# 18. Effect on carbon emissions

## 18.1 Introduction

This chapter considers whether the interventions in the Sustainable Travel Towns had an impact on carbon emissions, and, from examination of the available data, what the magnitude of the impact was. Our principal source of evidence is the data on changes in personal travel (and, in particular, changes in car driver mileage), as presented in Chapter 13.

Nationally, carbon emissions from the transport sector are dominated by emissions from passenger cars, which account for 58% of domestic transport emissions (i.e. excluding international aviation and shipping). Lorries and vans account for a further 31% of emissions, and public transport (including both rail and buses) for 4% (Department for Transport, 2009a). The Smarter Choice Programmes in the three towns were targeted at personal travel, and hence might be anticipated to have had an effect of reducing emissions from passenger cars, but also, potentially, of increasing emissions from public transport. We will therefore look at both the gross carbon savings from reduced car use, and net carbon savings once public transport emissions are taken into account.

Before proceeding to the analysis of the evidence from the towns, however, we note that carbon emissions from transport are affected by a further range of factors, some of which we are able to take into account here, and some not. First, changes in oil price and in economic activity affect the cost and the affordability of motoring. During the course of the Sustainable Travel Towns programme, we assume that these two factors operated to the same extent in the Sustainable Travel Towns as they did nationally. We make further adjustments to our figures for net carbon savings to allow for this, using data on car driver mileage from the National Travel Survey, and data on urban traffic from the National Road Traffic Estimates to provide an indicator of these underlying trends.

Second, changes over time in average passenger car emissions would be expected to influence the total carbon emissions from car travel, and these changes could be either upwards (if people buy larger and less fuel-efficient cars) or downwards (as vehicle technology improves). Total emissions might also be influenced by changes in driving style (for example, evidence from the Energy Savings Trust quoted in Department for Transport (2009a) suggests that 'eco-driving' programmes can reduce emissions by 8-15%). In the analysis that follows, we have assumed that the Sustainable Travel Town programme had no effect on car purchasing decisions by residents of the towns, and no effect on driving style, and that any changes in these two factors were the same in the towns as they were nationally. This is a conservative assumption: car purchasing behaviour and driving style were not the main focus of the Smarter Choice Programmes, but information on eco-driving was offered to households in Darlington, and information about 'responsible driving' was offered to households in Peterborough as part of the personal travel planning programmes in those towns.

The remainder of this chapter is structured as follows. We begin by estimating the change in annual carbon emissions in each of the three towns, first per capita and then across the whole population, as a result of reductions in car driver distance. For this, we use national average emissions factors for cars, but with sensitivity tests using emission factors for small and large cars. We examine what proportion of carbon savings arise from journeys in different distance bands, including sensitivity tests to allow for the disproportionate emissions from short journeys due to 'cold starts'. We also examine the proportion of gross savings according to journey purpose. We then make a series of adjustments to our gross carbon savings, to allow first for increased public transport travel, and then for changes in car driver mileage due to other factors, including oil price and GDP. Finally, we consider the uncertainties and limitations to the analysis. Throughout, we emphasise that our analysis should be considered indicative, being based on average emissions factors rather than emissions factors specific to the car 'fleets' in the three towns, and involving a series of further simplifying assumptions.

## 18.2 Our approach to calculating carbon savings from the reduction in car use

We have focused our analysis on the emissions of carbon dioxide ($CO_2$) saved from a reduction in car driving between 2004 and 2008 in the three towns. $CO_2$ emissions are calculated as a function of distance driven by car (in this case in km) and $CO_2$ emissions (grams per km) for each mode[1]. Distances driven by car in 2004 and 2008 are derived from the household travel surveys as detailed in Chapter 13, using the weighted datasets only[2]. Car driver trips (private and company) are considered, but distances undertaken as a car passenger or for the purposes of commercial journeys are not. As identified in Chapter 13, the main effect of the Sustainable Travel Town programme was on trips of less than 50km, and we have assumed no behaviour change on trips longer than this. Emissions resulting from any increase in public transport vehicle kilometres are considered separately in section 18.6.

Data on $CO_2$ emissions per car vehicle km was not available at the town level. The $CO_2$ emission factors used were therefore based on the emission factors developed by AEA (AEA, 2009) for the Department of Energy and Climate Change (DECC) and the Department for Environment, Food and Rural Affairs (Defra). All calculations were based on an average-sized car of a non-specified fuel type. However, emission factors for small and larger car vehicles were also used in order to test the sensitivity of the results to these assumptions.

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[1] Throughout this chapter, we report figures in terms of weights of $CO_2$ (e.g. grams $CO_2$ per vehicle km; tonnes $CO_2$ saved). To convert $CO_2$ to C, $CO_2$ emissions are multiplied by the ratio of the molecular weight of C (which is 12) to the molecular weight of $CO_2$ (which is 44), i.e. 12/44 which is 0.27. However, 'carbon' is still used in the text (e.g. 'carbon saved') when referring to $CO_2$ saved.

[2] Full details of the household travel surveys conducted by Socialdata & Sustrans are given in Chapter 13, sections 13.1, A13.1 and A13.8. A baseline survey was conducted in Autumn 2004, and an ex-post survey in Autumn 2008, with in each case approximately 4,000 respondents in each town completing a one-day travel diary. The samples for both the baseline and ex-post surveys were randomly selected (*not* a panel i.e. respondents at baseline were not specifically followed up in the ex-post surveys). The sampled area covered all residential households in each of the three towns. Socialdata and Sustrans used a weighting system to adjust for potential non-response bias in the survey returns. Following questions about the weighting approach which were raised by Bonsall and Jopson (2007), we repeated a number of analyses using both the weighted dataset and an unweighted dataset kindly provided by Socialdata & Sustrans. Although (as would be expected) weighting does make a difference to the results, often of the order of a percentage point or so in the changes observed from 2004 to 2008, there did not appear to be any consistent pattern of change which would cause concern of bias (sometimes weighting moved the results in one direction, sometimes in the other), and the general picture produced was broadly similar.

The $CO_2$ emission factors used are given in Table 18.1.

**Table 18.1: $CO_2$ Conversion factors for cars (unknown fuel)**

| | g $CO_2$/km |
|---|---|
| Average car | 202.82 |
| Small car | 177.48 |
| Large car | 280.00 |

Notes: Taken from AEA (2009). The AEA figures are estimated average values for the UK car fleet in 2008 travelling on average trips in the UK. They are calculated based on data from the Society of Motor Manufacturers and Traders on new car $CO_2$ emissions from 1997 to 2008 combined with factors from the Transport Research Laboratory. These factors are a function of average speed of vehicles derived from test data under real world testing cycles and an uplift of 15% agreed with the Department for Transport to take into account further real world driving effects on emissions relative to the test-cycle based data. We assume no change in $CO_2$ emission factors between the date of the baseline survey and the date of the ex-post survey.

## 18.3 Carbon savings from car driving

Carbon savings from the reduction of car driving are presented below. These are in relation to the carbon saved as a result of the fewer trips undertaken as a car driver in 2008 as compared to 2004, not allowing for any additional carbon saved or generated as a result of other changes to travel patterns. Savings are presented on a per capita basis in section 18.3.1 and on a town-wide basis in section 18.3.2.

### 18.3.1 Per capita carbon savings from car driving

Per capita carbon savings have been calculated based on the reductions in distance as a car driver (km per person per day) between 2004 and 2008. This allows a per capita daily carbon saving to be calculated which can then be factored up to an annual per capita total. In order to calculate an annual figure, daily travel distance is factored up by 365 days on the basis that the household travel surveys collected data from respondents for all days, including those when they were away from home.

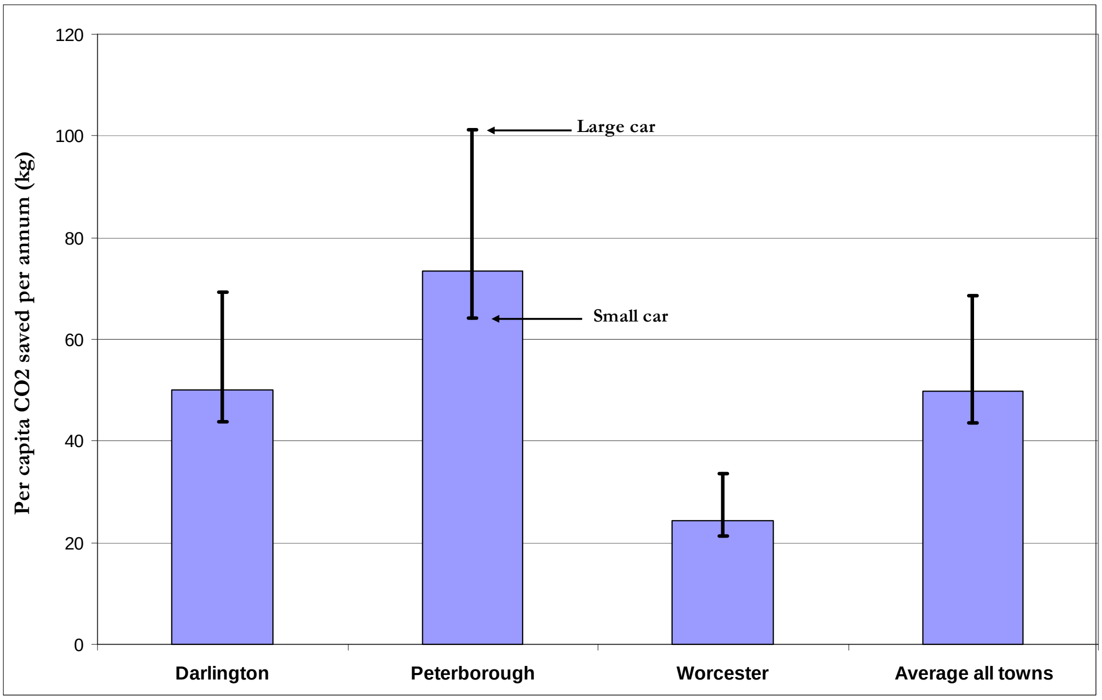
**Table 18.2: Per capita per annum carbon saving from car use in 2008, trips less than 50km only**

| | Darlington | Peterborough | Worcester | All towns |
|---|---|---|---|---|
| Change in distance driven per person (trips <50km) | -7.1% | -10.0% | -2.9% | -6.5% |
| Distance as a car driver saved (km per person per annum) | -247 | -362 | -120 | -245 |
| Total $CO_2$ saved (kg, average car) | -50.1 | -73.3 | -24.4 | -49.7 |

Notes: See Table 13.5 for calculation of estimates of changes in distance driven per person. Calculation uses weighted dataset. 'All towns' figures are derived from an aggregated dataset, using data from all three towns with no weighting by population size.

The savings in Table 18.2 have been calculated using the emissions factor for an average-sized car. However, larger cars emit 38% more $CO_2$ per kilometre on average than an average-sized vehicle and smaller cars 12% less (Table 18.1)[3]. If emissions factors were used which assumed that cars were larger or smaller, the differences in total per capita emissions savings would be as illustrated in Figure 18.1.

**Figure 18.1: Total per capita per annum carbon saving from car driving in 2008 (kg $CO_2$, trips less than 50km only)**




Notes: Trips less than 50km only, weighted.

Note that, as the calculation of emissions is pegged directly to the reductions in distance driven by car using one average emissions factor, the percentage reduction in carbon emissions on a per capita basis is the same as for distance (e.g. -6.5% per capita across all towns, for car driver trips under 50km). This is equivalent to a reduction of 4.6% per capita across all towns for car driver trips of all distances. These annual per capita savings can be placed in the context of the average carbon emitted per person when total carbon emissions from all sources in the UK are divided among the population. This currently stands at around nine tonnes $CO_2$ per capita per annum[4]. The carbon saved from reductions in car driver journeys of less than 50km in the three Sustainable Travel Towns therefore equates to around 0.6% reduction in average total per capita emissions in the UK in 2008, compared to the baseline in 2004.

These figures are solely for carbon savings in 2008 compared to 2004, but it would be expected that the behaviour change arising from the Sustainable Travel Towns programme would also have had some effect in the years between 2004 and 2008, and in subsequent years (although with some 'decay' of behaviour change after 2008 if investment in smarter choices ceased or reduced). We do not attempt here to estimate the carbon saved in the years before and after 2008 as a result of the Sustainable Travel Towns programme. Chapter 21 considers a method for estimating car driver km savings

[3] It is worth noting that average small cars are closer to the overall average for two reasons: (i) they represent a much larger proportion of the overall car fleet, and (ii) a larger proportion of small cars are petrol which has the effect of increasing their average emissions compared to larger cars.

[4] Total $CO_2$ emitted by all sources in 2008 was 532Mt$CO_2$ (DECC, 2009). On the basis of a population of 60 million, this equates to 8.74 tonnes per capita.

in other years, based on a set of assumptions about the relationship between annual expenditure on Smarter Choice Programmes and effect in the year expenditure was incurred and in subsequent years. In principle, this method could be applied to estimate the total carbon savings arising from the Sustainable Travel Towns programme.

### 18.3.2 Town-wide carbon savings from car driving

The calculation of town-wide per annum carbon savings uses a similar approach to the above, taking into account the number of residents in each of the three Sustainable Travel Towns in both the years 2004 and 2008 in order to calculate a figure for carbon reduction which is net of population growth. Across all three towns, the reductions in car driver journeys of less than 50km (based on an average car) resulted in a saving of 17,510 tonnes $CO_2$ (0.018 million tonnes of $CO_2$ ($MtCO_2$)) in 2008, of which 25% came from Darlington, 62% from Peterborough and 13% from Worcester.

**Table 18.3: Estimated change in town-wide car driver kilometres and carbon emissions (tonnes $CO_2$ per annum in 2008, trips less than 50km only)**

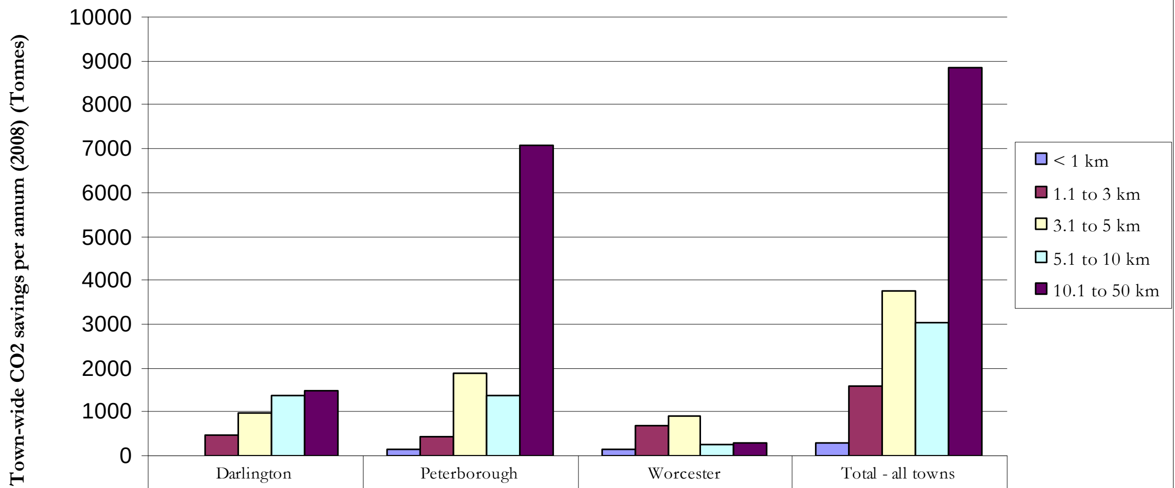
| | Darlington | Peterborough | Worcester | All towns (total) |
|---|---|---|---|---|
| Change in distance driven by all residents, 2008 relative to 2004 (trips <50km) | -6.9% | -4.5% | -1.9% | -3.7% |
| Total car driver distance ‘saved’ per year in 2008, all residents (km) | -21,168,840 | -53,904,627 | -11,261,252 | -86,334,720 |
| Total $CO_2$ saved by all residents in 2008 – average car (tonnes $CO_2$) | **-4,293** | **-10,933** | **-2,284** | **-17,510** |
| Total $CO_2$ saved by all residents in 2008 – small car (tonnes $CO_2$) | -3,757 | -9,567 | -1,999 | -15,323 |
| Total $CO_2$ saved by all residents in 2008 – large car (tonnes $CO_2$) | -5,927 | -15,093 | -3,153 | -24,174 |

Notes: Trips less than 50km only, weighted, net of population growth; for this calculation, the total distance saved was derived from the difference in the distances undertaken as a car driver (km per person per day) in 2004 and 2008 (see Table 13.5), factored up to an annual town-wide level net of population growth. Sampling approach for 2004 baseline and 2008 ex-post household travel surveys was designed to give representative results for the whole population of the three towns (not just those individuals targeted by interventions).We assume that the 2008 ex-post household travel survey is representative of the behaviour of all residents, new and old, in that year.

## 18.4 Carbon savings by journey distance

The trip length/travel mode matrices introduced in Chapter 13 allowed the carbon savings to be calculated in each journey distance band. Figure 18.2 and Table 18.4 illustrate the differences in the three locations in terms of the source of carbon emissions reduction from changes in patterns of car driving. In Peterborough and to a lesser extent Darlington, the greatest carbon savings came from reductions in longer journey lengths, whereas in Worcester, journeys of less than 5km were the main source of savings. This is consistent with the analysis presented in section 13.2 which showed that the percentage reduction in car driver trips was greater, the shorter the trip, but that trips in the longer distance bands had the strongest effect on the distance travelled. The same pattern has emerged for $CO_2$ savings – just under a third (32%) of carbon saved was from the reduction in car driver journeys of less than 5km, but the change in the 10-50km distance bands accounted for half of the savings.

**Figure 18.2: Town-wide per annum carbon saving from changes in car driving from each distance band in 2008 (tonnes $CO_2$, trips less than 50km only)**




| | Darlington | Peterborough | Worcester | Total - all towns |
|---|---|---|---|---|
| < 1 km | 2 | 153 | 147 | 302 |
| 1.1 to 3 km | 475 | 449 | 672 | 1597 |
| 3.1 to 5 km | 975 | 1876 | 891 | 3742 |
| 5.1 to 10 km | 1367 | 1387 | 271 | 3025 |
| 10.1 to 50 km | 1474 | 7068 | 302 | 8844 |

Notes: Trips less than 50km only, weighted, net of population growth.

**Table 18.4: Proportion of carbon saved in 2008 in each distance band in each town (trips less than 50km only)**

| | Darlington | Peterborough | Worcester | All towns |
|---|---|---|---|---|
| Less than 1km | 0.0% | 1.4% | 6.5% | 1.7% |
| 1.1km to 3.0km | 11.1% | 4.1% | 29.4% | 9.1% |
| 3.1km to 5.0km | 22.7% | 17.2% | 39.0% | 21.4% |
| 5.1km to 10.0km | 31.8% | 12.7% | 11.9% | 17.3% |
| 10.1km to 50.0km | 34.3% | 64.6% | 13.2% | 50.5% |

Notes: Trips less than 50km only, weighted. Note that these figures are factored up to an annual town-wide level net of population growth and are not per capita.

### 18.4.1 Carbon savings due to 'cold starts'

The analysis so far excludes explicit consideration of the additional fuel used to warm a car engine when starting a car from cold – so called 'cold starts'[5]. Specifically, when a vehicle's engine is cold, it emits pollutants at a higher rate than when it is warmed up to its designed operating temperature. Hence 'cold start' effects are the increases in fuel consumption and emissions experienced in the first few miles of a journey before the engine reaches normal operating temperature. For cars, cold starts often represent a significant proportion of the total emissions per trip and the effect will be disproportionately greater for trips undertaken in the shorter distance bands.

We therefore undertook a sensitivity test to help illustrate the potential impact of cold starts on the shorter length journeys. Theoretical uplifts of 5%, 10% and 15% have been applied (in the sensitivity test only) to the emissions factors presented in Table 18.1 for all journeys under 5km. While data exists to model the impact of cold starts more robustly, it requires information, for example on vehicle types and speeds, not available from this study on a town-wide basis. This simple approach was therefore used and Table 18.5 illustrates the impact of the inclusion of a cold start factor for journeys less than 5km.

**Table 18.5: Sensitivity analysis on carbon savings from car driving, accounting for 'cold starts' (tonnes $CO_2$, trips less than 50km only)**

| | No cold start factor | 5% uplift | 10% uplift | 15% uplift |
|---|---|---|---|---|
| Total $CO_2$ saved by all residents in 2008 – average car (tonnes $CO_2$) | 17,510 | 17,792 | 18,075 | 18,357 |
| Proportion of $CO_2$ saved by all car driver journeys less than 5km | 32.2% | 33.3% | 34.3% | 35.3% |

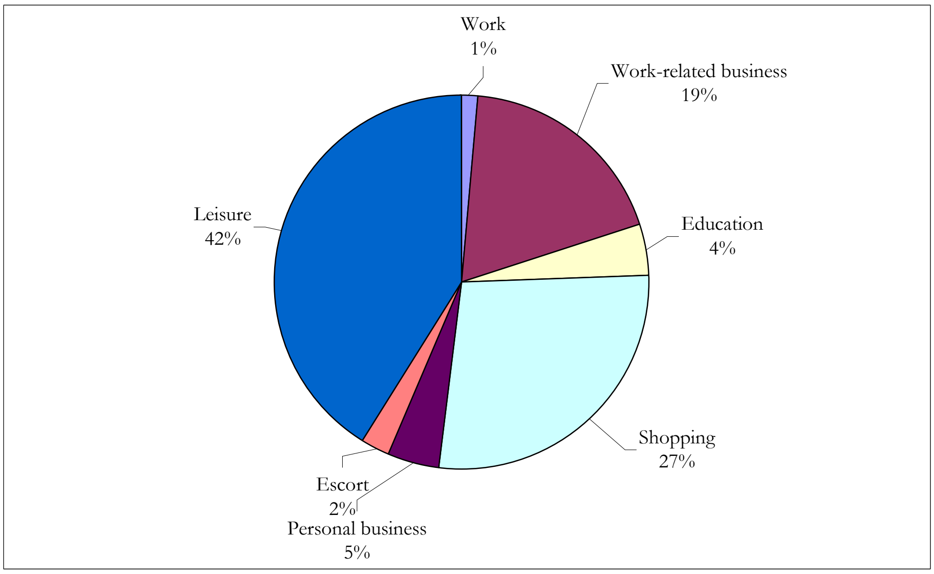
Without taking explicit account of the cold start fuel penalty, trips of less than 5km account for 32.2% of both the savings in car driver distance travelled and carbon savings. Table 18.4 shows that this proportion increases to 35.3% of savings if a cold start impact of 15% is assumed to take place on shorter journeys. Thus, given the smaller role that shorter journeys have on the overall carbon savings relative to reductions in longer length journeys, the impact of the extra fuel used per kilometre during short journeys due to cold start emissions is relatively minor and has little impact on the broad distribution of savings across distance bands.

[5] While the AEA uplift to test-cycle data of 15% (used to take account of real world driving effects) includes some consideration of the impact of cold starts, this is averaged out over the typical driving cycle as a whole. It therefore does not take account of speed or distance based impacts related to specific (short) journeys – which can be significant.

## 18.5 Carbon savings by journey purpose

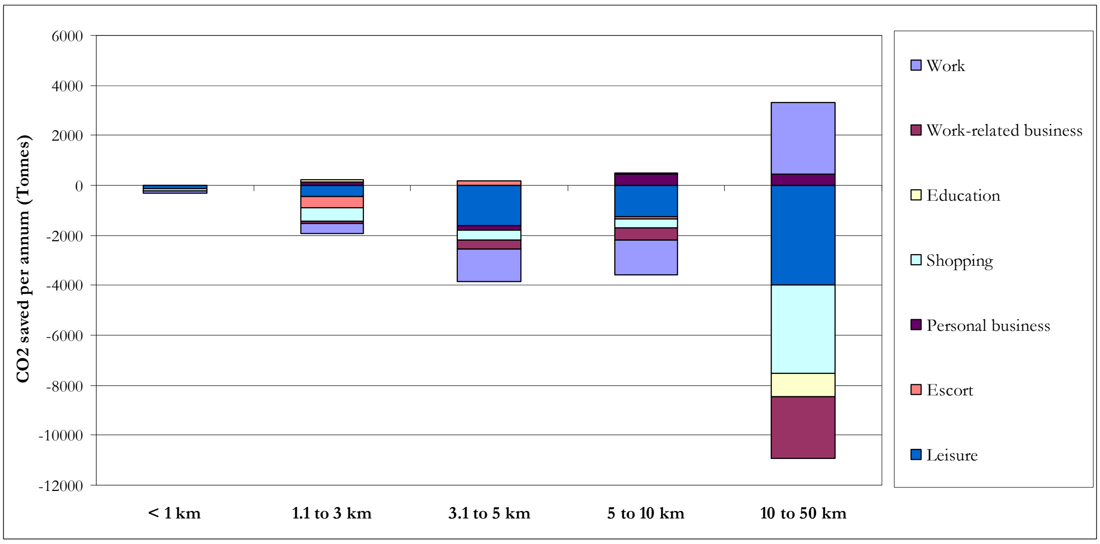
It is also possible to identify the carbon savings associated with journey purpose. We know from Chapter 13 (section 13.5) that the biggest reductions in car driver distance were made in commuting and business trips in the 10-50km band for Darlington; and leisure and shopping trips in the 10-50km band for Peterborough and Worcester. Figure 18.3 translates the distance savings for each journey purpose into the proportion of carbon saved for an average vehicle across all three towns combined. Together, reductions in car driver trips for leisure, shopping and work-related business account for 88% of the reductions in $CO_2$.

**Figure 18.3: Estimated savings of $CO_2$ emissions from car driving by journey purpose (town-wide per annum across all towns, trips less than 50km only, average vehicle)**




Note: The cold start fuel penalty has not been factored in to this calculation.

**Figure 18.4: Estimated savings of distance and $CO_2$ emissions from car driving by journey purpose and distance band (town-wide per annum across all towns, average vehicle)**



Combining the analysis of carbon saved from trip distance bands with the analysis in relation to journey purpose, we can identify both the *type* of car driver journeys and the *motivations* for the journeys that resulted in the most carbon savings across the three Sustainable Travel Towns. Figure 18.4 shows the following:

- The largest carbon savings are from leisure journeys, with effects on leisure journeys of all lengths over 3km, but particularly in the 10-50km distance band.
- Most of the carbon saved in relation to shopping trips was for trips in the 10-50km distance band.
- Most of the carbon savings on work-related business travel were for trips in the 10-50km distance band[6].
- There were significant carbon savings from reductions in driving to work in the shorter journey distance bands (<10km), but these were eroded by increases in relation to commuting journeys over 10km (resulting in a net saving of only 1% as shown in Figure 18.3)[7].

## 18.6 Net carbon savings

The estimates of carbon savings presented in this chapter have so far relied on a relatively straightforward use of average emissions factors applied to the changes in car driver distance between 2004 and 2008, as revealed by the household travel surveys in each of the three towns. The only sensitivity analysis carried out related to the size of the vehicle assumed and the disproportionate fuel penalty incurred on short trips due to the cold start effect.

In addition to cold starts and composition of the car fleet, there are a number of other reasons why the carbon savings attributable to changes in travel behaviour may be smaller or greater than the figures presented. These include:

- increased use of alternatives to the car
- car vehicle occupancy
- congestion effects
- underlying national trends (i.e. what would have happened 'anyway', or the 'counterfactual').

### 18.6.1 $CO_2$ from the increased use of modes other than the car

The reduction in car vehicle kilometres and the associated $CO_2$ emission reductions discussed in this chapter so far are a result of reduced car driver trips from either (i) a trip no longer being made or (ii) modal shift to an alternative mode. In the absence of panel data, we are unable to say whether there may have been shifts in travel behaviour within households as a result of the Smarter Choice Programme (for example, one household member using a car less, and freeing capacity for another who consequently uses the car more). However, any such changes would be expected to be reflected in the household travel survey results, since all household members were asked to complete a travel diary.

[6] However, this is based on a small number of trips and should therefore be treated with caution.
[7] In fact, as shown in Chapter 13, Figure 13.5, the increase in car driver distance for commuting (and hence carbon emissions) in the 10-50km distance band was primarily in one of the towns, Worcester.

As presented in Chapter 13, the majority of the reduction in car use was due to mode switch rather than a net reduction in the number of trips. In order to calculate the net carbon savings this modal shift needs to be considered.

While there are several ways in which net savings taking into account mode shift can be calculated, the most appropriate way for this study was consideration of emissions associated with increased public transport vehicle kilometres in each town. Collecting data at this level rather than on a per capita (grams per passenger kilometre) basis allows an estimate of whether the net result of the Sustainable Travel Town programme at the town-wide level was an increase or reduction in carbon emissions.

Analysis of bus patronage figures presented in Chapter 13 concluded that bus use grew substantially in Peterborough and Worcester during the period of the Sustainable Travel Town work, whereas it declined in Darlington. Data on bus vehicle kilometres (Chapter 14) was only available for Peterborough and is used in Table 18.6 to form the basis of a calculation of carbon emissions associated with increased bus vehicle kilometres.

**Table 18.6: Bus vehicle kilometres operated in Peterborough 2004-2008**

| Year | Total bus vehicle km |
|---|---|
| 2007 to 2008 | 4,850,783 |
| 2006 to 2007 | 4,199,160 |
| 2005 to 2006 | 3,737,031 |
| 2004 to 2005 | 3,522,181 |

Source: Peterborough City Council

This shows an increase of 1,328,601 bus vehicle km driven over the 2004 to 2008 period. Using data from the National Atmospheric Emissions Inventory, a bus vehicle emission factor of 906.66 grams of $CO_2$ per vehicle km (NAEI, 2007) was applied. There was therefore an additional 1,204.59 tonnes of $CO_2$ associated with the increase in bus vehicle km in 2008, compared to 2004. This equates to 11% of the emissions saved from reductions in car travel in the town (Table 18.3).

Thus, the most pessimistic estimation is that 11% of the emissions savings from the reduction in car driver distance in Peterborough was offset by an increase in bus travel. However, this does not take into account any improvement in vehicle efficiency due to the introduction of newer vehicles. It also makes no allowance for second-order effects which could have significant impacts on carbon emissions. For example, the increased use of alternatives to the car may mean that a family car is not replaced or not acquired in the first place; may lead to increased choice of destinations closer to home; and may have a wider benefit as social norms are altered.

Although we do not have data on operated bus vehicle km in Worcester or Darlington, the effects in both these towns are likely to have been smaller than in Peterborough. In Worcester, there was some investment in new bus services at the start of the Sustainable Travel Town period, but there was not the same pattern of ongoing bus service expansion as in Peterborough. In Darlington, there was little, if any, investment in bus service expansion over the Sustainable Travel Town period.

An equivalent calculation could of course be carried out for rail. However, there was no additional rail capacity provided as part of the Sustainable Travel Town initiative, and only a minimal increase in distance travelled by rail by residents of the towns (about a tenth of the overall increase in distance travelled by bus, for trips of less than 50km). Although increased rail travel by residents of the towns may have only had a marginal impact in this case, it would become an important factor if activity to encourage rail use were to be scaled up.

We have assumed walking and cycling are 'zero carbon' modes consistent with the other emissions factors used in the calculation of carbon, which only take into account direct emissions.

### 18.6.2 Estimating the effect of underlying trends in oil price and GDP

As outlined in Chapter 10, attributing the estimated changes in travel behaviour or carbon emissions to the smarter choices investment requires an understanding of 'what would have happened anyway'. In the context of our discussion of carbon emissions, we need to understand whether a proportion of the gross per capita carbon savings reported in section 18.3.1 might be attributable to causes other than the Smarter Choice Programmes in the towns, and, in particular, the economic downturn or increases in the price of fuel. Relevant comparisons of traffic reductions elsewhere in Great Britain have revealed that, even in the absence of the Sustainable Travel Town programme, we might expect a reduction in urban traffic somewhere between 0.9% and 1.4% to have taken place. National Road Traffic Estimates (NRTE) for car and taxi traffic suggest that nationally there was a small decrease in urban traffic of 1.4% between the relevant quarterly periods in 2004 and 2008 and National Travel Survey (NTS) data for medium urban areas (25,000-250,000 population) between 2004 and 2008 indicates a 0.9% reduction during that period.

These estimates were used to adjust the figures for per capita per annum carbon savings downward to allow for 'what would have happened anyway'. For the purposes of calculating a range of effects, the NTS (0.9%) and the NRTE (1.4%) figures were both applied at the per capita level and the traffic reductions were assumed to apply to all journey lengths equally. In order to calculate this, the car driver distances in each journey band in 2008 from the household travel surveys, used as a basis for the carbon calculations, were factored *up* by 0.9% and 1.4% in order to effectively remove the traffic reduction that would have happened anyway in the absence of the Sustainable Travel Town programme. Table 18.7 compares the total carbon savings with and without the adjustments.

For the towns taken together, a 0.9% adjustment in traffic savings (that is from -6.5% to -5.6%) translates into 13% less carbon savings that can be attributable to the Sustainable Travel Town initiatives on a per capita basis. In the towns where the reductions in car distance between 2004 and 2008 were smallest, the impact of the counterfactual adjustment is largest so that the impact ranged from 8% in Peterborough, to 12% in Darlington and 30% in Worcester. A 1.4% adjustment translates into a 20% reduction in attributable per capita carbon emissions savings.

**Table 18.7: Total per capita $CO_2$ savings (kg per annum in 2008) adjusted for two counterfactual scenarios**

| | Darlington | Peterborough | Worcester | All towns |
|---|---|---|---|---|
| Per capita total $CO_2$ saved in 2008 (kg, average car) | | | | |
| No adjustment | -50.1 | -73.3 | -24.4 | -49.7 |
| 0.9% adjustment | -44.2 | -67.4 | -17.0 | -43.3 |
| 1.4% adjustment | -40.9 | -64.1 | -12.9 | -39.8 |

Notes: Calculation uses weighted dataset. 'All towns' figures are derived from an aggregated dataset, using data from all three towns with no weighting by population size.

## 18.7 Uncertainties and limitations in the analysis

The foregoing analysis is subject to a number of uncertainties and limitations, which have the potential to affect the headline changes in per capita carbon emissions, both downwards and upwards. Particular limitations of the analysis are as follows:

- Estimates of carbon savings have attributed all the carbon from a car journey to the car driver, without taking into account any other car occupants and apportioning emissions accordingly. Any increase in car passenger trips for which the driver of the car was a non-resident of one of the towns would be missed in the car driver kilometre figures we have inferred from household travel survey results. We know from the household surveys that there was a fall in car passenger trips of 6.3% but a small increase of 0.2% in car passenger distance, due to more car passenger trips in the 5-10km distance band (aggregated weighted dataset; trips <50km). It seems likely that these additional, relatively short, car passenger trips were made in vehicles being driven by residents of the towns (rather than by non-residents), and hence we judge that our estimates are likely to reflect changes in car passenger travel as well as changes in car driver travel.

- Emissions factors used are for average driving conditions on average roads. Yet given that emission rates under stop-start driving conditions, often associated with congested traffic, are much higher than those when vehicles are driven more smoothly, use of these emissions factors may underestimate the carbon savings from urban based smart measures.

- We have assumed that there was no change in car driver distance for trips over 50km. These relatively uncommon trips were outside the scope of the policy measures implemented in the towns, and although recorded in the household travel survey are very small in number. We are hence unable to judge whether there may have been any offsetting effect, whereby residents of the towns were marginally more likely to make longer trips as a car driver because of the cost savings that they may have made through reducing their car use for within-town trips. However, from the relatively small number of car driver trips over 50km for which we have data (slightly over 800 in 2004 and in 2008), there is a fall in car driver kilometres of 2% (aggregated weighted dataset), which makes any such offsetting effect seem unlikely.

- We have assumed that residents of the towns did not make any changes to their car purchasing behaviour as a result of the information they received; and we have also assumed that they made no change towards more energy-efficient drivign styles. The effect of these assumptions may be to underestimate the carbon savings resulting from the Sustainable Travel Towns programme.

- Our analysis of the effect of changes in fuel prices and economic activity has, of necessity, been rudimentary. While we have used comparative data from the National Travel Survey and National Road Traffic Estimates for time periods which are as similar as possible to the periods of the baseline and ex-post surveys in the three towns, they are not an exact match, and hence our assessment of 'what would have happened anyway' in the three towns is approximate.

## 18.8 Summary and conclusions on carbon savings

We conclude that the interventions in the Sustainable Travel Towns were successful in delivering carbon savings, and that large-scale Smarter Choice Programmes therefore represent a viable tool for reducing carbon. As we will see in Chapters 19 and 21, the Smarter Choice Programmes also delivered substantial benefits in relation to other Government objectives, notably congestion relief, resulting in a high benefit:cost ratio. This means that Smarter Choice Programmes will result in a net benefit per tonne of carbon saved.

Estimations based on the household travel surveys suggest that the Sustainable Travel Town programme resulted in annual per capita carbon savings of roundly 50kg $CO_2$ across the three towns as a result of reductions in car driver journeys of less than 50km in 2008, compared to 2004. This ranged from 24kg in Worcester, 50kg in Darlington and 73kg in Peterborough. Grossing this up to town-wide level and accounting for increases in population, this resulted in combined saving of 17,510 tonnes $CO_2$ (0.018 million tonnes of $CO_2$ ($MtCO_2$)) per annum in 2008, of which 13% came from Worcester, 25% from Darlington and 62% from Peterborough.

In Peterborough and to a lesser extent Darlington, the greatest proportion of carbon savings came from reductions in longer journey lengths, whereas in Worcester, journeys of less than 5km were the main source. Overall, just under a third (32%) of carbon saved was from the reduction in car driver journeys of less than 5km, but the change in the 10-50km distance bands accounted for half of the total savings in $CO_2$. A sensitivity test to assess the potential impact of cold starts showed that the extra fuel that may be used during short journeys is relatively minor and has little impact on the broad distribution of savings across distance bands.

Overall, most savings came from reductions in car driver trips for leisure, shopping and work-related business. Together, these accounted for 88% of the reductions in $CO_2$. In particular, the journey category responsible for the largest savings were leisure trips in the 10-50km distance band. There were significant savings from the reduction in work trips in the shorter distance bands, though these were eroded by an increase in longer distance journeys to work (between 10 and 50km).

A range of estimates was undertaken to account for the fact that some of the carbon savings from car driving would have been offset by modal switch from the car to other mechanised means of transport or might indeed have happened anyway in the absence of the Sustainable Travel Town initiatives. In Peterborough, up to 11% of the emissions savings from the reduction in car driver distance was offset by an increase in bus travel.

Assuming that somewhere between a 0.9% and 1.4% reduction in urban traffic might be expected to have taken place in the three towns even in the absence of the Sustainable Travel Town programme, the total per capita carbon savings attributable to the programme would be reduced by between 13% and 20%. Across the towns this means that the programme was responsible for savings of between 40kg and 50kg $CO_2$. per capita in 2008.

## 18.9 References

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