WinACC
Winchester Action on Climate Change!

Greenhouse gas emissions in Winchester district: Part II
Estimates and trends (2005-2010)

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This report was written to assist Winchester City Council's Climate Change Programme Board in making informed decisions about how to reduce Winchester district's greenhouse gas emissions. It will help to ensure that resources are allocated, and exhortations made, where they will have the most impact. It will also enable the Board to assess whether the resources currently available are likely to achieve the Winchester District Strategic Partnership's target of a 30% reduction in the carbon footprint of Winchester district by 2015 (relative to 2004).

RECOMMENDATIONS

To reduce greenhouse gas emissions in Winchester district, and in particular to meet targets that have been set, at least the following measures need to be taken.

- To persuade the commercial and business sector to reduce its emissions from electricity and goods vehicles which have actually increased since 2005.
- To encourage the domestic sector, including about 2,500 smaller commercial users, to reduce their electricity consumption.
- To encourage car drivers to cut their emissions even more by using alternative modes of transport, using more efficient vehicles, driving less and better etc.
- To encourage rail travel.
- To discourage air travel for leisure purposes.

- To investigate why as many as 1 in 5 households in some areas of the district use Economy 7 electricity. If this is for space heating then gas or other energy sources would provide a lower emissions alternative.
- To investigate and understand the causes of anomalous emissions from electricity and gas in some areas e.g. because of new build homes or commercial premises.
- To track the emissions from public buildings that are required to provide Display Energy Certificates to ensure that they remain on course to cut their emissions.

EXECUTIVE SUMMARY

This report is based on two premises: that climate change is largely caused by humankind's activities and that, to mitigate its effects and avoid exceeeding 2℃ of warming, it is necessary to reduce greenhouse gas emissions now as a matter of urgency. Since most emissions come from burning fossil fuels the report stresses areas where fossil fuel use can and should be reduced. The alternative approach, to expand the use of renewable energy as a way to replace fossil fuels, is not addressed here.

Since 2005, good progress has been made to reduce Winchester district's emissions from private cars and non-transport petroleum products, albeit below the average for Great Britain as a whole. Emissions from gas are close to being on track to meet the district's target of a 30% cut in emissions by 2015 relative to 2004.

The commercial and business sector needs to significantly cut its emissions from electricity (especially in some specific areas with a high number of shops, stores and businesses), and from road transport (especially by diesel light goods vehicles) both of which have increased since 2005.

Passengers using Winchester station have increased since 2005 but passenger numbers at Southampton airport, after a dip in 2008-2010, have started to increase again.

The emissions from electricity and gas in 14 sub-areas in the district reveal striking differences in average energy use presumably because of different domestic life styles and the varying proportions of domestic and commercial users.

Overall, but excluding emissions from land use changes (no 2005 figures available) and rail and air travel emissions (no accurate estimates exist) emissions in Winchester district reduced by only 5% between 2005 and 2010 (from 1270 thousand tonnes CO_2-eq to 1206 thousand tonnes CO_2-eq). This reduction estimate excludes the mostly harder-to-quantify sectors of food, consumerism and services; the total reduction may have been less.

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INTRODUCTION

This report follows, and largely replaces, an earlier report completed in 2011 for the Climate Change Programme Board of Winchester City Council.[1] While it brings up to date the greenhouse gas emissions data provided from several sources at Winchester district level it also explores electricity and gas emissions at sub-local authority level and presents some new data now available on land use changes.

All emission figures presented here are on a 'production basis', which allocates them according to the location where they are emitted, rather than on a 'consumption basis', which allocates them to the location of the ultimate consumer of the resulting goods and services. Most of the emissions are expressed in terms of the amount of the greenhouse gas carbon dioxide with an equivalent warming potential (CO_2-eq). The exceptions are road transport and land use changes, for which only carbon dioxide (CO_2) emissions are available. The background to the need to monitor emissions at local authority level, in the context of climate change and the UK government's stated emissions reduction targets, and further explanation of the difference between production and consumption emissions can be found in the earlier report.

The need to reduce greenhouse gas emissions globally, and therefore nationally and locally, has only been strengthened by the findings of scientific research since the last report. More

frequent extreme weather events worldwide are now beginning to be attributed to climate change which is widely accepted to be largely anthropogenic in origin. This only serves to add urgency to the work being undertaken in Winchester district to reduce greenhouse gas emissions.[2]

Data availability

Table 1 lists the sources of data which have been used and shows the date of the latest information. The dataset previously called NI186 gives summaries of emissions at local authority level[3] but currently is not available for years after 2009. Therefore other data sets, also published by the Department for Energy and Climate Change (DECC), have been used here.

Table 1. Sources of data available at Local Authority (LA) or sub-LA level which provided primary estimates of emissions for this investigation (grey boxes). Sub-LA data cover so-called Medium Level Super Output Areas (MLSOAs).

Source	Year								
	2003	2004	2005	2006	2007	2008	2009	2010	2011
DECC electricity (including MLSOA data)								publ March 2012	
DECC gas[a] (including MLSOA data)								publ Dec 2011	
DECC road transport								publ June 2012	
DECC other fuels								publ Dec 2011	
Land use changes							Report dated 2010		

Trellis pattern = less reliable, experimental statistics
Blank boxes = pre-2005: data not compatible with post-2005 data sets; post-2005: no data yet available.
a. The 'gas year' runs from 1 October until 30 September
b. 'NI186' statistics up to 2010 were published in late August 2012 by DECC just as this report was finished and are not presented here.(ref. 3)

Data accuracy

Collecting accurate data on energy use and greenhouse gas emissions at local authority level is difficult. Estimates are frequently made based on incomplete or inappropriately classified data or by using models that have inherent assumptions. However, whatever the failings of a particular data set, to a large extent trends can be discerned with more confidence provided that there is consistency in the estimation process from year to year. For that reason the absolute accuracy of annual emissions presented here should be treated with some caution whereas the trends are likely to be closer to reality. A more detailed discussion is provided in reference 4.

Determining trends in the data

Winchester District Strategic Partnership chose 2004 to be its baseline year when it set a target of a 30% reduction in greenhouse gas emissions by 2015. However, DECC recommends that its 2005 data, which are classed as National Statistics, should ideally be used as the baseline when making historical comparisons of the electricity and/or gas data because they are significantly more robust than the data from earlier years. For example, DECC advises that the pre-2005 gas consumption datasets should not be used for time series analysis, because changes in consumption recorded in the figures are mainly caused by improvements in data quality rather than by real changes in consumption. So here DECC energy data, and for consistency all other data, have been plotted using 2005 as the reference year. Plots of emission reductions referred to a 2005 baseline will therefore indicate slightly greater values assuming that energy consumption increased between 2004 and 2005. Nevertheless the directions of any consistent trends in the data will remain valid.

The effect of population changes

Energy use and emissions will depend to an extent on changes in the district's population. Winchester's population was 107,222 in 2001 and 116,600 in 2011, (ref.[5]) an average increase of 0.84% per annum, and this may have affected emissions. For example, in the five years from 2005 until 2010 the population would have increased by about 4.3%, assuming a uniform growth rate. The number of households increased from about 46,000 in 2001 to 46,900 in 2011, (ref[6]) an increase of 2%, implying that the number of households may have increased by about 1% between 2005 and 2010. On the other hand industrial/commercial emissions will largely reflect the economic activity within the district. Since the Winchester City Council's stated emissions target relates to total emissions, and does not refer to *per capita* emissions, the possible influence of population and household changes is not mentioned further.

PRIMARY ESTIMATES OF EMISSIONS

Primary estimates of emissions are defined here as those that can be estimated from the metered use of electricity, gas, transport fuels, other fuels and land use changes. They are investigated at both local authority (LA) and sub-LA level.

Electricity

DECC collects electricity data with the help of the electricity industry.[7] Annualised consumption data are generated by agents of the electricity suppliers, who collate/aggregate electricity consumption levels for each customer meter. Consumption data are then merged together to enable consumption data to be mapped to postcodes and aggregated to local authority and government office regions levels. The electricity consumption data are generated for both non-half-hourly (NHH) meters (domestic and small/medium industrial/commercial customers[8]) and for half-hourly (HH) meters (larger industrial/commercial customers). For the NHH data, an estimate of annualised consumption is based on consumption recorded between two meter readings or, where two meter readings are not available, it is produced using historical information and knowledge of the customer's consumption 'profile'. The NHH data include both Ordinary and Economy 7 type tariffs. Larger domestic customers, defined as those usually consuming more than 100,000 kWh per year or, following specific validation, of those consuming over 50,000 kWh are reallocated to the industrial/commercial sector (this latter definition seems to apply in Winchester district where the average annual industrial/commercial consumption per meter has been about 74,000 kWh).

Fig.1 shows the metered electricity consumption in Winchester district from 2005-2010. Although domestic consumption decreased by 4% overall, it increased by 1.5% from 2007 while industrial/commercial consumption increased by 4.9% over the same period. The consumption per domestic meter decreased steadily by 8.2% between 2005 and 2009 but has steadied at 4820 kWh in 2009-2010. The consumption per industrial/commercial meter on the other hand has remained between 73,000 and 75,900 kWh for the whole period (constant within 4%).

Emissions from electricity consumption are calculated using the relevant factor to convert from kWh to kg CO_2-eq published by DECC for each year.[9] Reference 9 states 'This factor changes from year to year, as the fuel mix consumed in UK power stations changes (as well as the net amount of imported electricity). Because these annual changes can be large (the factor depends very heavily on the relative prices of coal and natural gas as well as fluctuations in peak demand and renewables), and to assist companies with year to year comparability, the factor presented by DECC is the rolling average of the grid conversion factor over the previous five years.'

Total emissions for the district were between 387,000 and 395,000 tonnes CO_2-eq per year. However, as domestic emissions have decreased from 2005 to 2010, the share of emissions from the industrial/commercial sector has increased from 62% to 64% (Table 2).

Table 2: Emissions from electricity consumption in each sector since 2005.[10] The industrial/commercial emissions include those of the half-hourly meters.

Year	Domestic sector (tonnes CO_2-eq)	Industrial/commercial sector (tonnes CO_2-eq)	Total (tonnes CO_2-eq)
2005	148,262	241,956	390,218
2006	145,163	242,099	387,262
2007	142,708	247,433	390,141
2008	142,274	253,065	395,340
2009	140,114	251,015	391,129
2010	141,317	252,969	394,286

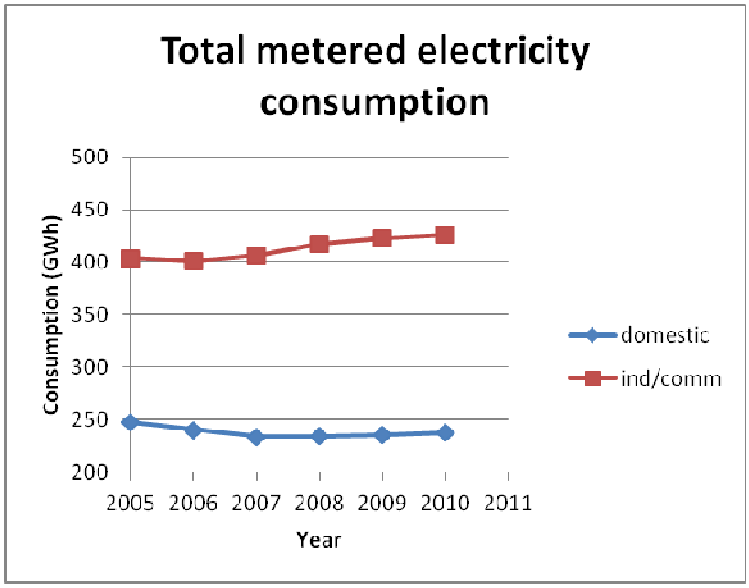


Figure 1. Metered electricity consumption in Winchester district (2005-2010).

Fig.2 shows trends in the emissions from using electricity relative to 2005. Fig.2 shows that, because consumption varied only slightly, the total emissions for Winchester district closely followed changes in the conversion factor.[11] Closer inspection shows that emissions from the domestic sector decreased more rapidly and, since 2007, those from the industrial/commercial sector less rapidly.

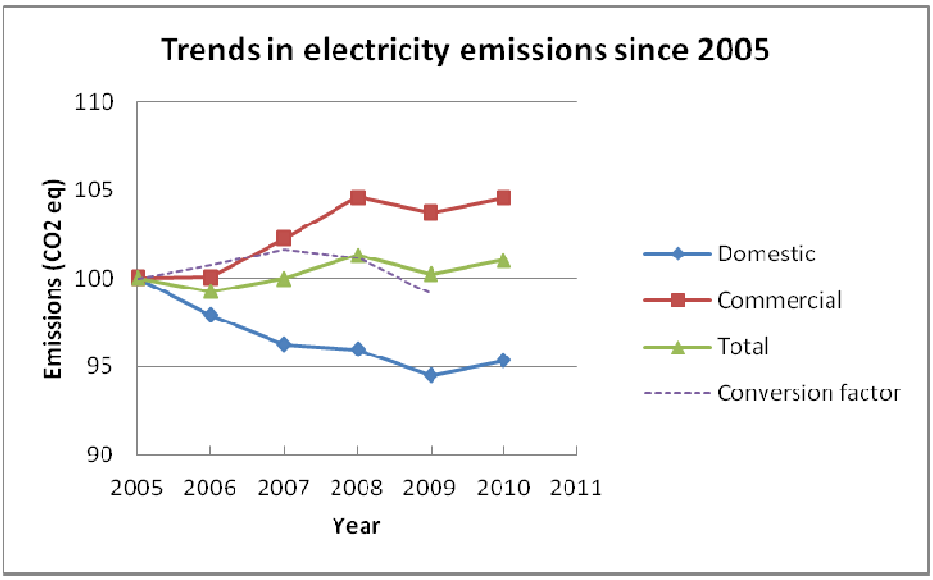


Figure 2. Trends in greenhouse gas emissions from electricity consumption relative to 2005 (=100). The conversion factor is explained in the text. The conversion factor for 2010 is not yet available from DECC and was assumed to be the same as for 2009 in the estimated emissions.

Domestic electricity consumption within different parts of Winchester district

DECC also supply electricity consumption data for 14 sub-areas of Winchester district from so-called Middle Level Super Output Areas or MLSOAs.[12] In 2010 these MLSOAs each contained between 2000 and 3900 households. The areas are listed in Table 3. DECC provides readings from Ordinary and Economy 7 meters.[13] Figures 3 and 4 show average annual consumptions per meter for each MLSOA in 2010 measured by the two different sorts of meter. Economy 7 meters made up between 7% and 19% of all meters; the areas with the highest proportion of Economy 7 meters are spread equally between town and country.

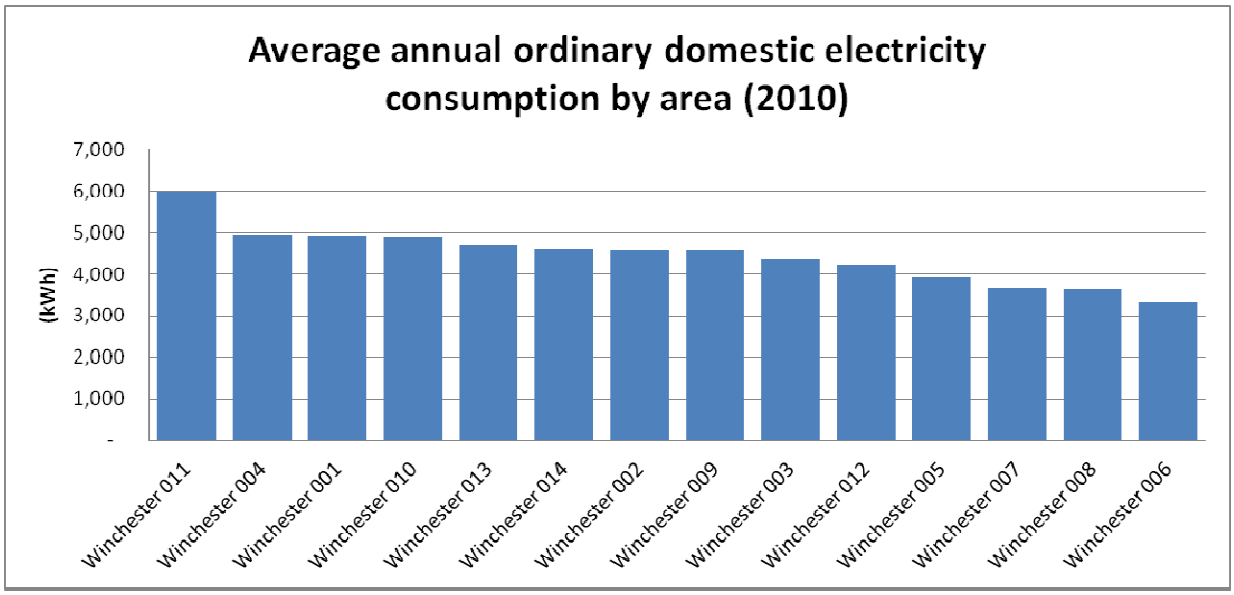


Figure 3. Ranked average annual Ordinary domestic electricity consumption per meter in 2010 by area.

Table 3. Middle Level Super Output Areas in Winchester district and their approximate geographical coverage.

Middle Layer Super Output Area	Main towns/villages in Middle Layer Super Output Area
Winchester 001	Micheldever Station/Wonston to E Stratton/S Wonston
Winchester 002	Northington/M3 Services/Kings Worthy to Itchen Stoke/Chilcomb
Winchester 003	Crawley/Littleton/Harestock/Sparsholt
Winchester 004	New Alresford/Bishops Sutton/Cheriton/Kilworth/Beauworth/Kilmeston/Bramdean
Winchester 005	Weeke/Fulflood/HM Prison
Winchester 006	M3 Jct.9/Winnall/St Giles Hill/Bar End
Winchester 007	Hyde/Central Winchester/Cathedral/St Cross
Winchester 008	Stanmore/Sleepers Hill/West Hill/Winchester College
Winchester 009	Olivers Battery/Badger Farm/Hursley/Compton
Winchester 010	Twyford/Colden Common/Owslebury
Winchester 011	W Meon to Soberton Heath-Newtown/Chidden/Hambledon
Winchester 012	Dean/Bishops Waltham/Waltham Chase/Shirrel Heath
Winchester 013	Wintershill/Durley/Curdridge/Shedfield/Wickham/Whiteley
Winchester 014	Denmead/Walton Heath/N Boarhunt/Boarhunt/Southwick

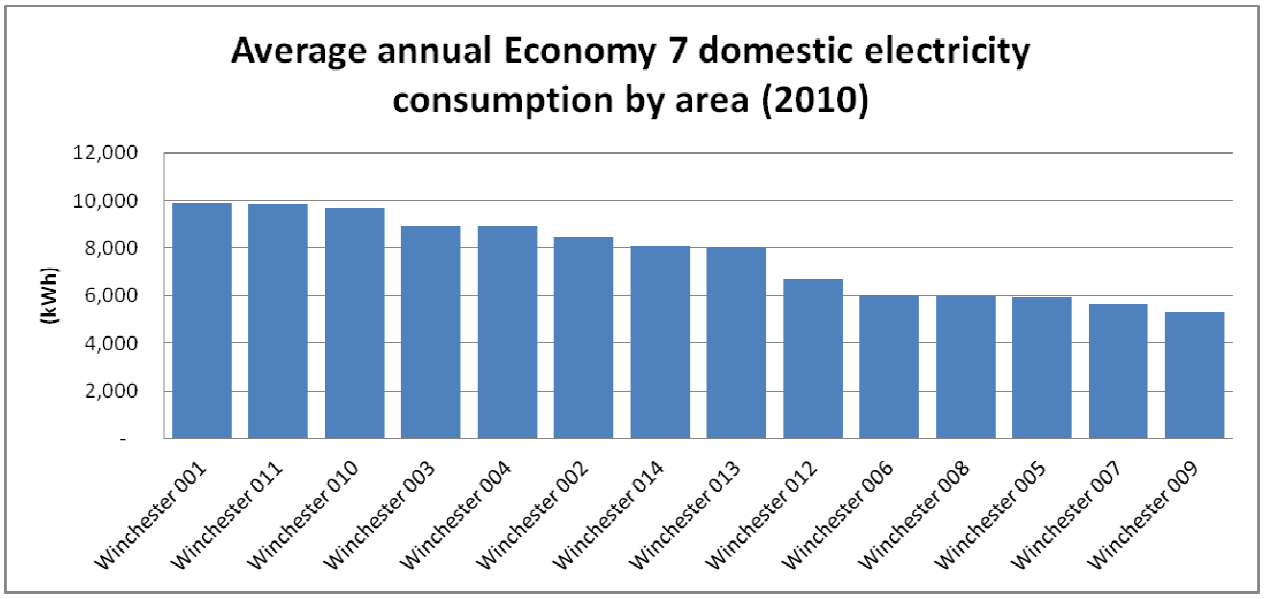


Figure 4. Ranked average annual Economy 7 domestic electricity consumption per meter in 2010 by area.

The highest (6000 kWh) and lowest (3300 KWh) averages of Ordinary meter readings are in areas 011 and 006, respectively. The highest average Economy 7 meter readings (ca. 9800 kWh) are in areas 001, 010 and 011. In fact the highest eight Economy 7 averages (Fig.4) are all in rural areas suggesting that some households in these areas rely heavily on storage heaters for space heating. The lowest average Economy 7 meter readings are in areas (005, 006, 007, 008 and 009) which are all within the city of Winchester. Presumably these homes are smaller and/or better insulated than their rural counterparts or they don't use electricity for space heating.

It is no surprise therefore that the highest domestic emissions from electricity consumption per meter in 2010 was 4.0 tonnes CO_2-eq per meter in area 011 and the lowest was about 2.3 tonnes CO_2-eq per meter in areas 005, 006, 007 and 008 (including the less prosperous areas in Winchester). It is remarkable that on average households in area 011 emitted 74% more than in area 006 (Fig.5).

In 2010 Ordinary meters were responsible for the emission of 114,600 tonnes of CO2-eq and Economy 7 meters for 26,700 tonnes.

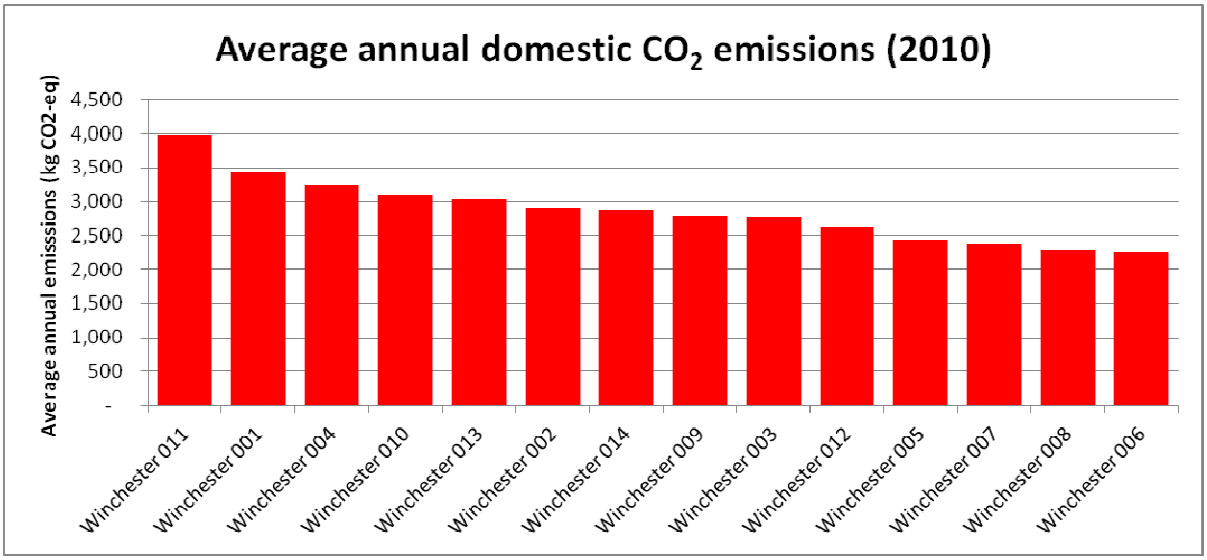


Figure 5. Ranked average annual domestic electricity emissions per meter, by area in 2010.

Changes in domestic electricity emissions 2005-2010

To investigate changes in domestic electricity emissions at MLSOA level data from 2005 and 2010 were compared. Data for 2004 were not used for the reasons explained earlier. Table 4 lists the 5-year changes in emissions for each area. The most striking feature of Table 4 is that average Ordinary emissions per meter decreased in all areas by between 4.0% and 11.6%. Similarly, Economy 7 meters recorded average decreases per meter between 8.8% and 18.1% in all areas except 003. Assuming that Economy 7 meters are principally used for space heating these latter figures might indicate improved home insulation and/or a reduction in ambient temperatures in homes although local weather could be a factor too.

Nine areas registered a decrease in Ordinary emissions; areas 005, 007 and 013 showed an increase and areas 001 and 011 showed no change. Only area 013 showed an increase in Economy 7 emissions; area 007 was unchanged. Area 007 includes a large number of shops and offices. When the emissions from Ordinary and Economy 7 meters are combined decreases of between 1.0% and 8.4% are seen except for an increase of 3.3% in both areas 007 and 013.

Table 4. Decreases in domestic electricity emissions in MLSOAs measured by Ordinary and Economy 7 meters from 2005 to 2010. Increases are indicated by a negative decrease.

MLSOA	Ordinary meters			Economy 7 meters		
	Average emissions per meter (% decrease)	No. of meters (% decrease)	Absolute emissions change (% decrease)	Average emissions per meter (% decrease)	No. of meters (% decrease)	Absolute emissions change (% decrease)
Winchester 001	6.64	-7.14	-0.02	8.75	-5.90	3.37
Winchester 002	6.74	-6.77	0.43	13.06	6.75	18.93
Winchester 003	10.75	-2.66	8.38	-1.73	6.83	5.22
Winchester 004	7.26	-5.19	2.45	14.96	0.20	15.13
Winchester 005	8.34	-12.33	-2.96	16.36	7.65	22.75
Winchester 006	6.79	-2.55	4.41	13.59	2.48	15.74
Winchester 007	4.00	-8.62	-4.27	9.59	-10.74	-0.12

Winchester 008	4.10	-1.41	2.74	12.28	-1.11	11.31
Winchester 009	7.61	-5.55	2.48	11.71	11.10	21.50
Winchester 010	9.23	-7.38	2.53	9.07	4.03	12.74
Winchester 011	6.28	-6.74	-0.04	10.56	3.69	13.86
Winchester 012	11.60	-6.18	6.14	18.10	3.48	20.95
Winchester 013	10.28	-14.51	-2.74	12.96	-21.17	-5.47
Winchester 014	8.20	-5.68	2.99	14.18	5.31	18.73

Table 5. Changes in average industrial/commercial electricity emissions in MLSOAs and by Super consumers from 2005 to 2010. Increases are indicated by a negative decrease.

MLSOA	Average annual Industrial/commercial electricity emissions per meter (% decrease)	No. of meters (% decrease)	Absolute Industrial/commercial emissions change (% decrease)
Winchester 001	-24.09	5.43	-17.35
Winchester 002	-7.62	-5.73	-13.78
Winchester 003	80.73	-7.43	79.30
Winchester 004	15.50	-2.54	13.35
Winchester 005	17.91	-17.45	3.59
Winchester 006	4.88	0.55	5.41
Winchester 007	14.98	-3.11	12.33
Winchester 008	4.78	-6.54	-1.45
Winchester 009	9.29	-7.39	2.59
Winchester 010	5.87	-17.95	-11.02
Winchester 011	10.64	-0.22	10.45
Winchester 012	7.39	-3.91	3.77
Winchester 013	1.71	-32.07	-29.81
Winchester 014	5.27	-5.24	0.30
Super consumers	-3.57	-12.12	-16.12
Whole sector	2.27	-7.65	-5.21

Industrial/commercial electricity consumption within different parts of Winchester district

Electricity consumption by the industrial/commercial sector is made up of Ordinary meter readings provided at MLSOA level and readings recorded on a half-hourly basis by the larger consumers (here called super consumers). The latter readings are consolidated across the district and '… cannot be disaggregated to MLSOA as doing so would break the UK Statistics Authority's Code of Practice for official statistics relating to data disclosure.'[14] i.e. would risk breaching data confidentiality. In 2010 the 222 super consumers accounted for 297,795 MWh of electricity which is 70% of all the electricity consumption in the industrial/commercial sector.

Fig.6 shows the ranked average industrial/commercial electricity consumption per meter in MLSOAs. There is a factor of 2.5 difference between the largest and smallest values. Area 006, with the highest consumption, includes Winnall where there is a concentration of medium to large stores and other businesses. Area 008, the area with the lowest consumption, but also within Winchester town, is largely residential.

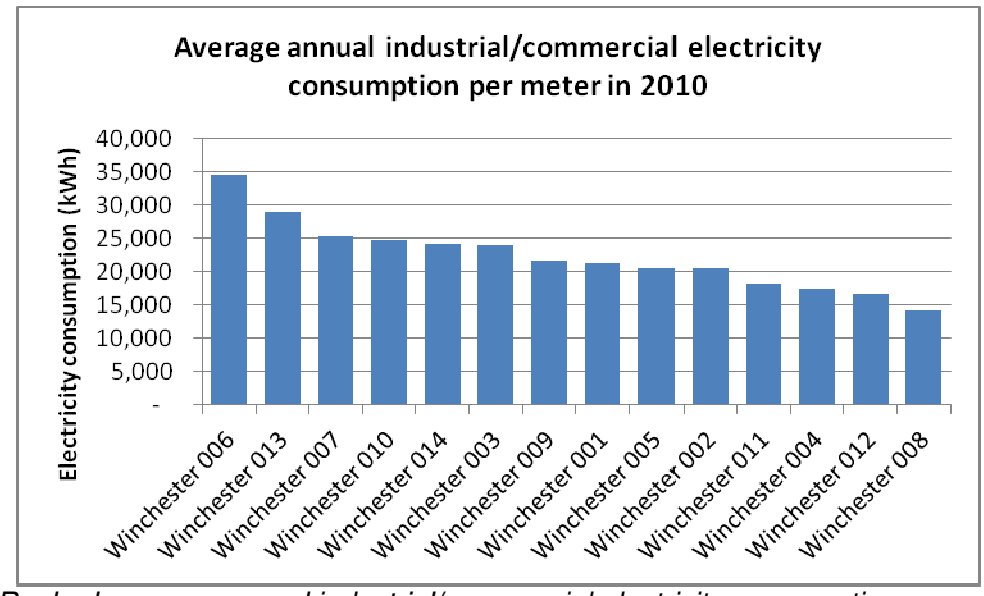


Figure 6. Ranked average annual industrial/commercial electricity consumptions per meter in 2010 by MLSOA. Note that this figure excludes the far larger consumption of super consumers (see text).

Changes in industrial/commercial electricity emissions 2005-2010

The changes in emissions between 2005 and 2010 are shown in Table 5. Across the whole sector, emissions increased by 5.2%. However, super consumers increased their total consumption by over 16% in the same period.

Average annual emissions per meter in the 14 areas decreased by 17% but emissions per meter increased by 3.6% among the super consumers. There was an astonishing decrease in emissions per meter in area 003 of over 80% between 2005 and 2010. Both the last two remarks could possibly be influenced by one or more users being re-classified as a super consumer. In all other areas, decreases per meter over 5 years have been far more modest (1.7% to 17.9% in eight areas) and consumption actually increased in two areas (001 and 002).

The number of meters increased in all areas, except areas 001 and 006, with the largest increases in areas 005, 010 and 013.

Electricity Summary:

- *Overall, the district's emissions from electricity consumption increased by 3.9% between 2005 and 2010.*
- *Electricity consumption in the district in 2010 was divided in the ratio 36:64 between domestic and industrial/commercial sectors (Table 2). This domestic figure includes SMEs using less than 50,000 kWh per year.*
- *Across the whole district since 2005 domestic emissions have decreased by 5% more than rates determined by changes in the fuel mix for electricity generation. Industrial/commercial emissions, on the other hand, have increased by 5% more than the fuel mix (Fig.2).*
- *At MLSOA level the highest Ordinary and Economy 7 average domestic meter readings in 2010 were in area 011 (Figs. 3 and 4)*

- *The highest Economy 7 average domestic meter readings are in rural areas and the lowest are in Winchester town (Fig. 4) although areas with the highest proportion of Economy 7 meters are spread equally between town and country.*
- *On average, area 011 emitted 4.0 tonnes CO2-eq per domestic meter whereas the four least emitting areas in Winchester town emitted about 2.3 tonnes CO2-eq per domestic meter.*
- *Between 2005 and 2010 twelve areas out of fourteen show an average decrease of 5% in domestic emissions from Ordinary and Economy 7 meters combined (cf Fig.2) whereas areas 007 and 013 show an increase of 3.3%.*
- *At MLSOA level the highest average industrial/commercial consumption per meter in 2010 was in area 006 (Winnall to Bar End; Fig.6).*
- *Between 2005 and 2010 there was an unexplained decrease in industrial/commercial emissions in area 003 of over 79%. Elsewhere emissions decreased in seven areas and increased in six (Table 5).*
- *Between 2005 and 2010 the emissions from the whole industrial/commercial sector increased by 5% although the emissions from the super consumers, those using half-hourly meter readings, who account for 70% of consumption in this sector, increased by over 16% (Table 5).At MLSOA level, the highest average industrial/commercial consumption per meter in 2010 was in area 006 (Fig.6), although the MLSOA figures only relate to the 30% of industrial/commercial emissions arising from NHH users.*

Natural gas

DECC provides weather-corrected gas consumption estimates for 2005-2010 at local authority and government office region level.[7]

A company called xoserve provides annual estimates of consumption for all gas meters based on two meter readings at least six months apart. The estimate is then adjusted to include a weather correction that reflects the observed warming trend, including year to year fluctuations, over the last 17 years.[15] However for around 4 million meters each year (approximately 18% of the total) no up to date annual estimate can be made because no new meter readings for those meters have been taken! There is no reliable allocation of estimates between the domestic and industrial/commercial sectors for consumers with relatively low gas consumption. This is because the gas industry uses a crude 73,200 kWh level as the cut off point for defining customers as domestic or industrial/commercial. The implication of this is that nationally only around half a million businesses are allocated to the industrial/commercial sector, with around 2 million small and medium businesses allocated to a sector which contains mainly domestic meters.

Total metered gas consumption for each sector is shown in Fig.7. The values for 2005 are suspect because the consumption by the industrial/commercial sector is inexplicably much higher than later values. Between 2006 and 2010 consumption in the domestic sector declined by 14.3% and in the industrial/commercial sector by 13.5% although between 2009 and 2010 the decline in both sectors significantly reduced (Fig.7; Table 6). Although the number of domestic consumers increased by 3.3% the average consumption fell by 16.9%. On the other hand the number of industrial/commercial meters decreased by a third but the average consumption per meter rose by 21.3%! The reason for this change is unknown.

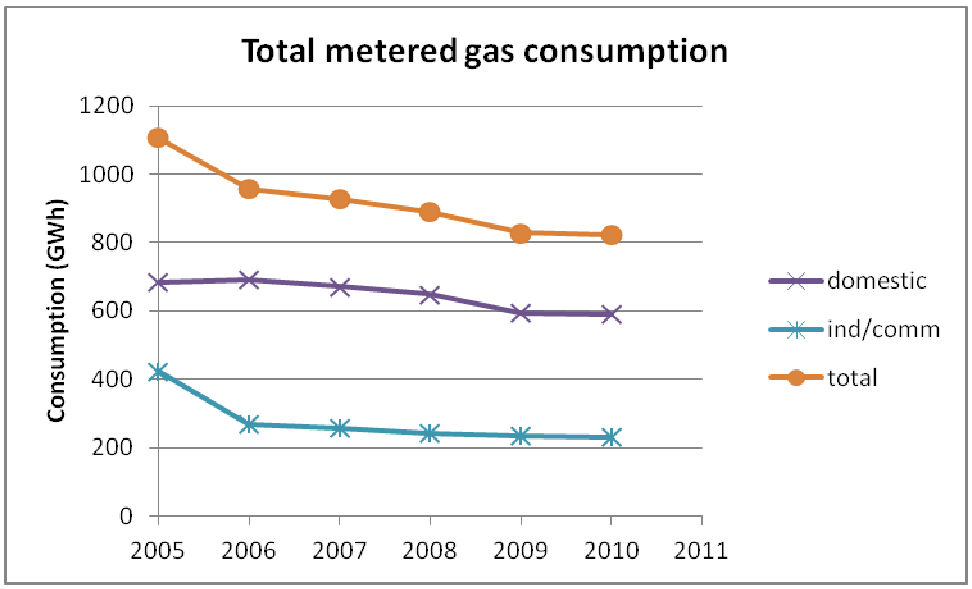


Figure 7. Metered gas consumption in Winchester district (2005-2010). Note that the domestic sector includes some small and medium-sized businesses.

Table 6. Emissions from gas consumption in each sector since 2005.

Year	Domestic sector (thousand tonnes CO_2-eq)	Industrial/commercial sector (thousand tonnes CO_2-eq)	Total (thousand tonnes CO_2-eq)
2005	153	95	249
2006	155	60	215
2007	150	58	208
2008	145	54	200
2009	133	53	186
2010	133	52	185

Emissions from gas consumption were calculated using DECC's conversion factor of 0.22419 kg CO_2-eq/kWh for all years (Table 6).[16] Emissions from both the domestic and industrial/commercial sectors have decreased significantly since 2005 (Fig.8), by 13.6% and 45.3% (but only 13.5% since 2006) respectively, in spite of the total number of meters increasing by almost 8% from 35,600 to 38,400 over the same period. The industrial/commercial sector accounted for 28% of these emissions (except in 2005).

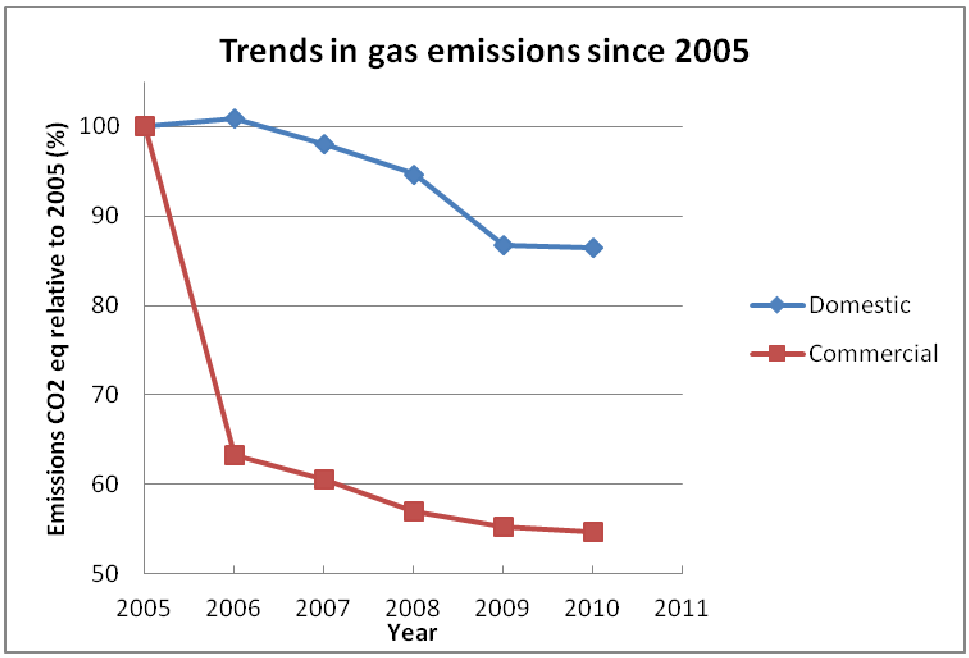


Figure 8. Relative changes in greenhouse gas emissions from the consumption of gas in Winchester district (2005-2010). The industrial/commercial emissions in 2005 were significantly higher than subsequently and have distorted the 'commercial' curve in the figure.

Domestic gas consumption within different parts of Winchester district

As already explained, when presenting electricity consumption data, DECC supplies gas consumption data for 14 sub-areas of Winchester district from so-called Middle Level Super Output Areas or MLSOAs.[12]

Fig. 9 shows ranked annual domestic gas consumption per meter by MLSOA in 2010. Average annual consumption varies between 12,500 kWh (area 006) and 17,900 kWh (area 011) corresponding to average annual emissions per meter of 2.8 to 4.0 tonnes CO2-eq.

Changes in domestic gas emissions 2005-2010

Table 7 shows the changes in annual average domestic gas consumption, and therefore emissions[17], from 2005 to 2010 by MLSOA. All areas have decreased their average annual consumption per meter by between 17.7% and 22.3% over 5 years.

All areas, except 013, have decreased their gas consumption in absolute terms by between 11.1% and 17.5% over the 5-year period. In area 013 there was a 1.8% increase perhaps reflecting the substantial increase in the number of meters (Table 7). Clearly these figures are liable to depend on changes in the number of households in an area but this information is not readily available at MLSOA level. Since 2006/2007 the number of housing completions in Winchester district has varied from year to year by a factor of two.[18]

The number of meters has not remained stagnant and increased by between 1.6 and 25.7% over the 5-year period. Overall there was an 8.6% increase.

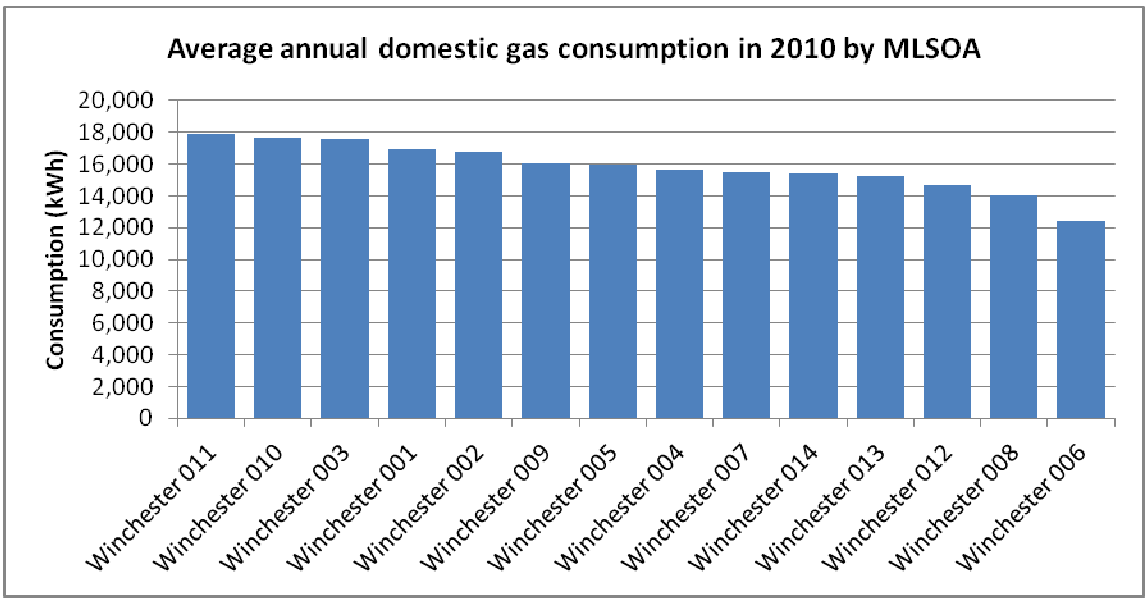


Figure 9. Average annual domestic gas consumption per meter in 2010 by MLSOA ranked by consumption.

Table 7. Changes in domestic gas consumption in MLSOAs between 2005 and 2010. Increases are indicated by a negative decrease.

MLSOA	Average annual domestic gas consumption per meter (% decrease)	No. of meters (% decrease)	Absolute consumption change (2005-2010) (% decrease)
Winchester 001	19.92	-3.61	17.02
Winchester 002	21.31	-11.69	12.11
Winchester 003	19.56	-5.55	15.10
Winchester 004	21.49	-6.88	16.09
Winchester 005	22.08	-10.91	13.58
Winchester 006	20.09	-3.22	17.52
Winchester 007	20.15	-11.38	11.07
Winchester 008	17.70	-1.64	16.35
Winchester 009	19.23	-2.96	16.84
Winchester 010	21.30	-9.27	14.01
Winchester 011	19.22	-2.86	16.91
Winchester 012	22.29	-6.65	17.12
Winchester 013	19.03	-25.71	-1.79
Winchester 014	19.54	-8.16	12.97

Industrial/commercial gas consumption within different parts of Winchester district

Although the gas consumption by the industrial/commercial sector is only about 28% of the total gas consumption the average annual consumption per meter, and therefore emissions, is about 24 times as much! Fig.10 shows the average annual gas consumption per industrial/ commercial meter in 2010 for each MLSOA. Values differ by more than a factor of four but

without further information it is difficult to give reasons for this other than by suggesting it is caused by different sizes and types of commercial organisation.

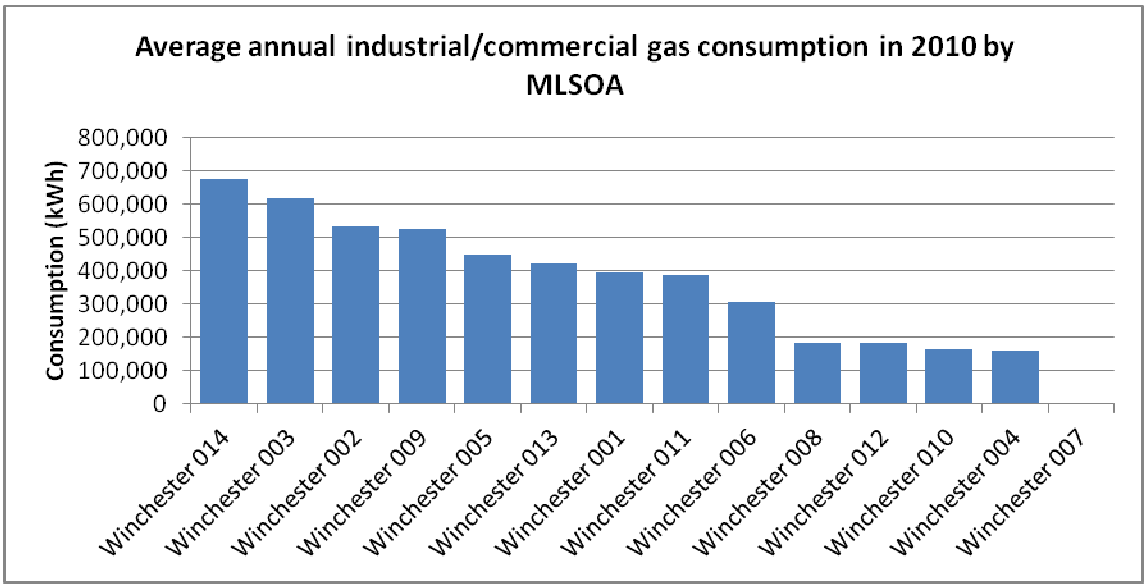


Figure 10. Ranked average annual industrial/commercial gas consumption per meter by MLSOA in 2010. The consumption in Winchester 007 was combined with that in Winchester 001 in the DECC data.

Table 8. Changes in industrial/commercial gas consumption in MLSOAs between 2005 and 2010. Published data for areas 001 and 007 have been combined and cannot be disaggregated. Increases are indicated by a negative decrease.

MLSOA	Average annual industrial/commercial gas consumption per meter (% decrease)	No. of meters (% decrease)	Absolute consumption change (2005-2010) (% decrease)
Winchester 001	-16.08	18.14	4.98
Winchester 002	-22.38	29.17	13.32
Winchester 003	-50.89	50.00	24.55
Winchester 004	13.62	26.19	36.25
Winchester 005	-11.80	28.07	19.58
Winchester 006	3.24	32.58	34.77
Winchester 007	See caption		
Winchester 008	-18.52	26.47	12.85
Winchester 009	-33.34	26.83	2.43
Winchester 010	4.70	32.81	35.97
Winchester 011	-29.82	-10.00	-42.80
Winchester 012	-8.72	45.95	41.23
Winchester 013	78.20	11.00	80.60
Winchester 014	-9.26	17.24	9.58

Changes in Industrial/commercial gas emissions 2005-2010

Changes in average annual gas consumption per meter between 2005 and 2010 are shown in Table 8 for the 12 areas where data are available. Eight of the areas show an increase in consumption, and therefore emissions, of between 8.7% and 50.9% over the 5-year period. In area 003 average emissions per meter have increased by over 50% in 5 years! Area 013 has decreased its average emissions by an astonishing 78%. Neglecting the effect of the latter decrease, the sector as a whole actually increased its average emissions per meter by almost 16% over the period 2005-2010. Again, without further information it is difficult to give reasons for these observations.

The number of meters per MLSOA also decreased in the 5-year period by between 11% and 50% except for area 011 where there was a 10% increase. In absolute terms consumption per MLSOA decreased by between 2.4% and 80.6% over 5 years except for area 011 where there was a 42.8% increase.

Gas summary:

- *Across the whole district in 2010 gas consumption was in the ratio 72:28 between the domestic and industrial/commercial sectors. The domestic sector includes SMEs using less than 73,200 kWh per year.*
- *Over the whole district since 2006 (ref.[19]) both domestic and industrial/commercial gas emissions decreased by around 14%.*
- *At MLSOA level the highest average domestic gas emissions per meter in 2010 were in area 011 (4.0 tonnes CO2-eq) and the lowest in area 006 (2.8 tonnes CO2-eq).*
- *Between 2005 and 2010 domestic gas emissions decreased by between 11.1% and 17.5% in all areas except one. Area 013 increased its emissions by 1.8% (Table 7).*
- *In 2010 in MLSOAs the average industrial/commercial emissions per meter varied by a factor of four (Fig.10) which is likely to reflect differences in the size and types of mainly commercial organisations. The largest average emissions were in area 014 and the least in the largely rural area 004.*
- *Between 2005 and 2010 many areas showed large decreases in industrial/commercial emissions of up to 80.6%. However area 011 increased its emissions by 42.8% (Table 8). These changes cannot be explained at present and may represent problems with the data.*

Road transport

In 2008 the transport sector accounted for around 24% of the UK's territorial emissions, producing approximately 130 million tonnes of CO_2 per year.[20] Of this 24%, almost 70% was emitted by road vehicles, mostly private cars and goods vehicles.[21] In 2006, in Winchester district, transport contributed as much as 29% of all emissions[22] so that around 20% of such emissions might be expected to be attributable to road transport. Thus it is important to understand the sources and current trends of road transport emissions in the district if effective measures are to be adopted to reduce local emissions. A very detailed survey of the district's emissions from road vehicles between 2008 and 2011 can be found in a separate WinACC report based on data sets provided by the DVLA and VOSA/MoT.[23]

DECC estimates fuel consumption by type of vehicle (bus, motorcycle, petrol car, diesel car, heavy goods vehicle (HGV), petrol light goods vehicle (LGV) and diesel LGV) for each local authority. The estimates are based on where the fuel was consumed rather than on where it was purchased or where vehicles are registered. The starting point for the work is information available from the National Atmospheric Emissions Inventory (NAEI) programme for Defra. The

estimates are produced using CO_2 emissions data from NAEI, fuel consumption factors and traffic flow data from the Department for Transport. Fuel consumption factors are expressed in grams of fuel per kilometre, for each detailed vehicle class, which are taken from two distinct data sources: first, vehicle emissions test data provided by the Transport Research Laboratory (TRL) over different drive cycles from measurements on a limited sample of vehicles; and second, car manufacturers' data on CO_2 emissions and surveys with freight haulage companies on fuel efficiency of HGVs. DECC warns that 'The road transport estimates are modelled rather than real consumption estimates, and are based on the use of a number of different information sources. As a result the estimates are subject to potential modelling inaccuracies.'

The principal classes of road vehicle that consume fuel are diesel and petrol cars, HGVs and diesel LGVs; they account for over 96% of all fuel consumed. The remainder includes buses, motorcycles and petrol LGVs.

Total fuel consumption for the four principal classes of vehicle is shown in Fig.11. Fuel consumption by goods vehicles has changed relatively little since 2005; HGVs peaked in 2008 and then dropped back and diesel LGVs have increased by 12.8%. Consumption by diesel cars increased by a quarter whereas petrol cars reduced by 23.5%. Overall, total fuel consumption dropped by 6% between 2005 and 2010.

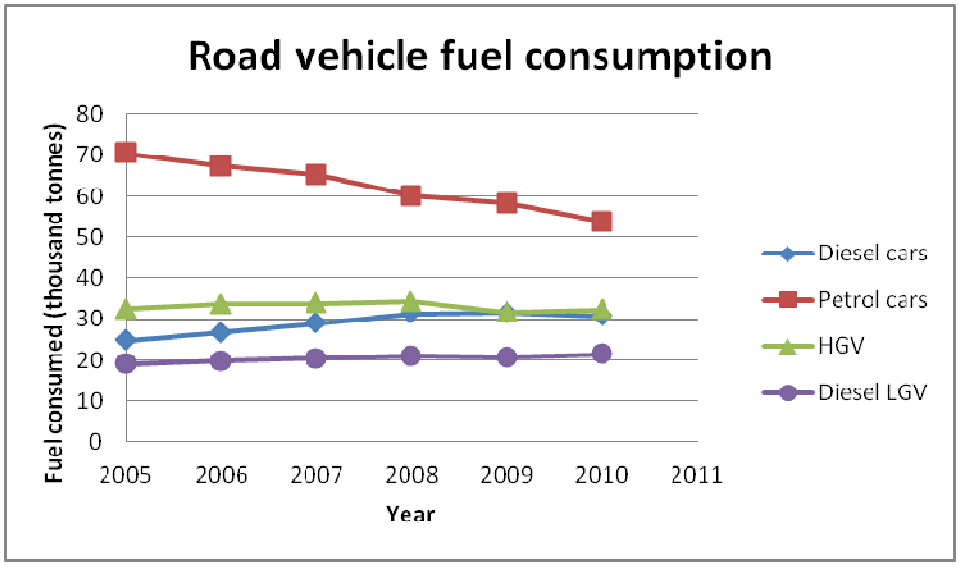


Figure 11. Fuel consumption by the four principal classes of road vehicle in Winchester district (2005-2010).

The CO_2 emissions from petrol and diesel engines were estimated assuming that a vehicle emits 2.32 kg CO_2 per litre of petrol and 2.66 kg CO_2 per litre of diesel.[24] The emissions of methane and nitrous oxide from most vehicles are negligible[25] so that the computed CO_2 emissions will closely approximate the CO_2-eq values. The emissions from all seven classes of vehicle are shown in Table 9. Unsurprisingly, when plotted against time they show very similar trends to the plots of fuel consumed.

Defra have recommended that an additional 15% should be added to vehicle emissions rates quoted by manufacturers to allow for the real world effects of using accessories, such as air conditioning, lights and heaters, and also vehicle payload (no allowance is made for passengers or luggage weighing over 25 kg), poor maintenance (tyre under inflation and maladjusted

tracking), and gradients (tests effectively assume a level road).[26] Therefore the totals in Table 9 (right-hand most column) have been 'uplifted' by 15%.

Table 9. Estimated CO_2 emissions (thousands of tonnes) from road vehicles in Winchester district (2005-2010) using the factors described in the text to convert from fuel used to CO_2 emitted.

Year	Buses	Diesel cars	Petrol cars	Motor cycles	HGV	Diesel LGV	Petrol LGV	Total	Total +15%
2005	10.2	79.2	220.8	2.5	103.5	60.8	5.1	482.1	554.4
2006	10.1	85.0	211.1	2.5	107.6	63.5	5.1	484.9	557.7
2007	9.9	92.5	204.2	2.5	108.0	64.8	4.5	486.5	559.5
2008	10.0	100.2	188.1	2.6	109.5	67.1	4.1	481.6	553.8
2009	9.6	100.5	182.6	2.8	101.1	66.0	3.7	466.3	536.3
2010	9.6	98.3	168.9	2.2	103.1	68.6	3.4	454.2	522.3

Fig.12 shows the relative changes in emissions in the four main classes of vehicle since 2005. Overall, total emissions peaked in 2007 and then decreased by 6.7%. Up to 2009 the decrease in emissions from petrol cars was offset by a similar increase from diesel cars, reflecting trends in car numbers,[27] but after 2009 emissions from all cars decreased possibly as drivers purchased more efficient cars and/or drove in a more environmentally friendly manner to save fuel or used their vehicles less. Emissions from goods vehicles increased steadily up to 2008, decreased in 2009 presumably as a result of the economic situation, but since then have resumed their inexorable rise. This is demonstrated more clearly in Fig.13. The emissions from private vehicles decreased by 11% since 2005.

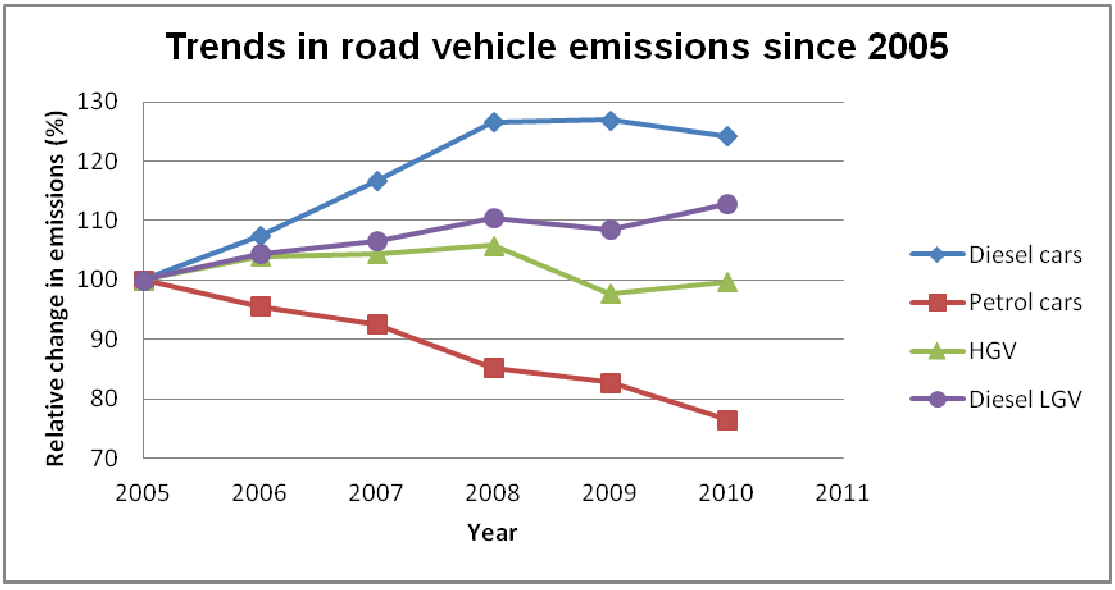


Figure 12. Trends in the emissions from the four main classes of road vehicle in Winchester district since 2005 (2005 = 100).

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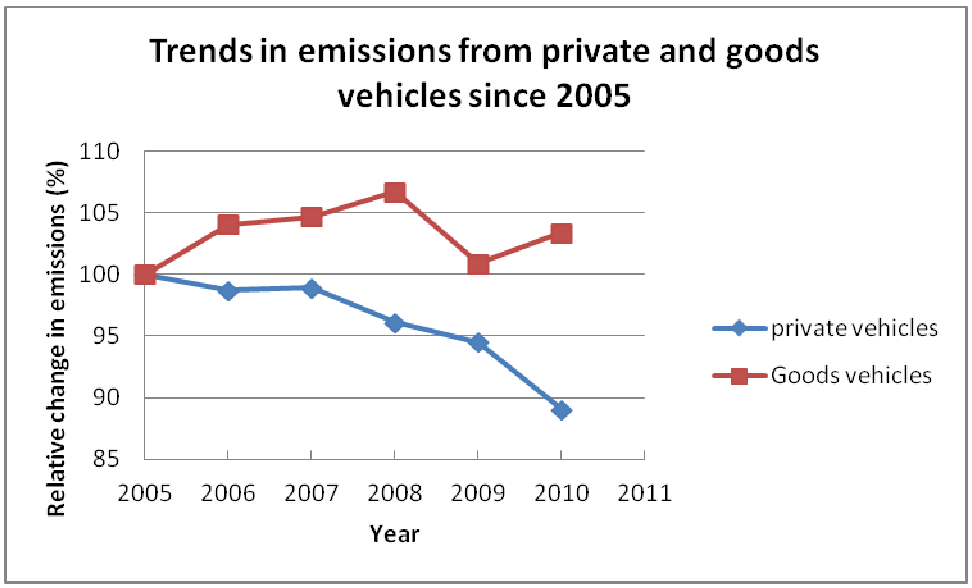


Figure 13. A comparison of trends in emissions from private vehicles and goods vehicles in Winchester district since 2005 (2005 = 100).

It is interesting to compare the emissions modelled by DECC with emissions calculated independently by a more direct method (based on the number of vehicles, their average emissions per kilometre and estimated annual mileages).[23] See Table 10.

Table 10. Comparison of emissions of CO_2 from vehicles in Winchester district estimated by two different techniques without applying a 15% uplift.

Vehicle type	DECC emissions in 2010 (thousand tonnes CO_2)	DVLA/VOSA emissions in 2011 (thousand tonnes CO_2) (ref.23)
Private cars	267	157
Light Goods	72	142
Total (all categories)	454	319

This is not the place to investigate the discrepancies in detail but it is likely to be the result of the different models used and assumptions made in the two independent methods. The range of values is surprising and illustrates the difficulty of making estimates of energy consumption. Clearly for tracking purposes the year on year trends in emissions, computed by whatever method applied consistently, are more valuable than the absolute values of the estimated emissions.

Road transport summary:

- *In Winchester district over 96% of road transport fuel is consumed by diesel and petrol cars, heavy goods vehicles and diesel light goods vehicles.*
- *Overall fuel emissions decreased by 5.8% between 2005 and 2010. The emissions from private cars decreased by 11%. Although there was an increase in emissions of 19,100 tonnes CO_2 from diesel cars this was more than offset by a decrease of 51,900 tonnes CO_2 from petrol cars. However diesel LGVs increased their emissions by 12.8% (Fig. 12).*

Other fuels

'Other' or 'remaining' fuels listed by DECC up to 2009 include domestic and industrial coal and manufactured solid fuels (e.g. coke), petroleum consumed for non-road transport purposes and combined renewable energy sources, such as wood, and wastes.[28] The dataset does not cover fuel used by the aviation and national navigation sectors, as this information cannot be allocated to regions and local authorities, and also data for heat sold which is already modelled at a UK level and accounts for a very small percentage of total energy use.[7] International aviation and shipping are also excluded. The total quantity of other fuels consumed in Winchester district in 2009 (35,100 tonnes oil equivalent) is equivalent to about 127,000 tonnes CO_2-eq[29].

Fig. 14 shows trends in the emissions from petroleum fuels, manufactured solid fuels and coal. Overall there has been a decline in emissions from the other fuels sector since 2005 dictated mainly by the strong decrease in consumption of petroleum fuels. From 2005 to 2007 total emissions fell by 7.4% and then declined more slowly. From 2005 to 2009 emissions declined by 8.4%.

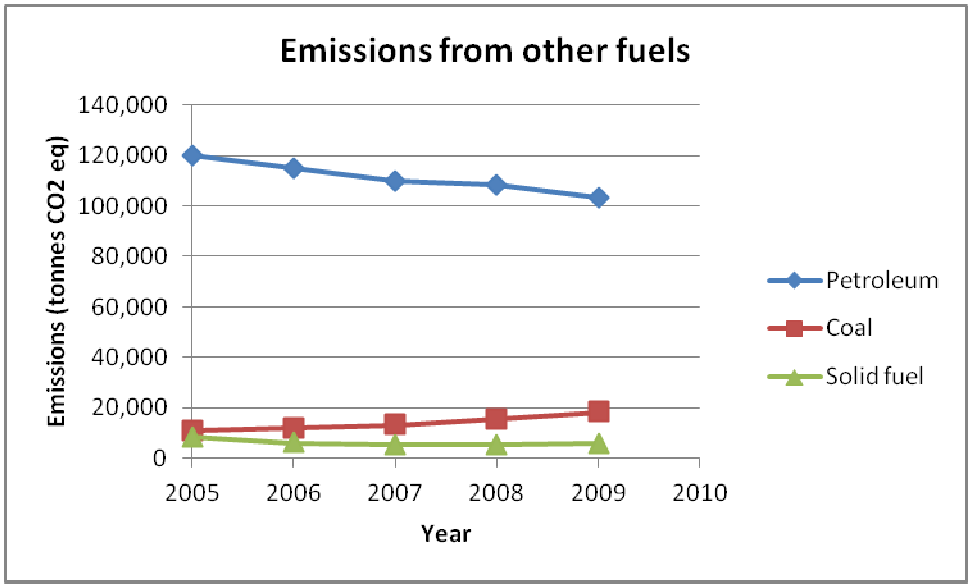


Figure 14. Emissions from three classes of other fuels in Winchester district between 2005 and 2009.The emissions from renewables and waste are omitted because they are relatively insignificant.

Other fuels summary:

- *The emissions attributable to other fuels comprise about 9% of all the district's emissions and declined significantly between 2005 and 2009 by 8.4%.*

Land use changes

Changes in land use can have important consequences for carbon dioxide sequestration and release into the atmosphere as well as for other greenhouse gases involved in agricultural activities. Green spaces in cities can equally 'lock up' carbon. For example, a survey in Leicester concluded that an estimated 849 thousand tonnes of CO_2 is stored within the above-ground vegetation of Leicester, equating to 11.6 kg CO_2/m^2 of urban area, with 97.3% of this carbon pool being associated with trees rather than herbaceous and woody vegetation.[30] The researchers concluded that current national estimates of this ecosystem service undervalue

Leicester's contribution by an order of magnitude. It is worth noting that the carbon stored above ground in Leicester is only slightly less than that emitted annually by the production emissions of Winchester district! There are clear environmental benefits to planting and preserving trees, both within and outside towns and cities, even though trees have long lifetimes that mean the annual uptake of carbon is relatively modest, and to using wood to a greater extent in construction and other projects which ensures that the embodied carbon is not released for many years.

This is not the place to review how land use can affect greenhouse gas emissions but Defra has published a useful document that does just that[31] and activities that emit or sequestrate carbon are also listed in Table 1 of Hallsworth and Thomson (2010).[32] The latter authors map estimates of Land Use, Land Use Change and Forestry (LULUCF) sector emissions and removals at the local authority scale within the UK for the 1990-2008 inventory. 2008 appears to be the latest year for which this information is available. Tabulated estimates of carbon (from CO_2) emissions and sequestration are given only at national level; here average estimates have been taken from the colour-coded area representing Winchester district on the authors' maps representing different categories of land use change (Table 11). Land use changes in Winchester district caused about 22,000 tonnes of CO_2 to be emitted in 2008. This is a rough estimate that concurs with a final figure in Hallsworth and Thomson (2010) which provides a colour-coded estimate of the total emitted within Winchester district that is in the range of zero to 24,000 tonnes of CO_2. This figure omits emissions of non-CO_2 greenhouse gases that are produced by biomass burning during wildfires or the conversion of Forest Land to Grassland or to Settlements, or by nitrogen fertilisation of new forests. Emissions of methane and nitrous oxide are relatively small and together made up around 1.7% of England's LULUCF emissions of CO_2 in 2009.[33] Table 11 also indicates that the more important land use activities, from the CO_2 emissions/sequestration point of view, are land converted to cropland, grassland or settlements and lowland drainage.

Table 11. Estimates of the emission and sequestration of CO_2 by different processes within Winchester district in 2008. 'Land' refers to land of all sorts combined.[34] The area of Winchester district was taken to be 661 km^2.(ref.[35]) Emissions have positive values.

Activity	Total annual emissions of CO2 (tonnes)
Forest land	0
Liming of cropland	2666
Liming of grassland	1212
Land converted to cropland, effect on soil	36354
Land converted to grassland, effect on soil	-41201
Land converted to settlements, effect on soil	12118
Land converted to cropland, effect on non-forest biomass	848
Land converted to grassland, effect on non-forest biomass	-606
Land converted to settlements, effect on non-forest biomass	364
Crop yield improvement	-3029
Lowland drainage (prior to 2005)	12118
Deforestation to grassland	364
Deforestation to settlement	364
Forest wildfires	303
TOTAL	**21873**

No data are made available to study trends at local authority level although the authors state that a more detailed analysis of trends could be carried out in future reports.

Land use summary:
The net emissions from land use changes within Winchester district are relatively small. No data are available with which to study trends in land use emissions.

SECONDARY ESTIMATES OF EMISSIONS

Secondary estimates of emissions are defined here as those that either include some element already included in primary estimates or those that cannot be estimated from the metered use of fuels. They include, in particular, monitoring of non-domestic buildings within the district.

The estate and operations of Winchester City Council

This section relies on measurements made by Winchester City Council (WCC) of the operation of its estate and transport. The actual measurements reported here are not included in the estimate of Winchester's total emissions, to avoid double counting, but provide accurate estimates of how well one particular sector in the district is performing.

From April 2008 the UK government required Local Authorities to compile CO_2 emissions statistics for their estate and operations. These formed part of the National Indicator series statistics and were called NI185. However from FY 2010/2011 the NI185 system was replaced by a requirement to collect data by the end of July each year for all greenhouse gas emissions expressed, as CO2-eq, for the preceding fiscal year (1 April -31 March). The data cover Scopes 1, 2 and 3 emissions.[36]

WCC provided their 'NI185' data for the three years from 2008 until 2011 (Fig.15).[37] Total emissions were close to 3000 tonnes CO2-eq each year. Figure 15 shows that Scopes 1 and 2 emissions decreased by 8.4%, from 1950 to 1787 tonnes CO2-eq, from 2008/09 to 2010/11. On the other hand Scope 3 emissions increased by 22.5%, from 1066 to 1306 tonnes CO2-eq, in

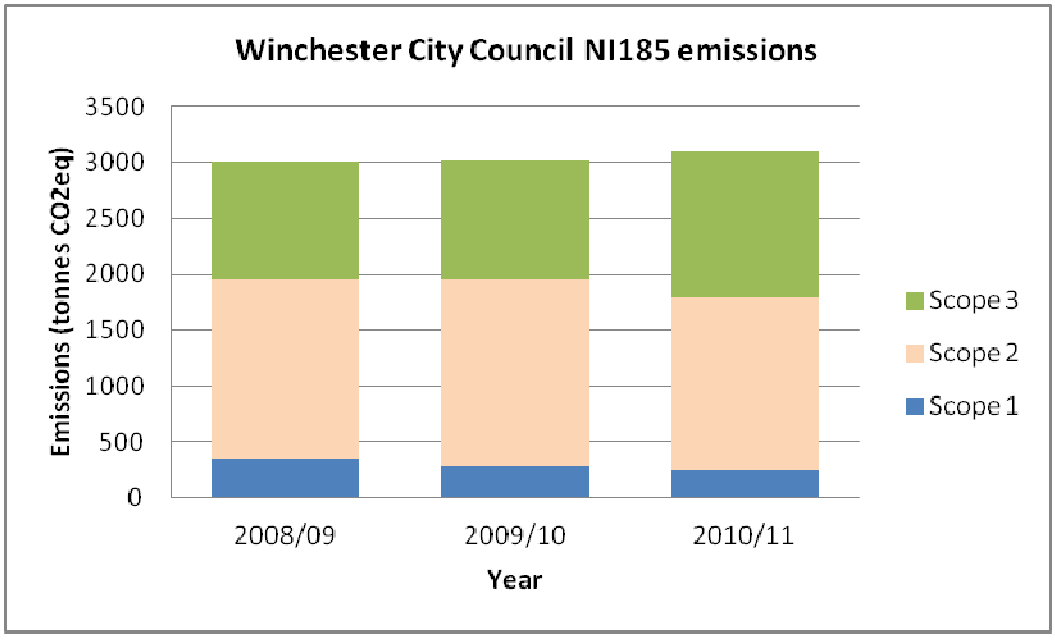


Figure 15. Winchester City Council's 'NI185' emissions from 2008/2009 to 2010/2011.

the same period. WCC attribute the increase in Scope 3 emissions in 2010/11 to the introduction of buses in the new Park & Ride scheme. 'NI185' rules do not allow these emissions to be offset by the reduced emissions from less traffic entering the town. Overall, the 'NI185' figures show a small increase in total emissions by 2.56% from 2008/2009 to 2010/2011.

Winchester City Council summary:
WCC's 'NI185' emissions increased by 2.6% from 2008 to 2010 but when Scope 3 measurements are omitted there was a reduction of 8.4%.

Buildings

Display Energy Certificates (DECs)
A measure of the emissions from large buildings[38] accessible to the public is the Display Energy Certificate (DEC) controlled by the Department for Communities and Local Government (DCLG). This obligation was introduced by law in 2007 and is enforced by Trading Standards Officers. DECs grade buildings on a scale of A to G based on their energy consumption and efficiency. Users have to submit actual meter readings or consignment notes for all fuels used in their buildings. This may include gas fuels, oil fuels, solid fuels, district heating and cooling, grid electricity and electricity generated on site or obtained by private distribution systems from other sites. Although the scheme may be imperfect[39] it provides a useful basis on which to judge the performance of public buildings and to monitor their improvement over time especially for energy consumption and emissions which are free of possible 'massaging' by the building user**.**

DEC data are available from the Centre for Sustainable Energy (CSE).[40] For sites with Alresford or Winchester as their local postal town,[41] up to 49 organisations had provided DECs in the

Table 12. Annual emissions of carbon dioxide from a selection of buildings with addresses in Alresford or Winchester postal towns including all those emitting over 900 tonnes in 2009 or 2010. (n.a. = data not available from CSE)

	Annual carbon dioxide emissions (tonnes)		
Building	2008	2009	2010
Royal Hampshire County Hospital, Main Building	4,598	n.a.	4,540
HM Prison, Romsey Rd	2,295	n.a.	n.a.
Law Courts, High Street	n.a.	2,152	n.a.
Hampshire Constabulary, West Hill, Romsey Rd	1950	1,517	n.a.
River Park Leisure Centre	1,403	1,207	1,262
The University of Winchester, University Centre	n.a.	n.a.	1,040
Royal Hampshire County Hospital, Florence Portal House	n.a.	n.a.	985
Winchester Guildhall (West Wing)	109	100	86
Westgate School, Cheriton Rd	563	575	n.a.
Peter Symonds College, Owens Rd	n.a.	556	n.a.
Kings School, Romsey Road	654	n.a.	417
Winchester City Council Offices, Colebrook St	420	494	311
The University of Winchester, West Downs Campus	1,038	n.a.	261
HMRC, Cromwell House, Andover Rd	n.a.	206	184

period 2008 to 2010. The buildings include offices of public bodies, schools, Winchester's leisure centre, hospitals and the University of Winchester. By law DECs are supposed to be renewed every 12 months but the data published by CSE may not be complete. The metric of most interest here is the estimated total annual CO_2 emissions for each DEC building which in 2010 varied between 4,598 tonnes and 54 tonnes. A selection of emissions data from representative buildings are given in Table 12.

Table 12 shows that the seven biggest emitters with Alresford or Winchester as their postal town are the Royal Hampshire County Hospital, Main Building; HM Prison, Romsey Rd; The Law Courts, High Street; Hampshire Constabulary, West Hill, Romsey Rd; River Park Leisure Centre; The University of Winchester, University Centre and Royal Hampshire County Hospital, Florence Portal House which together account for almost 14,000 tonnes CO_2 per year. Where more than one measurement is available, all but two of the buildings in Table 12 can be shown to have reduced their emissions by between 5 and 22% each year. The large apparent reduction at University of Winchester, West Downs Campus is suspect.

A different picture emerges when the emissions of CO_2 per square metre of floor area are calculated; this can be used as a measure of energy efficiency. Some caution is needed here as the use of floor area for DEC purposes depends on how different spaces in a building are assigned to one of eight categories by the user. Taking the latest (2010) figures at face value, apparently the eight least efficient buildings are those listed in Table 13. They lie in only three sites, the University of Winchester, the Royal Hampshire County Hospital and River Park Leisure Centre.

Table 13. The eight buildings in Alresford and Winchester postal towns with the highest emissions of CO_2 per square metre of floor area according to Display Energy Certificates published by CSE.

Organisation	Building	Emissions of CO_2 per unit area (kg CO_2 /sq. metre)
The University of Winchester	UNIVERSITY CENTRE	271.97
Royal Hampshire County Hospital	MAIN OUTPATIENTS & PHARMACY	195.44
The University of Winchester	ST. EDBURGA BUILDING	182.32
River Park Leisure Centre		167.37
Royal Hampshire County Hospital	MAIN BUILDING	157.23
Royal Hampshire County Hospital	QUEENS ROAD OFFICES	157.19
Royal Hampshire County Hospital	FLORENCE PORTAL HOUSE	157.12
Royal Hampshire County Hospital	PATHOLOGY BUILDING	156.76

In contrast Table 14 lists the eight most efficient buildings by the same token. There is a stark difference, by up to a factor of 7, between buildings in the two tables even though some of the same organisations feature in both tables. Clearly it is not necessarily the occupants who are responsible for the high or low emissions per unit area. The age, design and function of the buildings play a bigger part possibly as well as how floor space is classified by the user.

Table 14. The eight buildings in Winchester postal town with the lowest emissions of CO_2 per floor area according to Display Energy Certificates.

Organisation	Building	Emissions of CO_2 per unit area (kg CO_2 /sq. metre)
The University of Winchester	TOM ATKINSON & FRED WHEELER BUILDING	66.20
Winnall Primary School		65.54
Royal Hampshire County Hospital	TRAINING & DEVELOPMENT	64.53
Environment Agency		58.33
Weeke Community Primary School		56.86
The University of Winchester	ST GRIMBALDS COURT	56.14
Western Primary School		55.05
Kings School		37.08

Public buildings summary:

- *In 2008-2010, the operators of 49 large public buildings submitted information required to obtain a DEC. In 2010, emissions from these buildings varied between 4,598 and 54 tonnes CO_2.*
- *The biggest emitters are Royal Hampshire County Hospital, Main Building; HM Prison, Romsey Rd; The Law Courts, High Street; Hampshire Constabulary, West Hill, Romsey Rd; River Park Leisure Centre; The University of Winchester, University Centre and Royal Hampshire County Hospital, Florence Portal House which together account for almost 14,000 tonnes CO_2 in 2010.*
- *When buildings are compared on a kWh/square metre basis there is a variation by a factor of 7. This is likely to be partly the result of floor areas being classified by users for DEC purposes in different ways and of buildings of different ages and designs being used for different purposes.*

Other non-domestic emissions

The DEC scheme discussed above does not (yet) include buildings deemed not accessible to the public. For instance, within Winchester district, hotels, independent schools and many office buildings or complexes are not included.

The government also runs a scheme through the Environment Agency called the CRC Energy Efficiency Scheme (formerly the Carbon Reduction Commitment Scheme) but the rules for this scheme are in a state of flux and the government has recently (18 June 2012) completed a consultation on this subject. The scheme is mandatory and aimed at improving energy efficiency and cutting emissions in large public and private sector organisations which together are responsible for around 10% of the UK's emissions.[42] A 2010/2011 national performance league table for a large number of participating organisations is available which lists their emissions.[43] It is not known how many of these 1300 plus organisations operate in Winchester district but some do e.g. BT, Marks & Spencer's, Next and Tesco.

Another source of emissions data for large companies operating in Great Britain is provided by the Environmental Tracking (ET) Carbon Ranking of the Environmental Investment Organisation.[44] This web site provides information, as of 15th September 2011, on a company's greenhouse gas emissions intensity[45] as well as its level of disclosure and verification. The aim of the ET Carbon Ranking is to encourage higher levels of disclosure and verification while incentivising corporate greenhouse gas emissions reduction on a global scale. However this site

lists only the emissions of the whole company and does not break down emissions to a local authority level. Companies active in Winchester district such as banks, BT Group, Kingfisher, Next, Tesco, Serco Group etc. are listed.

An increasing number of large companies voluntarily publish information on their greenhouse gas emissions, although the data are of variable quality and consistency[46] and are highly unlikely to include specific information about emissions in Winchester district.

The government has drafted an order that from April 2013 all businesses listed on the Main Market of the London Stock Exchange will have to report their levels of greenhouse gas emissions from the start of the next financial year. It is not clear how this scheme, announced by Defra,[47] will operate alongside the CRC scheme.

Other non-domestic emissions summary:

- *Data on the emissions from large organisations are available, or becoming available, from various sources, but are of little relevance from a Winchester district perspective as they typically relate to emissions at national or international level.*

Domestic buildings (homes)

Trends in the state of the housing stock provide a qualitative indicator of how emissions from such buildings are changing.

The Energy Saving Trust manages the Home Energy Efficiency Database (HEED) which contains data on professionally installed home insulation from a variety of sources. However, some records do not get imported into HEED, either because they are not provided by the energy suppliers or if a record cannot be matched to a valid UK address. The average proportion of missing records in Great Britain is estimated to be around 12%.

One scheme recorded in HEED is the Carbon Emissions Reduction Target (CERT) which requires all domestic energy suppliers with a customer base in excess of 50,000 customers to make savings in the amount of CO_2 emitted by householders.[48] Suppliers meet this target by promoting the uptake of low carbon energy solutions to household energy consumers, thereby assisting them to reduce the carbon footprint of their homes. The current phase of CERT was introduced in 2008 and is planned to run until the end of 2012. Energy suppliers are now required to deliver measures by that date that will provide overall lifetime carbon dioxide savings of 293 $MtCO_2$.

Fig. 16 shows the number of CERT-based insulation measures in the Winchester district since April 2008. It is disappointing to see the low take-up since March 2011 (end of FY 2010/11) but the same effect occurred nationally. Between April 2008 and March 2012, only 4,606 (9.5%) of the 48,285 homes in Winchester district have been insulated under CERT. Nationally Winchester district falls in the lowest quartile of local authorities when ranked by the proportion of homes insulated under CERT. The highest proportion (28.6%) is found in Kirklees.

Nevertheless, other home insulation schemes have been instigated in Winchester district. Since Summer 2011 'Insulate Hampshire' has been offering homeowners and private renters free, professionally installed, cavity wall and loft insulation. It also offers free loft insulation for homeowners to install themselves. This scheme runs until September 2012 after which the free offer will be superseded by low interest loans. Over 8,000 people are said to have benefitted from Insulate Hampshire.[49] In East Hampshire alone a total of 609 households have benefited from the scheme which is estimated to be saving residents a total of £91,445 each year and over 370 tonnes of CO_2.[50] Unfortunately no figures could be found for Winchester district alone.
3

The introduction of the scheme may partly explain the observed strong reduction in CERT measures in 2011-12 (Fig.16).

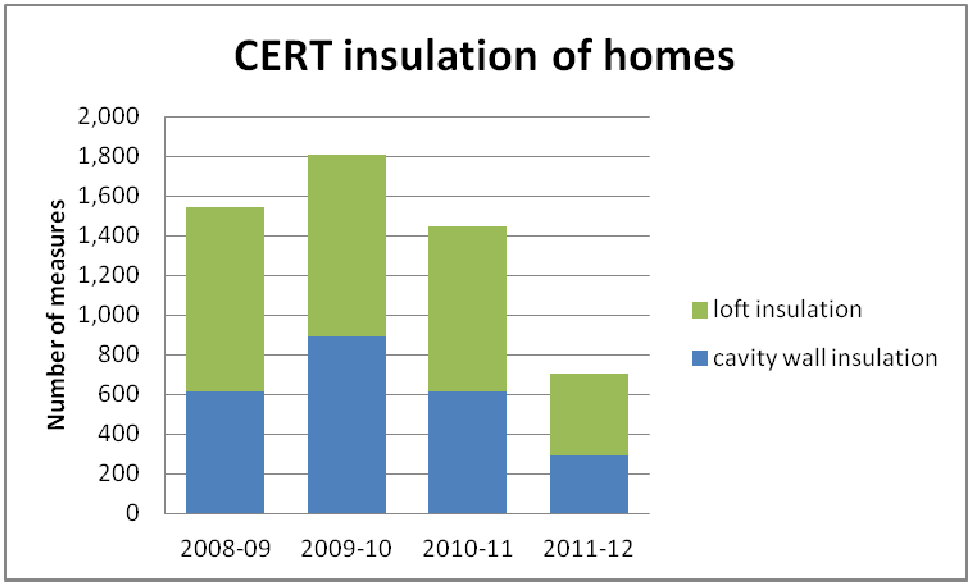


Figure 16. The application of home insulation in Winchester district (2008-2012) under the CERT scheme.

Domestic buildings summary:

- *The CERT insulation scheme has reached only 9.5% of homes in Winchester district. Insulate Hampshire appears to have, so far, reached only a much smaller number.*

Rail travel

The numbers of journeys starting and ending at UK railway stations are published annually by the Rail Regulator.[51] Winchester district contains four railway stations at Botley, Micheldever, Shawford and Winchester. Winchester is by far the busiest station by about a factor of thirty. 2,110,356 passengers departed from Winchester in the year ending 31 March 2011. The number of passengers entering Winchester station in 2010-2011 increased by 28% since 2005-2006 (Fig. 17). This rate of increase in passengers is well in excess of the increase in the district's population in the same period.

Figure 17. Total number of passengers entering Winchester station from 2005/06 until 2010/11. The number of entries and exits in the published figures are identical.



It is hard to estimate the emissions associated with these passengers because I was unable to find statistics on journey lengths. See a previous report for a brief discussion of possible emissions associated with rail travel from Winchester station.[1] The conclusion was that rail travel is likely to contribute a relatively small amount compared to the likely emissions from flying or road transport.

Rail summary:

- *In spite of relatively high fares the number of passengers using Winchester station continues to increase.*

Air travel

Although Southampton airport is the closest to Winchester district people living in the district will clearly use other airports such as Bournemouth, Gatwick, Heathrow, Luton, Stansted and London City for their trips.

According to the Civil Aviation Authority the number of passengers departing from or in transit through Southampton airport increased relentlessly from 2002 but peaked at 1,965,422 in 2007 and since then declined until 2010 when it picked up again in 2011 (Fig.18). The timing of the peak and the subsequent fall in numbers roughly coincides with the onset of the economic recession in 2008. Overall, the number of passengers passing through Southampton airport declined by 5.5% between 2005 and 2010.

The emissions associated with the flights of passengers from Winchester district are impossible to estimate although they were discussed in the earlier report.[1]

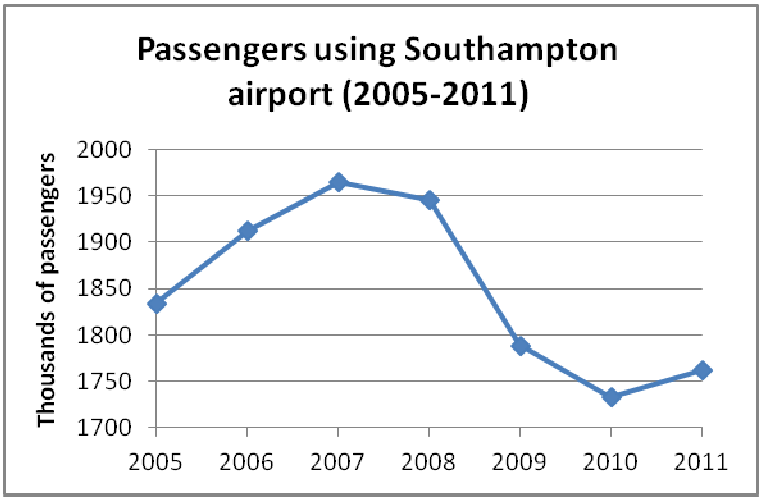


Figure 18. Plot of the number of departing and transit passengers at Southampton airport from 2005 until 2011 (ref. [52]).

Aviation summary:

- *Although the number of passengers using Southampton airport fell sharply after 2008 there was an increase in passenger numbers in 2011.*

SUMMARY OF RESULTS

Table 15 summarises the emissions that have either been identified above or, for rail and air transport, were estimated in an earlier report.[1] All emissions are in CO_2-eq except for the CO_2 figures for cars, goods vehicles and LULUCF all of which closely approximate the CO_2-eq value.

Fig.19 presents the emissions as a pie diagram. This shows that 42% of emissions (domestic electricity and gas, and cars) are directly attributable to households, including some SMEs, and 36% to the industrial/commercial sector (electricity, gas and goods vehicles); the remaining 22% cannot readily be allocated between these two sectors.

Table 15. Summary of CO_2-eq emissions in Winchester district in 2010.

Source of emissions	Emissions (thousands of tonnes of CO2-eq)	Emissions as percentage of total (%)
Electricity ('domestic')+	141.3	10.3
Electricity ('industrial/commercial')+	75.9	5.5
Electricity ('super consumers')+	176.8	12.8
Gas ('domestic')+	132.0	9.6
Gas ('industrial/commercial')+	43.6	3.2
Cars*	307.3	22.3
Goods vehicles*	201.4	14.6
Other fuels	127.3	9.2
Rail transport**	15.0	1.1
Air transport**	136.0	9.9
Land use changes	21.9	1.6
TOTAL	**1378.5**	**100.0**

+ The electricity and gas totals are slightly less than those in Table 2 and Table 6, respectively, because they are derived from MLSOA data. MLSOA data include a small amount of consumption which cannot be allocated to an MLSOA for technical reasons and is excluded from Table 15.
*After applying a 15% uplift (see text). The much smaller emissions from buses and motorcycles (Table 9) have been omitted from these figures for simplicity.
**Rough estimates from ref.[1]

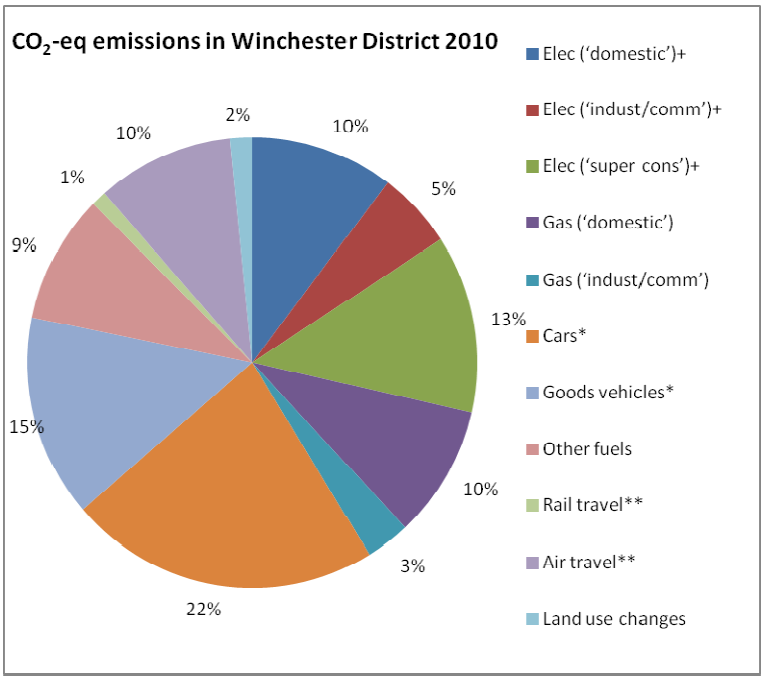


Figure 19. Pie diagram of estimated emissions of CO_2-eq in different sectors of Winchester district for 2010. Total emissions are estimated to be 1,379 thousand tonnes CO2-eq. For an explanation of superscript symbols see Table 15.

It is clear from Table 15 and Figure 19 that the greatest emissions are attributable to the consumption of electricity by 'super consumers' and the emissions from cars and goods vehicles; these account for 50% of all Winchester's emissions. They are closely followed by the domestic consumption of electricity and gas, other fuels and air travel although the latter figure is only a rough estimate. Relatively small contributions are made by the electricity and gas consumed by the industrial/commercial sector (other by than super consumers and possibly by the ca. 2,500 SMEs which fall within the 'domestic' sector), rail travel and land use changes.

Overall, but excluding LULUCF emissions (for which no 2005 figures are available) and rail and air travel emissions (for which no accurate estimates exist) emissions in Winchester district reduced by 5% between 2005 and 2010 (from 1270 thousand tonnes to 1206 thousand tonnes of CO_2-eq). Fig.20 displays the percentage change in emissions over the 5-year period 2005-2010 for each sector listed in Table 15.

It is gratifying that emissions from the majority of sectors have decreased even if some of the reduction may have been driven by the current economic situation.[53] However, to meet Winchester's target of a 30% reduction by 2015, all sectors should have reduced their emissions by around 15% between 2005 and 2010. Only industrial/commercial electricity (neglecting super consumers) and gas, and domestic gas come close to this figure.

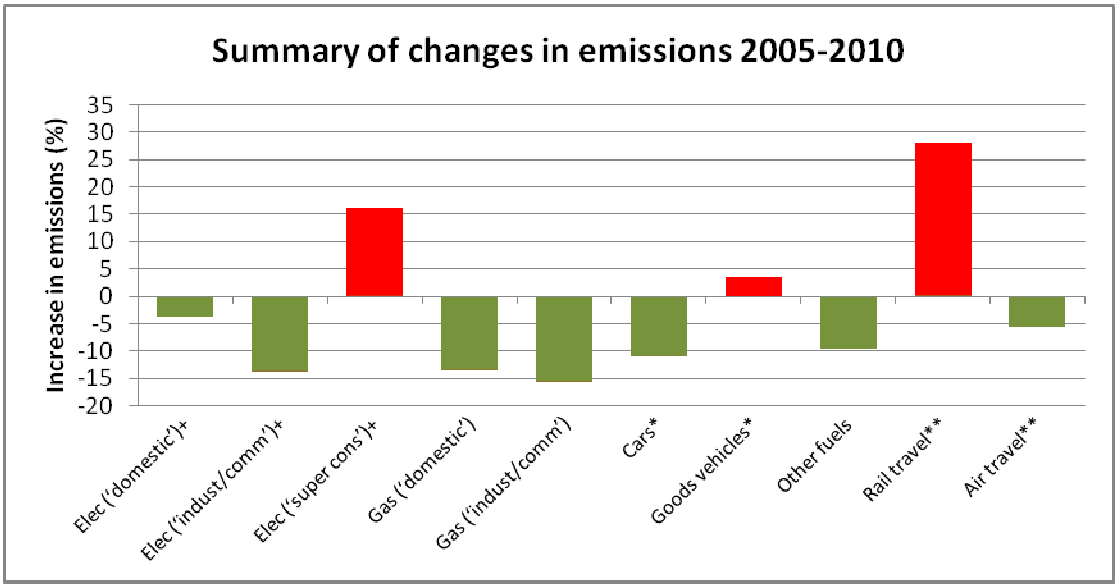


Figure 20. Summary of percentage changes in emissions from different sectors between 2005 and 2010 in Winchester district. Increases in emissions are shown in red (above the line) and decreases in green (below the line). Changes in LULUCF are unknown.

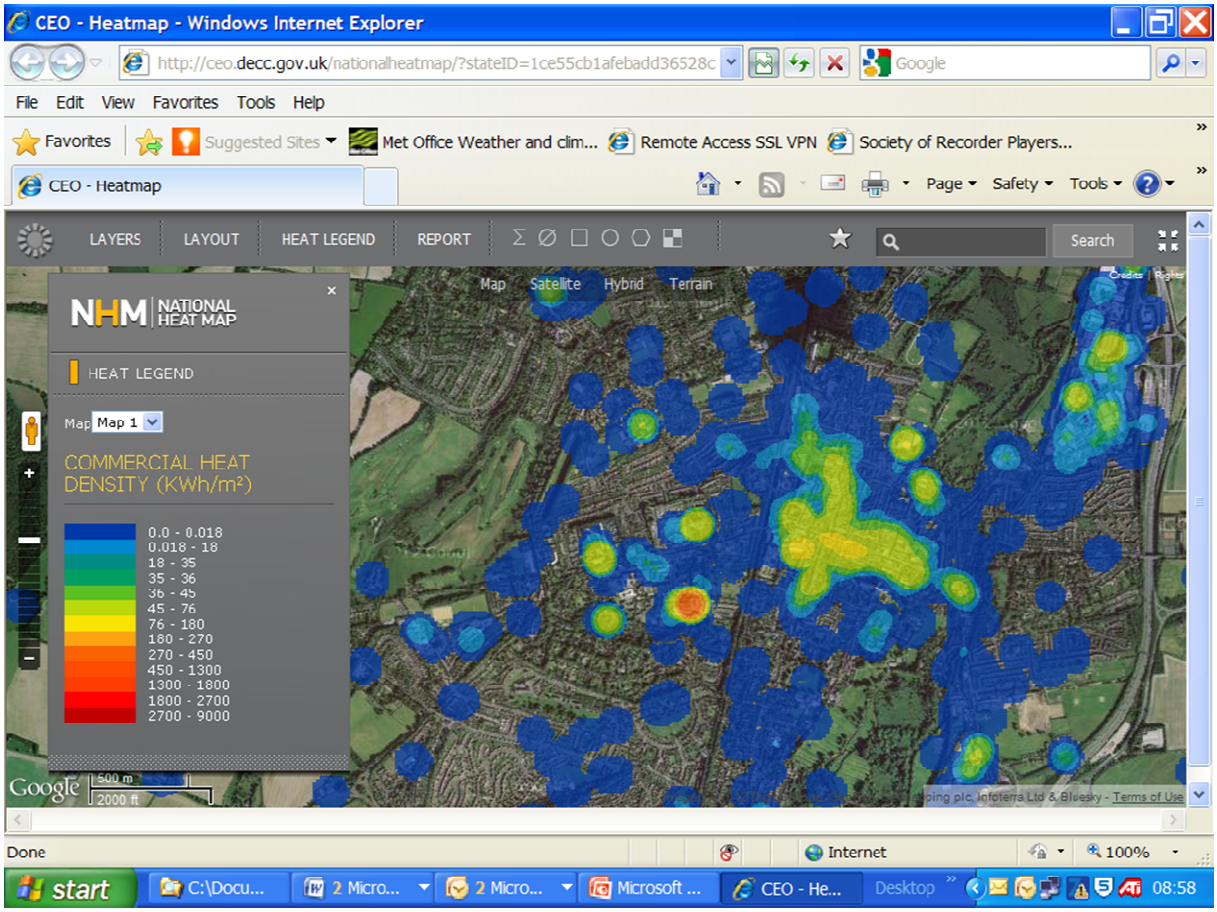
The large increase in rail travel 'emissions' is based on the increase in passengers using Winchester station; presumably this contributes to the decrease in car emissions and is to be encouraged. Similarly, the decrease in air travel 'emissions' in based on the change in the number of passengers using Southampton airport.

The sectors that most need to cut back their emissions if Winchester's target is to be met can be gauged by considering Figs. 19 and 20 together. The sectors with the largest absolute emissions and also the poorest record in reducing in their emissions since 2005 are the ones to target. Above all, electricity consumption by the super consumers (those with half-hourly

meters) stands out. Runners up are domestic electricity (which includes 2,500 SMEs), cars, goods vehicles, other fuels and air travel. Air travel, which has shown an upturn in passengers using Southampton airport in 2011, is a sector with a large proportion of leisure travel; a survey found that less than 40% of all Southampton airport passengers were travelling on business. It has also been reported that '… a mere 15% of London air travel is business rather than pleasure, the latter overwhelmingly that of outbound Britons'.[54] In 2011, only 37% of Heathrow passengers travelled on business.[55]

At present the emissions of the 222 super consumers in Winchester district cannot be divulged by DECC because of its policy on data privacy. It would be helpful if this policy could be overturned or if local super consumers, many of whom are probably readily identifiable from local knowledge, were asked informally what steps they are taking to reduce their emissions. For a start, all but three of the ca. 50 publicly accessible buildings discussed in the section on Display Energy Certificates consume enough electricity each year to be classed as a super consumer (more than 50,000 kWh/year). This is around 20% of all super consumers. Some of these buildings reduced their emissions between 2008 and 2010 (Table 12) which suggests that it may be the non-publicly accessible buildings that are more responsible for the increase in emissions by super consumers.

One, albeit imperfect, solution to the problem of locating sources of commercial emissions is to use DECC's Heat map of England. This internet based series of maps displays the density of heat demand (kWh per unit of floor area) at commercial, industrial and domestic sites plus



description.

public buildings.[56] For example, the map layer 'Public Buildings Heat Demand' reveals not only the heat demand density, based on actual meter readings, for all public buildings required to show a Display Energy Certificate, such as hospitals, government offices, and other public sector establishments but also their precise locations. For all other sites the estimated heat density depends on published sub-national energy consumption statistics but without making use of metered energy readings (see ref.[57] for more details). For example Fig. 21 shows a map of heat density for commercial sites (including public buildings) in central Winchester. The commercial areas of the Broadway to the top of the High Street, Southgate Street, Jewry Street and the Law Courts stand out very clearly as does the university's main site.

Comparing Winchester district's emissions with Great Britain's emissions

Fig.22 compares the changes in seven sectors in Winchester district's emissions between 2005 and 2010 with those achieved on average in LAs in Great Britain according to DECC's Sub-National Energy Consumption statistics[58] (DECC publishes Northern Ireland's emissions separately and so a UK comparison was not possible). The comparison shows mixed results although generally Winchester district followed a similar pattern of changes as for GB. Winchester district's emissions reductions are better than Great Britain's only for emissions from cars. It was not possible to extract half-hourly electricity meter readings for 2005 from DECC's GB statistics. Therefore Winchester district's electricity emissions from the industrial/commercial sector and super consumers (half-hourly meters) were combined to make a comparison. This figure shows an increase of 6.1% in Winchester district's industry/commercial electricity emissions[59] against GB's decrease of 8.7%, a difference of 14.8%. For all other sectors Winchester district performed worse than GB between 2005 and 2010 by up to 2.7% except for industrial/commercial gas where Winchester district's emissions declined by 8% less than the average (Table 16).

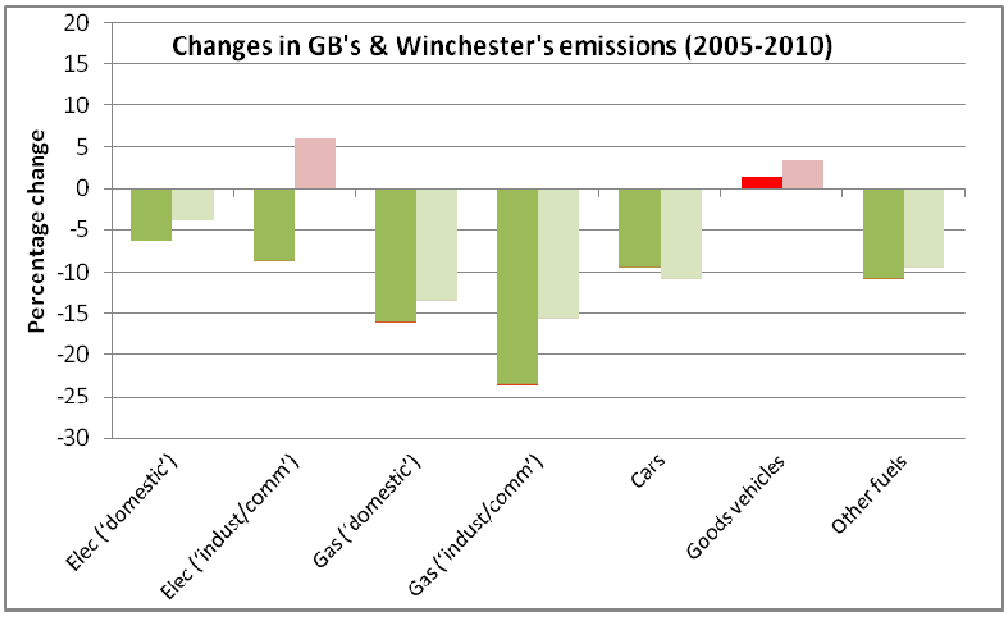


Figure 22. Comparison of emissions in Winchester district and in Great Britain (2005-2010). The paler colours relate to Winchester district.

Table 16. Comparison of CO2-eq emissions between 2005 and 2010 in Great Britain and Winchester district. Negative numbers indicate a decrease in emissions.

Sector	Percentage increase in emissions (2005 to 2010)		Percentage difference (GB%-WD%)
	Great Britain	Winchester district	
Electricity ('domestic')	-6.3	-3.7	-2.6
Electricity ('industrial/commercial')	-8.7	7.2	-14.8
Gas ('domestic')	-16.2	-13.5	-2.7
Gas ('industrial/commercial')	-23.6	-15.6	-8.0
Cars	-9.5	-10.9	1.4
Goods vehicles	1.4	3.4	-2.0
Other fuels	-10.9	-9.5	-1.4

CONCLUSIONS

The figures presented here are based on a variety of assumptions and even modelling methods and are subject to uncertainties. For electricity and gas consumption, DECC also use a misleading nomenclature of 'domestic', which actually include SMEs, and 'industrial/commercial', which includes public organisations, as explained above. DECC has also concluded that there is no 'industry' in Winchester district. These limitations need to be borne in mind when assessing some of the results presented here.

The principal findings of this report, based on the latest data available, mostly relate to calendar year 2010 or FY 2010/11, or to trends or changes in greenhouse gas emissions since 2005, and are,

1) The industrial/commercial sector accounted for 64% of all electricity consumption in the district in 2010. This figure excludes around 2,500 businesses using less than 50,000 kWh per year which are counted within the domestic sector. Further, between 2005 and 2010, the emissions from industrial/commercial users, increased by over 5%. It is clear that large industrial/commercial users of electricity need to be targeted to reduce their emissions from electricity. It is not possible with present data to gauge the contribution of businesses to electricity consumption in the 'domestic' sector.

2) It was very useful to analyse emissions generated in different parts of the district, at MLSOA level, in spite of some unexplained step changes in a few areas. For example, a surprisingly large number of homes (up to 19% in some areas) use Economy 7 electricity meters, presumably for heating. Although the proportion of Economy 7 meters seems independent of whether an area is rural or within Winchester town the highest average Economy 7 meter readings are all found in rural areas (where on average the homes are larger and/or just less well insulated?). It is slightly puzzling that there are over 2400 homes (16% of the total) with Economy 7 meters in Winchester town where presumably mains gas is readily available as an alternative source of heating. Among the fourteen MLSOAs in the district area 011 (W Mean to Soberton Heath-Newtown/Chidden/Hambledon) has the highest average domestic meter readings for electricity and gas. Area 011 uses on average 76% more electricity

and 40% more gas each year than area 006 (M3 Jct.9/Winnall/St Giles Hill/Bar End). The combined average annual emissions for electricity and gas for the two areas are 7.25 and 4.7 tonnes per meter, respectively.

3) Twelve MLSOAs reduced their domestic electricity consumption between 2005 and 2010 by 5% on average whereas areas 007 (central Winchester) and 013 (Wintershill/Durley/Curdridge/Shedfield/Wickham/ Whiteley) increased by 3.3%. This may reflect above-average increases in households in these two areas.

4) Between 2005 and 2010, the electricity emissions from industrial/commercial users using half-hourly meter readings (which at present cannot be attributed to any particular MLSOA and account for 70% of consumption in this sector), increased by over 16%. The 30% of industrial/commercial electricity emissions which can be allocated to MLSOAs decreased in seven areas and increased in six, with an overall decrease of 13.7%. The highest average industrial/commercial electricity meter readings in 2010 were in area 006 (M3 Jct.9/Winnall/St Giles Hill/Bar End).

5) Over the whole district both domestic and industrial/commercial gas emissions decreased by about 14% since 2006 but area 013 (Wintershill/Durley/Curdridge/Shedfield/ Wickham/Whiteley) increased its emissions by 1.8%. The industrial/commercial sector (defined as those using more than 73,200 kWh per annum) accounted for 28% of all gas consumption in the district in 2010.

6) In Winchester district, over 96% of road transport fuel is consumed by diesel and petrol cars, heavy goods vehicles and diesel light goods vehicles.

7) Overall, fuel emissions decreased by 5.8% between 2005 and 2010. The emissions from private cars decreased by 11%. However diesel LGVs increased their emissions by 12.8%.

8) In 2010, about 50 large buildings in Alresford and Winchester postal towns, held a Display Energy Certificate. The biggest emitters, all in Winchester town, are Royal Hampshire County Hospital, HM Prison, The Law Courts, Hampshire Constabulary HQ, River Park Leisure Centre and University of Winchester which together account for almost 14,000 tonnes CO_2 per year. Incomplete data do not allow trends in emissions to be computed in all cases but some buildings reduced their emissions by between 5% and 22% between 2005 and 2010.

9) In spite of relatively high fares the number of passengers using Winchester station between 2005 and 2010 continued to increase at an average rate of around 4.8% per year.

10) Although the number of passengers using Southampton airport fell sharply after 2008 there was an increase in passenger numbers from 2010 to 2011.

11) The net emissions from land use changes within Winchester district are small (1.6% of the total emissions identified here).

12) For all seven sectors but one, Winchester district's emissions decreased less between 2005 and 2010 than they did in Great Britain as a whole.

In conclusion, several sources of emissions stand out for further investigation as part of Winchester district's bid to reduce its emissions.

First, on average the electricity consumption of the industrial/commercial sector has increased by over 5% since 2005. Although those users with half-hourly meters apparently show an even greater increase in emissions this could be attributed to some non-half-hourly meter users becoming half-hourly meter users. Hopefully new legislation will improve the situation in this sector on a national scale but it is disheartening to see the lack of progress since 2005. Two of the top three average industrial/commercial electricity meter readings in 2010 were in areas 006 (M3 Jct.9/Winnall/St Giles Hill/Bar End) and 007 (Hyde/central Winchester/Cathedral/St Cross) which contain a large number of shops, stores and other businesses.

Second, greater efforts are required to reduce so-called 'domestic' electricity consumption. In 2010, there were 49,368 Ordinary and Economy 7 meters but the 2011 national census recorded only 46,900 households suggesting that around 2,500 SMEs are included in this sector. Even so the relative contributions of households and SMEs is unknown.

Third, although the savings made in car emissions are substantial even more needs to be done. On average, the emissions from diesel light goods vehicles have increased since 2005 and the emissions from heavy goods vehicles are unchanged. This appears to be yet another sector in which businesses need to take action if Winchester's target is to be met. Although vehicles are replaced on average only every 7-8 years there is a growing range of low emissions vehicles on the market to help tackle the problem. Other approaches are to improve driving skills (so-called ecodriving) and the logistics of loads, routes and frequency of journeys.

Fourth, air travel could be reduced substantially by passengers reducing the distance travelled or using an alternative mode of transport such as rail. Flying for leisure is an activity where changing social attitudes can have a large impact although EU regulations and the imposition of air passenger duties help. Until more people begin to realise the environmental damage caused by flying, it is hard to see how much progress can be made in this sector.

Fifth, the annual emissions from large buildings to which the public can gain access are now publicly available. This provides opportunities to track emissions and for the building owners to be asked to explain how they are cutting their emissions.

This report demonstrates that good progress is being made to reduce Winchester district's emissions from some sources, albeit below the average for Great Britain as a whole, and for a few sources, is close to being on track to meet the target of a 30% cut in emissions by 2015 relative to 2004. However the report also shows that the commercial and business sector needs to significantly cut its emissions from electricity (especially by super consumers and in some specific areas with a high number of shops, stores and businesses), and from road transport, (especially by diesel light goods vehicles). One way to do this is to create incentives for reducing emissions at a national, if not local, scale .[60]

Finally, it was not possible to solve the conundrum of why there are relatively high numbers of Economy 7 meters in Winchester town and in some rural areas. It is worth recalling at this point that the emissions from using one kWh of electricity are about 2.4 times the emissions from producing one kWh of heat from burning gas in a 90% efficient boiler. This provides an argument for switching from Economy 7 storage heaters to gas heating. Southern Gas Networks, who supply gas to the district, were unwilling to provide information about which towns and villages or even parts of Winchester are served by gas mains.[61] This is unfortunate because it would be advantageous from the emissions perspective to change from using electricity to gas for heating, at least in the medium term until more electricity comes from renewables, or to switch to a heat pump system or biomass boiler. It is not possible yet to

estimate the potential cut in emissions from making such a change simply because published Economy 7 meter readings are the sum of consumption at Ordinary and Economy 7 rates.

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[44] http://www.eio.org.uk/etindex.php?page=uk_100
[45] The measure currently used to calculate emissions intensity for the ET Carbon Rankings is: total Scope 1 + 2 emissions/$million turnover and 50% of total Scope 3 emissions/$million turnover
[46] Blowfield, M. and A. Murray (2011). Corporate Responsibility. Oxford, Oxford University Press: pp.464.
[47] http://www.defra.gov.uk/news/2012/06/20/greenhouse-gas-reporting/
[48] 'Guidance notes on CERT reports from HEED', January 2012, Energy Saving Trust, 10 pages.
[49] http://www.insulatehampshire.co.uk/news.html?newsId=54
[50] http://www.insulatehampshire.co.uk/news.html?newsId=49
[51] http://www.rail-reg.gov.uk/server/show/nav.1529
[52] http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&pageid=3&sglid=3
[53] See comment on UK's emissions in para.5 by Committee on Climate Change at Anon. (2012).Consumption-Based Emissions Reporting: Government Response to the Committee's Twelfth Report of Session 2010-12 - Energy and Climate Change at http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/488/48804.htm.
[54] Simon Jenkins in The Guardian newspaper, 29 August 2012. 'Yeo's runway taunt is big-willy politics, and that is the most dangerous politics of all'.
[55] http://www.heathrowairport.com/about-us/facts-and-figures
[56] http://ceo.decc.gov.uk/nationalheatmap/. Maps can be displayed at different scales showing different layers and combinations of road networks, satellite photos and topography.
[57] http://ceo.decc.gov.uk/en/ceol/cms/heatmap/about_map/about_map.aspx
[58] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/regional.aspx
[59] A weighted average was calculated using the 70:30 relative contributions of super consumers: industrial/ commercial sector in Winchester district.
[60] Anon. (2012). Study on Incentives Driving Improvement of Environmental Performance of Companies. Rotterdam, Ecorys**:** pp.166. The report quotes over 100 possible incentives.
[61] Telcon with Southern Gas Networks, 20 August 2012. They hold information only on a street name basis, without post codes, backed up by grid references.