the sales of bigger and smaller engine-sized cars in recent years, in particular for diesel cars at the expense of medium-sized cars. These trends are evident across England, Scotland and Wales (Figure 3.2). Scotland and Wales have slightly higher proportion of smaller engine-sized petrol cars than England and smaller proportions of larger engine-sized cars, while the proportion of diesel cars by engine size is very similar across the three DAs. Table 3.2 shows the impact on carbon dioxide emissions in 2008 when adopting country-specific data on car engine size in the inventory. Such an analysis could not be carried out on methane or nitrous oxide because emission factors are not available for different engine sizes for these pollutants due to lack of data.

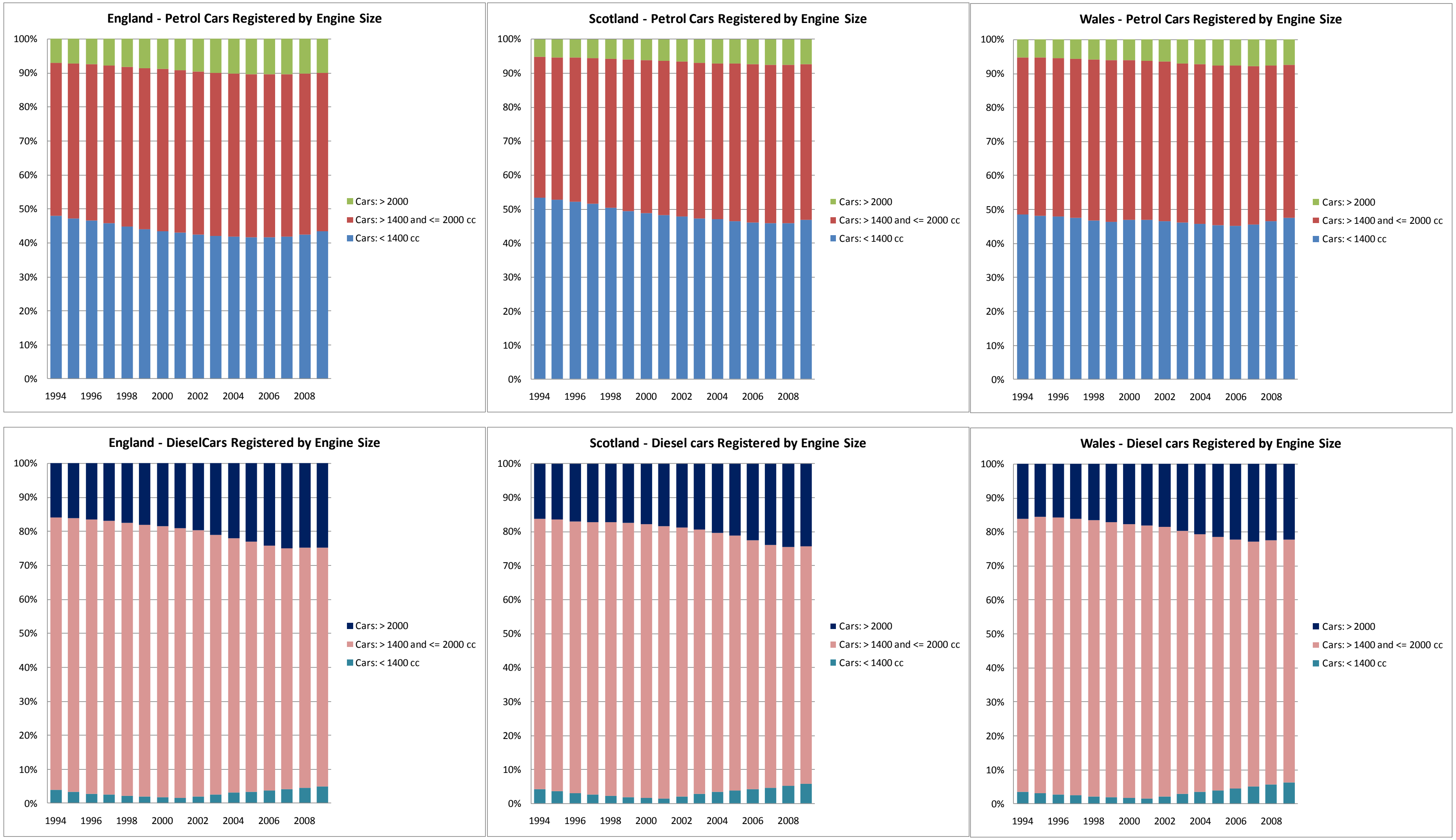
The analysis indicates that using country-specific data on car engine sizes would reduce total carbon dioxide emissions from road transport by 0.7% in Scotland and 1% in Wales.

Table 3.2 Proportion of cars registered in 2008 by engine sizes and DA regions, and changes in CO_2 emissions if DA-specific data are adopted.

	NAEI	England	Scotland	Wales	Northern Ireland
Petrol cars by engine size in 2008					
Petrol Cars: < 1400 cc	44.0%	42.5%	46.0%	46.5%	N/A
Petrol Cars: > 1400 and <= 2000 cc	45.9%	47.4%	46.5%	45.9%	N/A
Petrol Cars: > 2000	10.1%	10.2%	7.5%	7.5%	N/A
Diesel cars by engine size in 2008					
Diesel Cars: < 1400 cc	6.7%	4.6%	5.2%	5.8%	N/A
Diesel Cars: > 1400 and <= 2000 cc	68.4%	70.6%	70.4%	71.7%	N/A
Diesel Cars: > 2000	24.9%	24.9%	24.4%	22.5%	N/A
Change in CO_2 emissions if using DA-specific data					
Petrol cars			-1.7%	-1.8%	
Diesel cars			0.0%	-1.0%	
Total road transport			**-0.7%**	**-1.0%**	

Note: The values are shown in blue (or red) if they are smaller (or larger) than the values based on the current assumption used in the NAEI.

Figure 3.2 Petrol cars (top) and diesel cars (bottom) registered in England, Scotland and Wales by engine sizes, 1994 to 2009.



3.3 Age of the fleet

The emissions inventory depends on the age distribution of the fleet because newer vehicles are made to tighter emission regulations and are more fuel efficient than older vehicles, though for carbon dioxide the differences are quite small and for nitrous oxide, a non-regulated pollutant, older vehicles may actually be lower emitting than newer ones or, in the case of HGVs, emission are not known to have any dependence on age.

The current DA inventories assume that the age of the fleet for Great Britain as a whole applies equally to England, Scotland and Wales. Previous analysis on licensing data by post-town in 1995 had indicated the age of the fleet was very similar in England and Wales but somewhat newer in Scotland. However, this information was not used as it was felt that vehicles are not necessarily used on the roads in the regions where they are registered, and this would be particularly true for company cars and commercial vehicles. However, this aspect is being re-assessed with the use of more recent DVLA data that were made available in this study.

For Northern Ireland, the situation is slightly different. Vehicle licensing statistics for private and light goods vehicles (PLG) are available in Northern Ireland Transport Statistics from the Central Statistics and Research Branch of the Department of Regional Development in Northern Ireland (DRDNI, 2009). These show a newer fleet of these vehicles than in Great Britain. It has always been felt likely that most of the light duty vehicles on the road in Northern Ireland will be those licensed in Northern Ireland and *vice versa*. Hence the current DA inventory has taken into account that Northern Ireland has a newer car fleet on the road.

The following sections compare the age of cars, diesel LGVs (vans) and rigid HGVs as registered in England, Scotland and Wales in 2008 with the corresponding figures for GB as a whole which are used in the UK GHGI and currently in the DA inventories for these countries. The analysis was not extended to Northern Ireland because the licensing data from DRDNI does not provide age distribution figures separately for cars and LGVs, but for these vehicles combined, although the newer fleet of light duty vehicles evident in Northern Ireland probably does indicate that the car fleet in Northern Ireland is newer than the GB average.

The age distribution is represented in the following sections in terms of the distribution of vehicles by the Euro emission standard that the vehicle complied with when first registered which is related to the year-of-first registration and hence age of the vehicle in 2008. The figures do not only reflect the age distribution in the population of vehicles registered, but also the change in annual mileage with age, so the figures actually refer to the proportion of kilometres travelled by each Euro class. The same mileage-with-age profiles are used for all DAs, so the differences in figures for each DA are due to the differences in the age of the fleet.

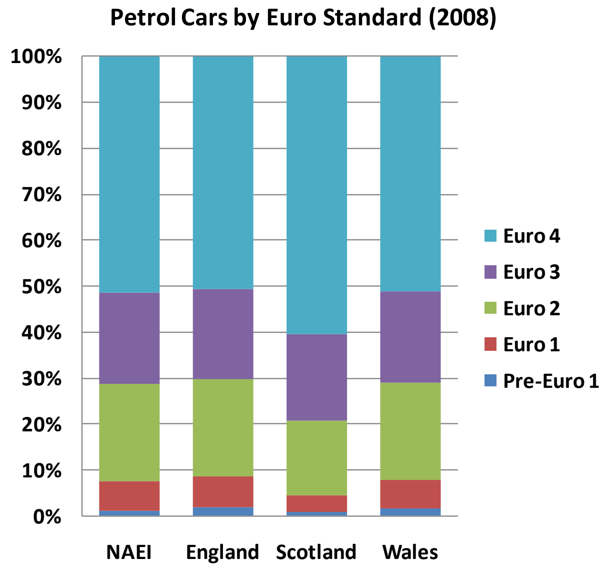
This application of fleet age data in this way is relevant to the calculation of emissions because it is the Euro standard of the vehicles in the fleet and the mileage they travel each year rather than just the vehicle age which determines emissions.

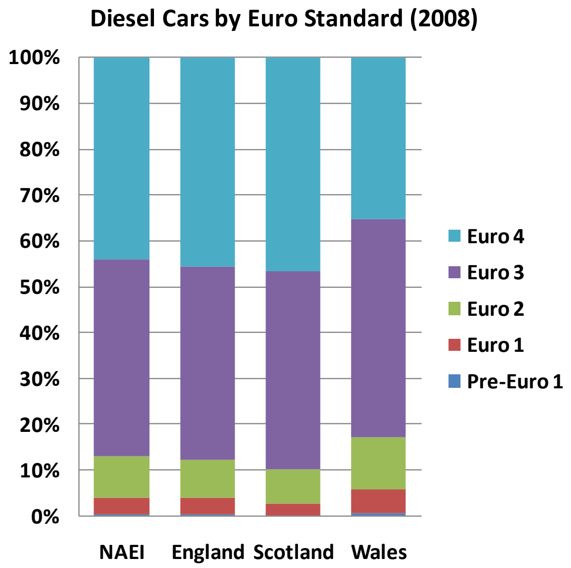
3.3.1 Cars

Figure 3.3 shows the percentage of petrol car and diesel car km travelled by Euro standard for England, Scotland and Wales in 2008 calculated from the DVLA data compared with the GB average used in the UK GHGI and in the current DA inventories for these countries.

The data indicate that petrol cars in England and Wales have similar age profiles (or proportion of vehicles by Euro Standard) in 2008 to the current GB profile while Scotland has a newer petrol car fleet. For diesel cars, England and Scotland have similar age profiles in 2008 to the current GB profile while Wales appears to have an older diesel car fleet.

Figure 3.3: Comparison between the GB fleet composition in 2008 as used in the UK GHGI (marked as NAEI) and fleet composition defined by DVLA data for England, Scotland and Wales for petrol cars (left) and diesel cars (right).



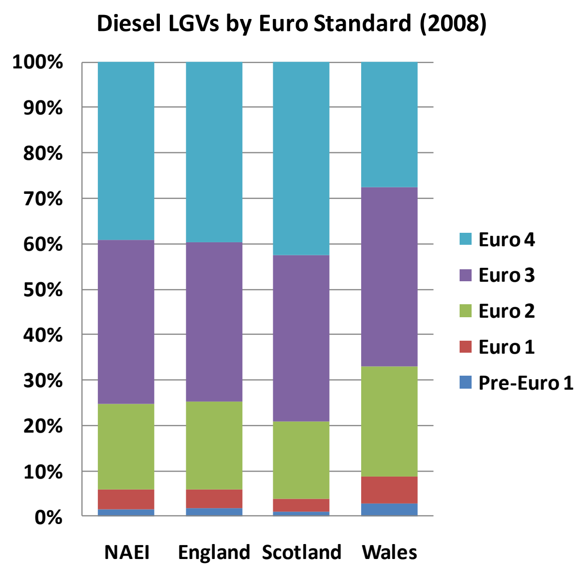


Note: Figures are expressed in terms of proportion of kilometres travelled by cars made to different Euro emission standards.

3.3.2 Diesel Light Good Vehicles (LGVs)

Figure 3.4 shows the percentage of diesel LGV (van) km travelled by Euro standard for England, Scotland and Wales in 2008 calculated from the DVLA data compared with the GB average used in the UK GHGI and in the current DA inventories for these countries. The data indicate that Scotland has a slightly newer LGV fleet compared with the GB average while Wales has an older fleet of vehicles. The analysis was not carried out on petrol LGVs as there are far fewer of these vehicles on the road compared with their diesel counterparts.

Figure 3.4: Comparison between the GB fleet composition in 2008 as used in the UK GHGI (marked as NAEI) and fleet composition defined by DVLA data for England, Scotland and Wales for diesel LGVs.



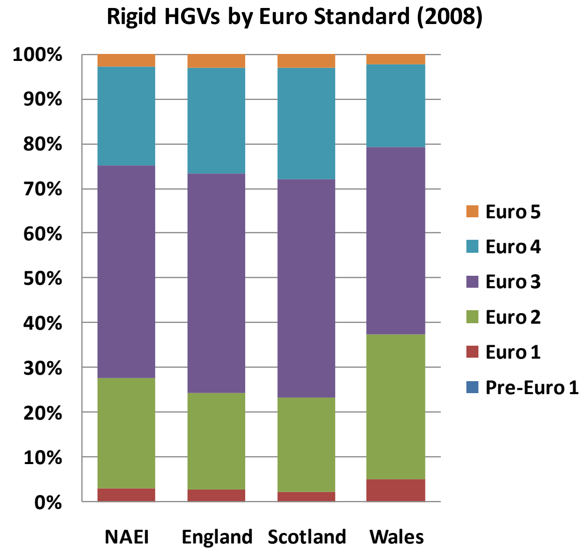
Note: Figures are expressed in terms of proportion of kilometres travelled by LGVs made to different Euro emission standards.

3.3.3 Rigid HGVs

Figure 3.5 shows the percentage of rigid HGV km travelled by Euro standard for England, Scotland and Wales in 2008 calculated from the DVLA data compared with the GB average used in the UK GHGI and in the current DA inventories for these countries.

The data indicate that rigid HGVs in England and Scotland have similar age profiles while the fleet in Wales is rather older.

Figure 3.5: Comparison between the GB fleet composition in 2008 as used in the UK GHGI (marked as NAEI) and fleet composition defined by DVLA data for England, Scotland and Wales for rigid HGVs.



Note: Figures are expressed in terms of proportion of kilometres travelled by HGVs made to different Euro emission standards.

The age profile of larger, articulated HGVs was not investigated because it is felt that these vehicles do longer distance journeys and spend less time in the areas where they are registered compared with smaller vehicles. Buses were also not investigated because there are likely to be variations in local bus fleets according to local authority measures to address air quality concerns that will not be reflected by licensing information, while coaches are like articulated HGVs and spend less time in the areas where they are registered.

3.3.4 Impacts on Greenhouse Gas (GHG) Emissions

The comparisons above have indicated that overall Scotland tends to have a slightly newer vehicle fleet while Wales has an older vehicle fleet compared with the GB average. The likely impacts on GHG emissions have been estimated by combining the current UK GHGI and the DA-specific fleet compositions with the average fuel consumption/CO_2, CH_4 and N_2O emission factors by Euro Standard (MacCarthy et al., 2010). The percentage changes in emissions in 2008 are shown in Table 3.3.

Note that for carbon dioxide, the effect on rigid HGV emissions was not estimated because the calculation of their emissions is based on national fleet-average fuel efficiency factors for HGVs provided in DfT's Continuous Survey of Road Goods Transport (CSRGT) rather than factors for different Euro standards (DfT, 2010b) so the age of the fleet is implicit to the fleet-averaged factors provided by the CSRGT. The use of these factors for estimating HGV fuel consumption and emissions of carbon dioxide is described in the national inventory reports (MacCarthy et al., 2010). The survey of hauliers is done on a GB scale and the same factors are used for all countries in the DA inventory. There are no fuel efficiency factors available for HGVs operating in each DA.

Table 3.3 Changes in carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions based on regional DVLA data on vehicle age in 2008 compared with current estimates based on GB-averaged fleet data.

	England	Scotland	Wales
Change in CO_2 emissions (DVLA vs NAEI fleet)			
Petrol cars	0.3%	-1.5%	0.1%
Diesel cars	-0.2%	-0.6%	1.0%
Diesel LGVs	0.0%	-0.5%	0.7%
Rigid HGVs			
Change in CH_4 emissions (DVLA vs NAEI fleet)			
Petrol cars	7.4%	-18.3%	3.9%
Diesel cars	-1.4%	-7.6%	10.9%
Diesel LGVs	1.1%	-7.4%	16.7%
Rigid HGVs	-2.5%	-4.0%	5.9%
Change in N_2O emissions (DVLA vs NAEI fleet)			
Petrol cars	2.3%	-22.1%	0.0%
Diesel cars	0.1%	0.4%	-0.5%
Diesel LGVs	-0.2%	1.0%	-1.8%
Rigid HGVs			
Change in GHG (GWP CO_2eq) emissions (DVLA vs NAEI fleet)			
Total road transport*	0.1%	-0.8%	0.4%

Note: Figures are shown in red (or blue) if the emissions results based on DA-specific age data have increased (or decreased) as compared to the current DA inventory based on GB fleet data.

*This include changes due to cars & LGVs only when adopting DVLA data

Emissions of methane and nitrous oxide from HGVs are calculated using fleet composition data and emission factors. However, for nitrous oxide the same emission factors are provided for all Euro standards because the effect of each Euro standard on emissions of this pollutant is not known. So, again, differences in the age of the HGV fleet will have no bearing on nitrous oxide emissions and therefore this was not included in the analysis. The effect of DA-specific fleet information on HGVs could only be assessed for methane which is a relatively unimportant source of GHG emissions from road transport.

For Scotland, using the newer car/LGV/rigid fleet will generally lead to a reduction in GHG emissions compared with current estimates based on the composition of the GB fleet. By contrast, the older fleet in Wales will lead to an increase in carbon dioxide and methane emissions, but a reduction in nitrous oxide emissions compared with current estimates based on the composition of the GB fleet. Table 3.3 shows the overall effect of use of DA-specific fleet data for cars and LGVs in England, Scotland and Wales on total road transport emissions of carbon dioxide, methane and nitrous oxide in each DA and the overall effect on total GHG emissions (the effect on HGV emissions was excluded for reasons outlined above).

Overall, the use of DA-specific fleet data on road transport emissions of carbon dioxide is small (<2% for all vehicle types), but larger for methane and nitrous oxide. The overall effect on total GHG emissions (CO_2eq) is <1%.

Because of the effect of Euro standards on controlling air pollutant emissions (e.g. NO_x, PM_{10}), the effect of using DA-specific age data is likely to be more significant than for the greenhouse gases.

3.3.5 Cars using alternative fuels and technologies

The dominant types of fuel used by cars are either petrol or diesel and only a very small proportion of cars are currently registered as using alternative fuels or technology. However, these are expected to increase in the future due to the promotion of uptake of low carbon vehicles. Table 3.4 shows the proportion of cars registered as running on LPG/gas, hybrid electric and electric cars by DA country in 2008. It can be seen that these currently make up no more than 0.2% of the car population in all the DAs.

Table 3.4 Proportion of Cars Registered as Alternative Fuel/Technologies in 2008

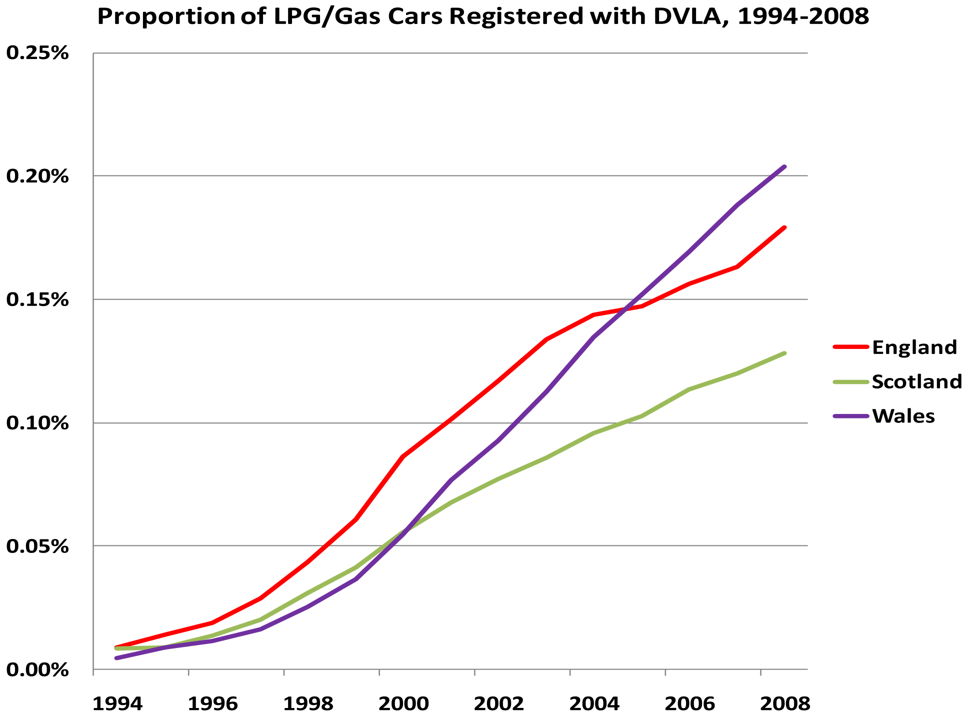
	England	Scotland	Wales	Northern Ireland
% of alternative fuel/technologies cars in 2008				
LPG/ gas	0.18%	0.13%	0.20%	N/A
Hybrid electric	0.18%	0.10%	0.06%	N/A
Electric	0.0053%	0.0009%	0.0004%	N/A
Other[a]				0.1%

a. The figure represents private and light goods tax group licensed in 2008 (DRDNI, 2010)[1]

Figure 3.6 shows how the proportion of LPG/gas cars registered in England, Scotland and Wales varies over time (1994-2008). Scotland has the lowest proportion compared to England and Wales but they all increase with time, though remaining at very low levels. There is an issue with licensing data on LPG vehicles in that many vehicles (usually vans or cars) are converted to run on this fuel and it is down to the vehicle owner to inform the DVLA of these conversions so the licensing data may not reflect a true record on the population of vehicles running on LPG. Consumption figures for LPG tend to support this as consumption appears to be higher than the population figures suggest, although it still is very small compared with consumption of petrol and diesel.

[1] Figure was obtained from Table 1.6 in Northern Ireland Transport Statistics 2009-10, Department for Regional Development (DRDNI).

Figure 3.6 Proportion of cars registered as LPG/Gas in England, Scotland and Wales, 1994-2008.



4 Analysis of Speed Data

Average traffic speeds on different road types in Great Britain that are used in the current DA inventory methodology are shown in Table 4.1. These data are published in the most recent UK Greenhouse Gas Inventory report (MacCarthy et al., 2010).

The speed data were derived from a number of sources;

- for principal urban roads in conurbations or urban areas, average speeds were based upon information provided in DfT’s Road Statistics 2006: Traffic, Speeds and Congestion (DfT, 2007a);
- for roads in rural areas, average speeds were based on information provided in DfT's Free Flow Vehicle Speed Statistics 2007, Table 3 (DfT, 2007b); and
- for other roads, data were obtained from 2008 national road traffic and speed forecasts (DfT, 2008).

Each of the Devolved Administrations were asked if they hold any alternative data on the average speed of vehicles in the DA, whether it be modelled or measured by traffic surveys which suggest different traffic behaviour from the GB average speeds in Table 4.1.

Table 4.1: Average Traffic Speeds in Great Britain

		LDV	HGV	Buses
		kph	**kph**	**kph**
URBAN ROADS				
Connurbation	Major principal roads	31	31	24
	Major trunk roads	38	37	24
	Minor roads	30	30	30
	Motorways	97	82	82
Urban	Major principal roads	36	36	32
	Major trunk roads	53	52	32
	Minor roads	35	34	29
	Motorways	97	82	82
RURAL ROADS				
Rural single carriageway	Major roads	77	72	71
	Minor roads	61	62	62
Rural dual carriageway		111	90	93
Rural motorway		113	90	95

Source: 2008 NAEI, MacCarthy et al., 2010.

As indicated in Section 2, responses from the Devolved Administrations indicated that whilst such data may be available in the future, it would take a significant amount of time to compile and analyse collected data. It was therefore decided not to pursue this further in the current project, but to consider this later if necessary following further analysis of current speed data.

Potential data sources mentioned, and to be re-considered at a later date, included:

Northern Ireland

- Roads Service Annual Census Data, which includes over 300 automatic count sites across the region;
- Monitoring of the Regional Transportation Strategy.

Scotland

- Traffic Scotland automatic traffic counters;
- LATIS modelled data on average speeds;
- Commercially available fleet vehicle trip data e.g. ITIS, MapMechanics.

Wales

- Data collected by automatic traffic counters on Welsh trunk roads.

Following responses from all the DAs, it was decided to use an alternative approach for the current study to assess how sensitive emission estimates are to differences in speeds. Sensitivity tests were undertaken for Scotland, Northern Ireland and Wales using DA-specific vehicle-km data and maximum and minimum (or 'High' and 'Low') speeds for cars, LGVs and HGVs on different road types which currently form the basis of the figures in the UK GHGI and DA inventories. The speeds used in the sensitivity tests are shown in Table 4.2 and were applied to the analysis for all DAs.

Table 4.2: Low and high speeds by vehicle and road type used in speed sensitivity tests

Vehicle type	Road type	Low speed (kph)	High speed (kph)
Cars and LGVs	Urban	30.5	53.5
	Rural	61.5	110.8
	Motorway	96.7	113.3
HGVs	Urban	29.9	52.4
	Rural	61.8	90.2
	Motorway	82.0	90.5

The approach therefore aimed to illustrate to all DAs the range of GHG emissions that could be expected over a wide range of speeds that would hopefully capture the speeds applicable to each DA. It would then be possible to gauge how important it would be to source DA-specific data given the effort required of the DAs to generate it.

The 2008 UK GHGI utilises the set of functions relating fuel consumption factors (in g fuel/km) and methane emissions to average speed which were generated by TRL on behalf of DfT and published in 2009 (Boulter et al, 2009).

Since fuel consumption for all vehicles and emissions of methane for cars and LGVs are speed dependent, total emissions calculated for each DA were compared for the low and high speed scenarios. Table 4.3 and Table 4.4 show the percentage differences in fuel consumption (hence CO_2 emissions) and methane, respectively, between the low and high speed modelled scenarios calculated for each vehicle type across all road types in each DA for the period 2002 – 2008. A percentage increase (red) indicates that fuel consumption or methane emissions increase at higher speeds; while a percentage decrease (blue) indicates a decrease at higher speeds.

It was not possible to carry out this analysis for nitrous oxide because the emission factors for this pollutant are only available for three general roads types (urban, rural and motorway) and not as continuous speed-functions.

Table 4.3: Difference in fuel consumption between low and high speeds by vehicle type in each Devolved Administration

% change fuel consumption	2002	2003	2004	2005	2006	2007	2008
Northern Ireland							
Petrol cars	2.1%	1.9%	2.0%	2.0%	1.9%	2.0%	1.8%
Diesel cars	4.9%	4.8%	5.0%	5.0%	5.0%	5.0%	4.9%
Petrol LGVs	20.6%	18.6%	17.2%	15.7%	14.3%	13.3%	12.1%
Diesel LGVs	30.3%	31.3%	32.7%	33.8%	34.4%	35.3%	35.5%
HGV rigid	3.1%	3.1%	2.7%	2.8%	2.9%	3.2%	3.1%
HGV artic	-1.7%	-2.1%	-2.1%	-2.0%	-1.4%	-0.3%	0.0%
Total road transport	**5.3%**	**5.2%**	**5.6%**	**5.8%**	**6.0%**	**5.8%**	**5.6%**
Scotland							
Petrol cars	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%
Diesel cars	3.8%	3.9%	3.9%	3.8%	3.9%	3.9%	3.9%
Petrol LGVs	18.5%	16.6%	14.4%	13.0%	12.0%	11.5%	10.5%
Diesel LGVs	27.6%	28.4%	28.7%	29.4%	30.2%	31.5%	31.7%
HGV rigid	2.4%	2.4%	2.5%	2.4%	2.5%	2.9%	2.8%
HGV artic	1.0%	1.0%	0.9%	1.1%	1.2%	1.4%	1.6%
Total road transport	**4.0%**	**4.2%**	**4.3%**	**4.6%**	**4.8%**	**5.3%**	**5.4%**
Wales							
Petrol cars	0.5%	0.6%	0.6%	0.5%	0.6%	0.5%	0.6%
Diesel cars	3.8%	3.9%	4.0%	4.0%	4.1%	4.0%	4.1%
Petrol LGVs	19.9%	18.0%	16.1%	14.7%	13.6%	12.5%	11.9%
Diesel LGVs	29.2%	30.2%	30.9%	31.8%	32.8%	33.4%	34.4%
HGV rigid	2.9%	2.7%	2.9%	2.9%	2.9%	3.2%	3.3%
HGV artic	1.7%	1.5%	1.4%	1.8%	1.7%	1.9%	2.0%
Total road transport	**4.5%**	**4.8%**	**5.1%**	**5.4%**	**5.6%**	**5.9%**	**6.3%**

Table 4.4: Difference in methane emissions between low and high speeds by vehicle type in each Devolved Administration

% change methane emissions	2002	2003	2004	2005	2006	2007	2008
Northern Ireland							
Petrol cars	0.8%	0.5%	1.2%	1.1%	-0.1%	-0.9%	-2.4%
Diesel cars	-16.6%	-17.7%	-18.8%	-19.7%	-20.7%	-21.6%	-22.1%
Petrol LGVs	3.5%	3.0%	3.8%	4.0%	2.9%	2.2%	0.3%
Diesel LGVs	12.1%	3.7%	-3.5%	-10.7%	-16.8%	-20.9%	-24.4%
Total road transport	**-0.3%**	**-0.7%**	**-0.7%**	**-1.0%**	**-1.8%**	**-2.4%**	**-3.3%**
Scotland							
Petrol cars	-6.2%	-5.2%	-5.1%	-5.6%	-5.6%	-6.5%	-7.4%
Diesel cars	-16.8%	-17.6%	-18.8%	-19.9%	-20.7%	-21.7%	-22.1%
Petrol LGVs	1.2%	0.4%	-0.6%	-0.5%	-0.3%	0.4%	-0.9%
Diesel LGVs	9.0%	1.1%	-6.7%	-13.3%	-18.1%	-21.0%	-24.1%
Total road transport	**-4.5%**	**-3.9%**	**-4.0%**	**-4.4%**	**-4.6%**	**-5.3%**	**-6.1%**
Wales							
Petrol cars	-6.2%	-5.0%	-4.3%	-4.8%	-5.0%	-6.1%	-6.3%
Diesel cars	-17.0%	-17.9%	-18.9%	-20.0%	-20.9%	-21.8%	-22.2%
Petrol LGVs	4.4%	4.0%	3.5%	3.2%	3.0%	2.1%	1.7%
Diesel LGVs	12.3%	4.2%	-3.7%	-11.1%	-16.4%	-20.5%	-22.3%
Total road transport	**-4.5%**	**-3.8%**	**-3.5%**	**-4.0%**	**-4.3%**	**-5.3%**	**-5.7%**

There is a note of caution that needs to go with these results. The relationships between average speed and fuel consumption and methane emissions are not linear. They generally adopt a distorted U-shape curve of varying extents, whereby emissions are greatest at low speeds, then decrease to a minimum level at around 60-80km/h and subsequently rise again (or level off) at the highest speeds. For example, Figures 4.1 and 4.2 show the fuel consumption and methane emission-speed curves for a medium-sized engine petrol car. If the low and high speeds happen to be on either side of the bottom of the curve, then the factors derived from them will not capture all the outcomes for emission factors within that range of speeds and therefore some speed scenarios could lead to different (lower) emissions than the ranges indicated by these results suggest. To explore this issue comprehensively would require a more thorough Monte-Carlo type statistical uncertainty analysis which time did not permit. Nevertheless, this analysis does provide an indication of how sensitive emissions are when varying speed assumptions

The results of the speed sensitivity tests show that fuel consumption for diesel LGVs are the most sensitive to these changes in speed (±36%); however, the differences in overall road transport fuel consumption when adopting the low and high speeds, are between 4-7%. The ranges are similar for all the DAs and all years.

For methane emissions, diesel vehicles are more sensitive to change in speed (±22%) but the differences in overall road transport methane emissions when adopting the low and high speeds are between 3-6%. The ranges are different in Northern Ireland compared with those for Scotland and Wales.

Figure 4.1 Fuel consumption by speed for petrol car <2.5 t (1400-2000 cc)

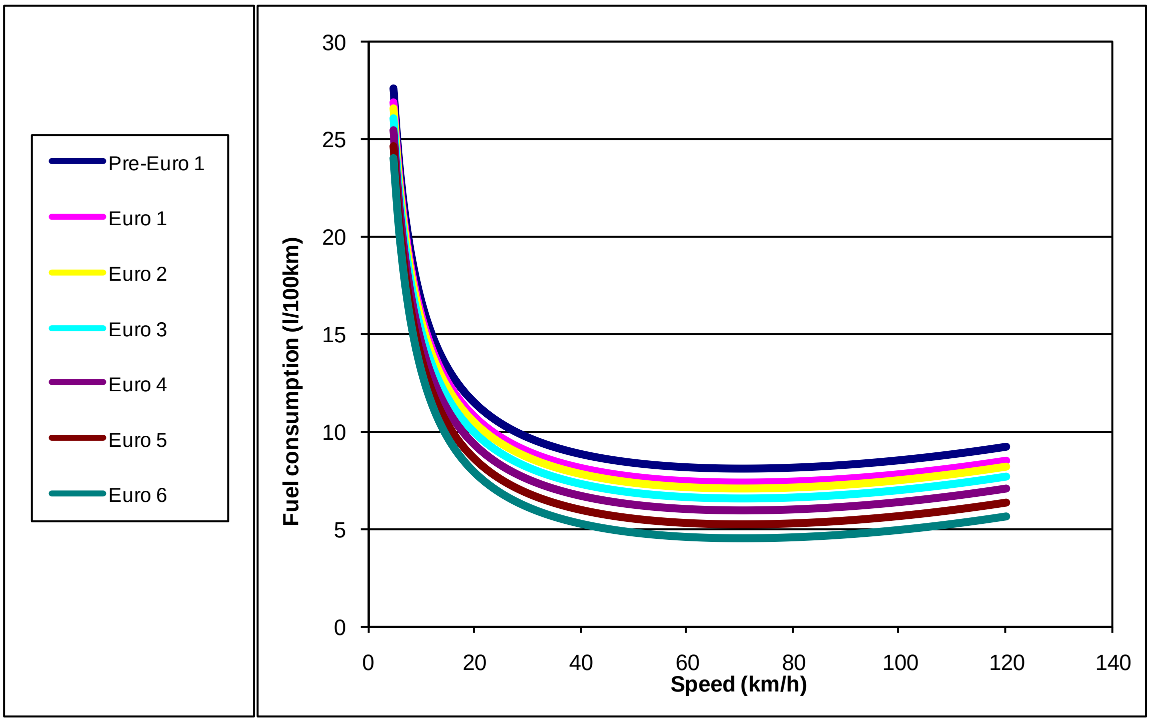
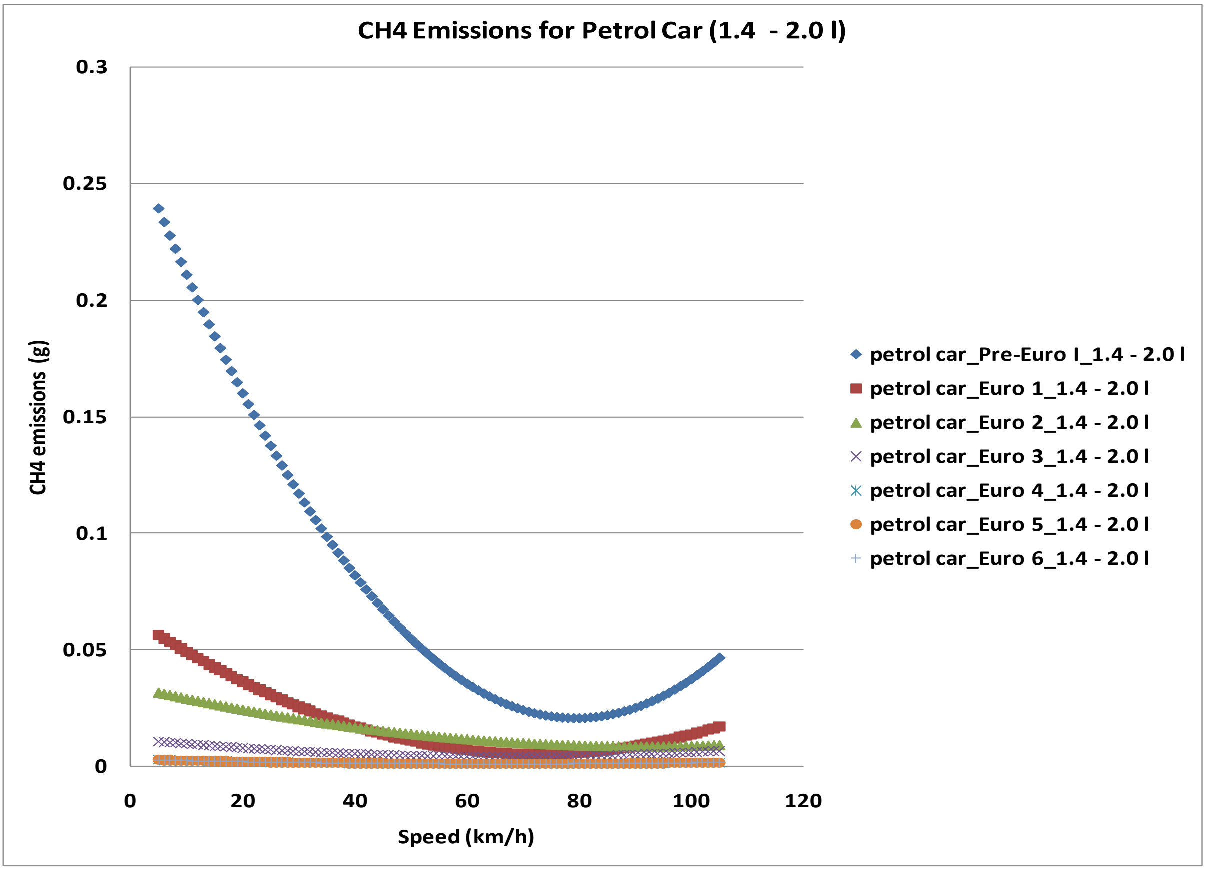


Figure 4.2 Methane emissions by speed for petrol car <2.5 t (1400-2000 cc)



The results highlight the importance of speed in the GHG emission calculations and may stimulate a more in-depth analysis of speed data already held by the DAs from current traffic census or further monitoring of speeds on the road networks in each country. However, some further thought should go into the worthiness of doing so before investing time and money in what could be an expensive and time-consuming exercise. The key issue is the representativeness of any speed data that could be captured for the road network as a whole in each DA and may first require considering whether there is any reason to believe that there could be any statistically significant differences in speeds by vehicles on the same type of roads in Scotland, Wales, Northern Ireland and England, whether these should be any different to the UK average and/or whether there is any reason to think that they might change in time. Deciding what speed data to use in the UK inventory is notoriously difficult because to cover a significantly large number of road types, data come from different sources or collection methods and consistency and comparability between these is an issue. For example, some data may come from traffic models, while others come from measurements or surveys. Some speed data come from measurements at fixed points on a road network, while others come from 'moving car' techniques and refer to average speed of a single vehicle over a distance travelled on a road network. The averaging period is also important. Some speed data refer to different times of the day or days of the week, while others refer to a longer time periods or even during periods when traffic is only free-flowing.

This issue should probably be discussed with the DAs as to the consistency of speeds and whether the DAs think they may have a need for having speed as a variable in the DA inventory so as to be sensitive to policies that they believe may affect average speeds on their road network. A speed measurement or analysis protocol might be considered to provide speed data for the same types of roads across all the DAs that are directly comparable and deemed worthy for using in the DA inventories. Measurements may need to continue at the same sites year on year so as to be able to pick up any statistically significant changes occurring due to DA transport or climate change policies or for any other reasons.

5 Trip Lengths for Passenger Cars

Information on the average length of trips made by passenger cars is used to estimate cold start emissions, the excess emissions that occur at the start of a trip when a car starts with its engine cold. These are particularly important for petrol cars and takes account of the time it takes for the catalytic converter to warm up to its normal operating temperature. In the UK GHGI, cold start emissions are only calculated for nitrous oxide emissions from petrol cars using a methodology described in the National Inventory Report (MacCarthy et al (2010)). Average trip length is used to estimate the total number of trips made per year by dividing the total kilometres travelled by average trip length. The number of trips made per year is used to calculate the cold start emissions.

A review of the cold start emission methodology used in the National Atmospheric Emissions Inventory (NAEI) included a review of national average trip lengths (MacCarthy et al, 2010). The DfT's National Travel Survey gives a value of around 14km, but this was at variance with other estimates from research studies made specifically for cold start emission calculations which suggested a value of 8.4km was more appropriate. The EMEP Emissions Inventory Guidebook suggests using a trip length of 10km for the calculation of cold start emissions in the UK in the absence of national statistics. These differences span a wide range and it is difficult to know what trip length is appropriate for the cold start methodology used. A key issue seems to be what the definition of a trip is according to motorist surveys and possibly how a trip with an intermittent, short-term stop is recorded, i.e. as one long trip or two shorter trips. The value of 10km has been adopted as a mid-point of the range for the purposes of calculating cold start emissions in the UK.

For this study, a review was made of information on average trip lengths in Scotland, Wales and Northern Ireland where these were recorded on a consistent basis, using the same trip definition, to see whether there was any variation across the DA countries that ought to be factored into the calculation of cold start emissions of nitrous oxide.

Cold start emissions are more important for air pollutant emissions such as oxides of nitrogen (NO_x), Non-Methane Volatile Organic Compounds (NMVOCs) and carbon monoxide (CO) than they are for greenhouse gases, so the trip length information reviewed here is more relevant to the calculation of their emissions in each DA. Moreover, trip information is also used to estimate evaporative emissions of NMVOCs from petrol vehicles that occur at the end of journeys (hot soak). These emissions occur due to transfer of heat from the engine and exhaust to the fuel system where fuel is no longer flowing leading to evaporation of fuel from the vehicle when it is parked.

In carrying out this review of trip lengths in each DA for comparison with GB as a whole, the following data sources were identified:

Great Britain

- 2010 National Travel Survey, Table NTS0306 Average trip length by main mode: Great Britain, 1995/97 to 2009 (DfT, 2010c);

Northern Ireland

- Travel Survey for Northern Ireland In-depth Report 2007-2009; Table 3.2: Average number of journeys per person per year and average journey length by main mode: 1999-2001, 2003-2005, 2006-2008 and 2007-2009 (DRDNI, 2011);

Scotland

- National Travel Survey (NTS), Scottish results; Table 6 Average length of trip by main mode (DfT, 2010c);

- 2010 Scottish Transport Statistics (STS); Table 11.3 Average length of trip by main mode (Transport Scotland, 2010).

Wales

- 2009 Welsh Transport Statistics; Table 6.1 Trips per person per year, and Table 6.2 Distance travelled per person per year (WAG, 2010a);
- 2010 Welsh Transport Statistics; Table 6.1 Trips per person per year, and Table 6.2 Distance travelled per person per year (WAG, 2011).

Data from these sources are shown in Tables 5.1 to 5.5. As all of the country-specific data are from travel surveys, it is assumed that the distances quoted are directly comparable.

Table 5.1: Average passenger car trip lengths for Great Britain (DfT, 2010)

Great Britain	1995/ 1997	1998/ 2000	2002	2003	2004	2005	2006	2007	2008	2009
Car/van driver										
km	13.7	13.8	13.5	13.8	14.0	13.5	13.7	14.3	13.7	13.5

Table 5.2: Average passenger car trip lengths for Northern Ireland (DRDNI, 2011)

Northern Ireland	1999 - 2001	2003 - 2005	2006 - 2008	2007 - 2009
Car/van driver				
km	11.7	12.2	12.1	12.1

Table 5.3: Average passenger car trip lengths for Scotland (DfT, 2010)

Scotland	1985/ 1986	1989/ 1991	1992/ 1994	1995/ 1997	1998/ 2000	2002/ 2003	2004/ 2005	2006/ 2007	2007/ 2008
Car/van driver									
km	13.5	12.9	12.7	13.7	13.8	13.4	14.0	13.7	13.8

Table 5.4: Average passenger car trip lengths for Scotland (Transport Scotland, 2010)

Scotland	1998/ 1999	2000/ 2001	2002/ 2003	2004/ 2005	2006/ 2007	2008/ 2009
Car/van driver						
km	13.5	14.6	13.4	14.0	13.7	14.3

Table 5.5: Average passenger car trip lengths for Wales (WAG, 2010[a], 2011[b])

Wales	2002/ 2003[a]	2004/ 2005[a]	2006/ 2007[a]	2007/ 2008[a]	2008/ 2009[b]
Car/van driver					
km	13.4	14.5	14.6	14.0	14.3

The data suggests that trip lengths in Scotland and Wales are very similar to the average for GB (to within 5%), but trip lengths in Northern Ireland are consistently shorter, by around 12%. The inventory for Northern Ireland currently uses the GB average figure of 10km.

A sensitivity test was therefore carried out to assess the impact of a trip length being 12% shorter than currently assumed on nitrous oxide emissions from cars and LGVs in Northern Ireland. The results are shown in Table 5.6 as percentage changes in total nitrous oxide emissions from cars and LGVs and from all road transport in 2008. The figures are highlighted in red to indicate an increase in the emissions relative to current estimates.

It can be seen that overall emissions of nitrous oxide are increased by 0.4% as a result of using the shorter trip length.

Table 5.6: Difference in Nitrous Oxide emissions from road transport in Northern Ireland resulting from changes in cold start emissions assuming a 12% reduction in average trip length.

% change in N_2O emissions	2008
Petrol cars	0.8%
Diesel cars	0.7%
Petrol LGVs	1.8%
Diesel LGVs	0.7%
Total road transport	0.4%

6 Consumption of Alternative Fuels

The main alternatives to fossil fuel petrol and diesel used by road transport in the UK have been liquefied petroleum gas (LPG) and various types of biofuels. The study examined whether there were different usage patterns of these fuels in different countries.

The study found that there are no regional data on consumption of LPG. Section 3.3.5 indicated that there are regional differences in the proportion of cars licensed as running on LPG with Scotland having the lowest proportion. However, the proportions are very small (<0.2%) and this is consistent with total UK sales of LPG being very small compared with sales of petrol and diesel (<0.3%).

The current method in the DA GHG inventories assigns national LPG vehicle emissions on the basis of the distribution of filling stations selling LPG. Given that such small amounts of LPG are consumed, it is not currently felt necessary to invest time in acquiring more DA-specific data to alter this method of distributing LPG emissions.

Since 2005, there has been a rapid growth in consumption of biofuels in the UK. Exhaust emissions of carbon dioxide from biofuel consumption are not included in inventories. The Renewable Fuels Agency (RFA) and HM Revenue & Customs (HMRC) provide total biofuels sold into the UK road market. According to statistics in DUKES and from HMRC (2010), 0.25 Mtonnes bioethanol and 0.93 Mtonnes biodiesel were consumed in the UK in 2009. On a volume basis, this represents about 1.5% of all petrol and 4.2% of all diesel sold in the UK, respectively, and on an energy basis it is estimated that consumption of bioethanol and biodiesel displaced around 0.152 Mtonnes of mineral-based petrol (about 1.0% of total petrol that would have been consumed) and 0.808 Mtonnes of mineral-based diesel (about 4.0% of total diesel that would have been consumed).

The DA contacts and biofuel experts within AEA were consulted regarding data on regional biofuel consumption; however, this information does not seem to be available. Information on the location of the major biofuel producers in the UK is available, however, this does not necessarily represent where the biofuels are consumed.

Most large scale biofuel production is used to produce 5% biofuel blends which are expected to be sold uniformly around the UK. There is some small scale production of biodiesel that is used for dedicated vehicle fleets and for individual cars. The small scale production is likely to be used as 100% biodiesel and to be used locally. However, the location of the small-scale producers of biodiesel is not known. Hence, it may be useful to collect information on captive fleets running on 100% of biofuel by, for example, the fleet of vehicles used by some supermarkets and local authorities. It may then be possible to account for this in the DA inventories.

7 Road Transport Greenhouse Gas Reduction Policies and Measures

The DAs were contacted with regards to the road transport policies that relate to reducing GHG emissions and which of these they would like to see captured in the DA road transport inventory.

From the responses received from the DA contacts, Northern Ireland indicated that their current policies would not be sufficiently advanced to begin to identify how these could be captured in the inventory. Wales is keen to have a model that tracks the Wales Climate Change Strategy once it is implemented and Scotland provided a reference to their recent report on emission reduction measures.

In parallel to this work, there is another DA inventory improvement task undertaken by AEA to review the climate change action plans as published by DECC, Welsh Assembly Government (WAG) and the Scottish Government (SG) impacting across all GHG emission sources. The main aim is to assess how sensitive the inventory is and will be in tracking progress against policy actions. The findings of this task will be discussed in a separate report produced in parallel to this report.

The latest documents to date produced by each DA on GHG reduction measures include:

- On March 14, 2011 the **Scottish Government** published the report *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022* (SG, 2011), which sets out specific measures for reducing GHG emissions to meet Scotland's statutory targets of 42% reduction from 1990 levels by 2020.
- The **Welsh Assembly Government** has also published the Climate Change Strategy Delivery Plan for Emission Reduction (WAG, 2010b), and there are 11 interventions identified for the Transport sector to help meeting Wales' target to reduce GHG emissions by 3% per year.
- In **Northern Ireland**, the Executive has set a target in the Programme for Government (PfG) to reduce GHG emissions by 25% below 1990 levels by 2025. A Cross-Departmental Working Group on Greenhouse Gas Emissions (CDWG GHG) has been set up and it has produced a Northern Ireland Greenhouse Gas Emissions Reduction Action Plan in February 2011 (DoE, 2011).

The DA inventory improvement report accompanying this one reviews in detail how individual policies and proposals introduced by the DAs and UK government may affect GHG emissions from road transport and how they can be captured by the DA inventories, either now or with provision of suitable data in the future.

In general terms, a policy or measure will or could be taken into account in the GHG inventory at DA level if it affects factors such as distances travelled (expressed as vehicle km), the composition of the fleet or driving pattern in a defined way. Some of these factors may already be picked up in input data sets already used (e.g. vehicle km) or could be picked up if, as a result of the analysis described previously in this report, the inventory methods and models were improved to be able to accommodate them. Some policies or measures would be more difficult to capture in the fleet, particularly those that affect driving behaviour. The current modelling approach can only use average speed as an indicator for the way people drive, so measures that are designed to control traffic such as through traffic management to ease congestion or through changes to speed limits, could only be captured if the effect these measures have on average vehicle speed were known and made available for use in the inventory.

Some measures, for example eco-driving, would be almost impossible to capture as such a measure is hard to define and to monitor. The ultimate measure of the effects of eco-driving might be improvements in fuel consumption, but whilst this may be possible to pick up in national (UK) fuel statistics, it would be difficult to judge this at DA-level unless DA-specific data on fuel sold were monitored at the point of sale in each DA country. To date, reliable data on fuel consumption at DA level are not available for inventory purposes.

The DAs are interested to track policies and measures introduced through the inventories. Whilst a policy or measure could be picked up by current inventory approaches, or after some modifications to the models, it could prove to be very difficult to determine the contribution made by the policy or measure compared with other influencing factors. For example a modal shift policy to encourage a switch from transport by car to bus may well lead to a change in the statistics on vehicle kilometres travelled by cars and buses. This would be picked up by the DA inventory, but the question would be how much of these changes could be attributed solely to the modal shift policy and not other influencing factors such as local planning, wider economic factors, fuel prices or other local policies and measures that were introduced. A policy which promotes the uptake or use of electric vehicles should be reflected in the change in the fleet and reductions in petrol/diesel fuel consumption. However, it may require additional analysis to establish how much of the fleet change is due to DA government policies and how much is due to other external/economic factors such as increase in fuel price or UK-wide measures. Policies and measures that lead to improved fuel efficiencies, such as eco-driving, could result in reduced fuel consumption, however, they could also incur a rebound effect with people driving more as the cost of driving comes down.

To be able to track a policy intervention would require some advice or information from DA officials.

Table 7.1 lists some examples of policies and measures that may be possible to account for in the DA inventory for road transport by making some changes to the current approaches in areas that have been the focus of this study. In other words, these are measures that could affect the local composition of the vehicle fleet, average speed, consumption of alternative fuels or else could lead to changes in emission or fuel consumption factors. To reflect these changes at DA level would require adapting the models to accommodate the DA-specific data which have been assessed in this report. Each measure is listed under the factor(s) that it may affect.

If each individual policy is to be tracked within the road transport inventory, then it will be necessary to measure or quantify how it has changed these parameters.

Table 7.1: Examples of current or proposed policies and measures at DA or national level that could be accounted for in the DA inventory models

Fleet	Speed	Fuel data	Fuel efficiency factors[2]
Scotland - Public Sector Low Carbon Vehicle Procurement Scheme	Scotland - Speed Limits (Proposal)	Scotland - Biofuel Business Programme (Proposal)	Scotland - Improving freight efficiency (Proposal)
Scotland - Biofuel Business Programme (Proposal)	Wales (WT9) - Improving traffic management on the strategic road network.[3]	Wales (WT11) - Alternative fuels infrastructure[4].	
Scottish Green Bus Fund			
Scotland - Improving freight efficiency (Proposal)			
Low carbon buses/ HGVs			
Scotland - Taxi emission strategy (Proposal)			
Wales (WT11) - Alternative fuels infrastructure.			

[2] Assumes it would be possible to establish the effect of the scheme on fleet-weighted average fuel efficiency
[3] This would require measurements of the effect of traffic management on network average speed
[4] This would require information on amounts of alternative fuels sold

8 Summary and Recommendations

This study has considered a number of road transport activity trends that could show regional differences at DA level and therefore could allow more country-specific greenhouse gas emission inventories to be developed to allow better tracking of climate change policies introduced by the governments of Scotland, Wales and Northern Ireland.

Particular consideration has been given to four specific transport features that influence emissions from road transport: vehicle fleet composition, speed, passenger car trip lengths and usage of alternative fuels.

Vehicle licensing data held by the DVLA for vehicles in Scotland and Wales and Department for Regional Development Northern Ireland for vehicles registered there were interrogated at DA level to investigate whether there were any differences in the diesel share of the passenger car fleet, the distribution of cars by engine size, the age of the fleet and the proportion of cars using alternative propulsion means (e.g. hybrid-electric and electric cars).

The analysis showed that:

- The proportion of diesel cars in the fleet is similar in England and Scotland, but is consistently slightly higher in Wales and much higher in Northern Ireland;
- Scotland and Wales have a slightly higher proportion of smaller engine-size petrol cars compared with England and the GB average while the size distribution of diesel cars is similar across all countries;
- Scotland has a newer petrol car fleet than England and Wales, while Wales appears to have an older diesel car fleet than England and Scotland;
- Northern Ireland also has a newer car fleet than the GB average which is already accounted for in the inventory;
- The van fleet in Scotland is newer than the GB average, while in Wales the van fleet is older;
- The fleet of rigid HGVs is older in Wales, but in England and Scotland they are similar;
- The proportion of cars running on LPG, hybrid electric or electric is very small in all countries. The proportion of registered LPG vehicles is slightly higher in Wales and lower in Scotland;
- The proportion of hybrid and electric cars is extremely small everywhere, but is higher in England than in Scotland and Wales.

The effect of using each DA-specific fleet dataset in the calculation of GHG emissions in Scotland and Wales was quantified and compared with estimates currently derived using GB-averaged datasets. The analysis was not extended to Northern Ireland because country-specific fleet data for cars are already used in the Northern Ireland GHG inventory or else other datasets were unavailable. The effect of each fleet characteristic on total road transport GHG emissions is shown in Table 8.1. It should be noted that the effects of individual fleet characteristics are not additive, for example, the effect of car engine size could be different if estimated against a baseline fleet which included DA-specific data on the diesel share of the car fleet. However, the results do give an indication of the magnitude of the effects of using DA-specific fleet data instead of the GB-average data currently used.

Table 8.1: Change in estimates of GHG emissions from road transport in 2008 when using country-specific data on characteristics of the vehicle fleet in Scotland and Wales compared with current estimates using GB-average fleet statistics.

Fleet characteristic	Scotland	Wales
% diesel cars	-0.02%	-0.1%

Car engine size	-0.7%	-1.0%
Age	-0.8%	+0.4%

Note: A negative number indicates emission estimates are reduced.

Although the effects are not additive, the results suggest that inventory estimates could be **0.5-1.5% lower** in Scotland and Wales if country-specific fleet data were used. This is a large enough difference to warrant further investigation, especially in light of sector targets at DA level for GHG reductions in this key source sector, such as the WAG 3% annual reduction targets for transport emissions.

It was not possible on the timescale of the project to obtain and analyse comparable vehicle speed data for each country to determine whether there were any statistically significant differences to average speeds assumed at GB level. Therefore, sensitivity tests were undertaken to assess how sensitive emission estimates are to the range of speeds that is currently used in the UK and GHG inventories. The results indicate that the differences in overall road transport carbon dioxide emissions are between 4-7% when adopting low and high speeds. However, careful thought would need to be given as to whether there are likely to be any statistically significant differences in speed data between DAs that should be accounted for and whether it is practicable to provide speed data for the inventory for each DA on a comparable basis. This may depend on the requirements of the DAs to have an inventory that reflect policies that may lead to changes in speeds.

Trip lengths are used to estimate cold start emissions of nitrous oxide from petrol cars. No significant differences in passenger car trip lengths were found for Scotland and Wales compared with the GB average currently assumed in inventories, but trip lengths are shorter in Northern Ireland. Using Northern Ireland-specific data increases estimates of cold start emissions of nitrous oxide by only 0.4%. There may be more significant differences in the inventories for air quality pollutant emissions from using DA-specific trip length data.

No information has been found that provides data on the consumption of biofuels in the road transport fleet across the DAs. There are differences in the number of LPG vehicles licensed, but these are presently regarded as too insignificant to warrant any change in the method to allocate LPG emissions between countries.

Finally, the potential for capturing the effects of GHG reduction policies and measures introduced by each DA in the inventories was considered in this and an accompanying report. The impacts of a DA transport policy will be reflected within the DA inventories if it leads to changes in transport parameters included in the modelling methodology, such as changes in kilometres travelled or changes in the fleet. Some policies could be more difficult or impossible to capture. This is where the effects the policy has on key transport parameters cannot be easily quantified. It would also be difficult to track the impact of individual policies if there are other policies or external factors (UK wide) that could also be having an effect that is difficult to differentiate from the specific policy being tracked.

The main study findings and recommendations are that DA-specific fleet data and trip lengths should be incorporated as a method improvement for the DA inventory estimates, at the earliest opportunity. Further investigation on the use of speed data and further developments of the models for examination of policy interventions should also be considered, subject to the priorities of the DAs.

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