WinACC
Winchester Action on Climate Change

Greenhouse gas emissions in Winchester district (2007-2009): Estimates and trends

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This report was written to assist the Winchester District Strategic Partnership High Quality Environment Group in making informed decisions about how to reduce Winchester district's greenhouse gas emissions. It will help to ensure that resources are allocated where they will have the most impact. It will also enable the Partnership to assess whether the resources currently available are likely to achieve the Partnership's targets of 1) a 20% reduction in the carbon footprint of Winchester district by 2012 and 2) a 33% reduction by 2015 (both on a 2007 baseline).

Recommendations

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

● flying, and flying for leisure purposes in particular, should be strongly discouraged.

● the use of electricity and gas should be reduced, particularly in the sector that includes large organisations such as supermarkets, hotels, big offices (private and public), schools, university campuses, Winchester prison and the Royal Hampshire County Hospital.

● the use of road vehicles that directly emit greenhouse gases should be reduced. The goods vehicle sector should be encouraged to reduce its emissions even more than has been achieved in recent years.

● rail travel is to be encouraged particularly where it reduces journeys made by road.

● Winchester district needs to cut its emissions by 6.25% each year from 2011 until 2015 inclusive to achieve the targets it has set itself. This figure is based on an analysis that excludes the mostly harder-to-quantify sectors of food, consumerism and services and may in fact be an underestimate.

Executive summary:

This report is based on two premises: that climate change is largely caused by humankind's activities and that to mitigate the effects of global warming it is necessary to reduce greenhouse gas emissions now as a matter of urgency.

At the national and local level emissions from some sources can be estimated from various publicly available statistics. However indicators derived from these statistics become available only with some delay and are collected using different classifications so that meaningful comparisons can be hard.

This report concentrates principally on emissions from the use of electricity, gas and motor vehicles but also considers rail and air transport.

First, Winchester district's emissions in 2007 are considered because that has been chosen as the base year for two locally adopted emissions reduction targets. National Indicator 186 (NI 186), which excludes emissions from some important sectors, estimated total emissions of 934 kilotonnes of CO_2, Stockholm Environment Institute (REAP tool), the most complete measure available, estimated 2,081 kilotonnes CO_2-eq (in 2006) and this report attributes about 1,034 kilotonnes CO_2-eq to electricity, gas and transport (this figure excludes the emissions attributable to harder-to-quantify sectors such as food, consumerism and public and private services).

Second, trends in component emissions since 2007 were investigated to indicate how well Winchester district is meeting its targets. Electricity consumption increased by 1.4% p.a. over the period to 2009, gas consumption, after a weather adjustment, fell by 5.4% p.a. to 2009, fuel consumption by personal transport fell by 3.8% in 2008 and by goods vehicles by 1.7% in 2008.

Overall these estimates, when taken together, indicate a net 1.35% p.a. reduction in actual **emissions** since 2007. In contrast, NI 186 recorded a 0.1% p.a. increase in 2008.

Even though the above annual rates are mostly decreasing they are set to miss both Winchester district's targets of a 20% cut by 2012 and a 33% cut by 2015. To meet both targets a 6.25% reduction in emissions is required for each of the next five years (from January 2011). This figure is based on an analysis that excludes the mostly harder-to-quantify sectors of food, consumerism and services and may in fact be an underestimate.

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Background

A recent Royal Society report stated 'There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation. The size of future temperature increases and other aspects of climate change, especially at the regional scale, are still subject to uncertainty. Nevertheless, the risks associated with some of these changes are substantial. It is important that decision makers have access to climate science of the highest quality, and can take account of its findings in formulating appropriate responses.'[1]

Mankind's burning of fossil fuels and changes in land use (agriculture and deforestation) have upset what was previously (until the Industrial Revolution around 1800) a naturally regulated balance between the natural emissions of greenhouse gases into the atmosphere and their take up by natural 'sinks', primarily the oceans and terrestrial vegetation. However since around 1800, carbon dioxide in the atmosphere, the principal greenhouse gas, has increased by almost 40% and today appears to be increasing at an ever greater rate. Many climate scientists predict, on the basis of past events in the Earth's history and on well tested numerical models, that within decades the Earth's average surface temperature will have increased by over 2°C and that this will unleash damaging and possibly unstoppable changes in the Earth's climate. For these reasons it is important that every effort is made as soon as possible to reduce, and eventually set to zero, net greenhouse gas emissions.

Efforts to reduce emissions at local levels are especially important because of the failure of nearly all governments, internationally and nationally, both to reach agreement on how to proceed and to act vigorously to reduce greenhouse gas emissions. Even at the national level the UK government, although it has passed or is promoting some important legislation (the Climate Change Act, 2008 and the Energy Bill, 2010/2011), is not visibly and consistently acting to ensure that the rapid changes in society that are required to mitigate global warming are being consistently implemented with the necessary urgency.

Thus this report aims to deliver accurate and up to date estimates of, and trends in, greenhouse gas emissions for the Winchester district with a view to quantifying what has occurred since 2007 and to encourage continuing and even more effective efforts in future.

This is a preliminary report written under tight time constraints and with limited time to research and access all the relevant data sets. A fuller report may be completed in future.

Emissions at the national scale

The UK is among a number of developed nations that have contributed to greenhouse gas emissions by burning large amounts of fossil fuels, such as coal and oil, since the mid-18th century. It has been claimed that the UK emitted more carbon dioxide (CO_2) than any other country between 1751 and 2007.[2] Today the UK remains among the highest emitters per head, being ranked tenth in the world in 2001 at 15 tonnes CO_2-eq per head.[3] It was also tenth in total annual emissions in 2010.[4]

At the national level carbon emissions are estimated according to a number of criteria. Emissions attributable to a country can be estimated in more than one way. The Kyoto Protocol estimates only **production** emissions – that is, emissions associated with goods produced within a country as laid down by the United Nations Framework Convention for Climate Change (UNFCCC). It excludes the emissions associated with imported goods (for example from China). When the **consumption** emissions for the UK in 2003 were estimated by adding the contribution of imports, and subtracting the contribution of exports, the figure was found to be 72% higher than the production emissions.[5] The UNFCCC figures also omit emissions from international aviation and shipping. When estimates of these were added to government production figures for the UK's emissions in 2000, the total increased by about 9%.[6]

The differences between the UK's UNFCCC emissions, consumption emissions and production emissions between 1992 and 2004 are shown in Fig.1 (ref.7). It is clear that by one criterion the UK's emissions have broadly decreased by about 5% (dotted line) but by a more realistic estimation the UK's emissions have actually increased by 13% (bold line).

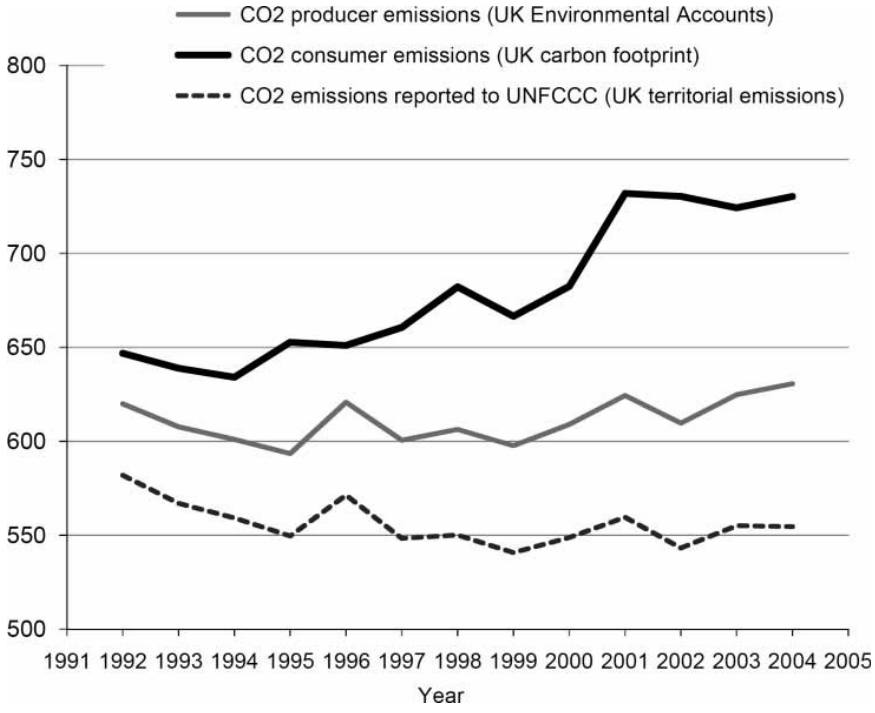


Figure 1. Total UK CO2 emissions from 1992 to 2004 according to different accounting principles. Vertical axis units are Mt CO_2. From Wiedmann et al., 2010.

Thus, in seeking data and metrics with which to estimate Winchester district's emissions it is important to be aware of contributions from sectors that may be overlooked because they cannot be easily quantified. The sources of data used in this report are described in the next section.

Sources of Local Authority emissions data

National Indicator 186

National Indicator 186 (NI 186) is one of a number of indicators produced annually by the Department of Energy and Climate Change (DECC)[8]. NI 186 measures the 'Per capita reduction in CO_2 emissions in a Local Authority area' and by implication, knowing the population of the area, the total emissions of that area. It is based on the UNFCCC guidelines, mostly 'end-user' statistics. It covers the commercial/industrial sectors (electricity, gas, oil and solid fuel, waste, agricultural processes & fuel, off-road machinery), the domestic housing sector (electricity, gas, oil and solid fuel, home and garden machinery) and road and rail transport. However the emissions from motorways, diesel railways, EU Emissions Trading Scheme sites, land use change, land use, forestry and international aviation and shipping are excluded.[9]

The NI 186 data are tabled under ten sources of emissions. They are presented as rounded numbers and therefore are less sensitive to demonstrating year to year trends. Road emissions are given according to the class of road used which is not as useful as considering the number and type of vehicle causing the emissions. NI 186 data are reported each autumn with a 21 month time-lag; this means that data reported in autumn 2010 apply to calendar year 2008. Although NI 186 data are reported with a longer time lag than if one accesses and analyses DECC data directly, as is done here, they are nevertheless useful in providing an independent check and will be considered later in the report.

REAP

The Resources and Energy Analysis Programme (REAP) of the Stockholm Environment Institute based in York is more ambitious and realistic in its estimates of carbon emissions. It uses 63 household consumption categories plus 73 services and infrastructure categories from Environmental Accounts of the Office of National Statistics (ONS). Whereas NI 186 is analogous to a measure of production emissions, REAP estimates consumption emissions including those from the manufacture and transport of imports and from international aviation and shipping. REAP covers the three sectors of government, private households (34 activities) and transport (39 capital investment sectors including civil aviation and air travel). Business activity is attributed either to one of the three main sectors or to exports from UK. Waste is included in Life Cycle Analyses. Food, consumables and services are also included.[10]

REAP methodology is still under development and REAP figures appear infrequently. The latest figures for local authority districts are for 2004 and 2006.

Government departments and the ONS

Government departments and the government's Office of National Statistics (ONS) also provide data in various publicly available databases some of which can be accessed over the internet. These tend to be quite up to date for specific measures and even now data are becoming available for 2010.

Others sources of data

There may be other sources of data, such as Hampshire County Council and Winchester City Council, which could usefully be included here. I would welcome information about any such sources.

NI 185 statistics, which were first produced in 2008/09 for Defra, and are now being collected for DECC under a successor scheme, may eventually prove to be a useful source of data covering the carbon emissions of buildings and services belonging to each Local Authority. However, like NI 186, they are collected using UNFCCC criteria and likely omit the contributions of emissions from some important sectors.

Periods covered by available data

Table 1 lists the periods of time covered by data sets that were available to the author in February 2011. NI 186 and REAP have already been described. DECC provides data on gas, electricity and fuel consumption within Local Authority areas.

The DVLA data are sold by their agents. All other data can be freely downloaded over the internet.

Table 1. Sources of Local Authority data available for this investigation (grey boxes).

source			Year							
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NI 186									due Oct 2011	
REAP										
DECC electricity										due Dec 2011
DECC gas										due Dec 2011
DECC transport									Due Jun 2011	
DECC other fuels									due ??	
DVLA							data	for	sale	only

Trellis pattern = less reliable, experimental statistics
Blank boxes = pre-2005: data not compatible with post-2005 data sets; post-2005: no data yet available.

Regional sinks

The net contribution to global warming of any nation or region depends not only on its greenhouse gas emissions but also on how well it conserves or expands the natural carbon sinks within it. For example, a forest that is cut down to provide timber or fuel can be said to be managed sustainably, over a certain period of time, if the cut down trees are replanted. Similarly, some agricultural practices are more environmentally sustainable than others. However, this report concentrates on emissions.

Winchester district's emissions in 2007

The most complete and recent estimate of Winchester district's emissions is that provided by SEI/REAP for 2006[11] (Fig.2). It gives total emissions for the district of 2,081,252 tonnes CO_2-eq. REAP covers seven principal sectors: housing, transport, food, consumer items, private services[12], public services[13] and capital investment. Some 53% of emissions came from housing and transport.

The consumption emissions associated with food are clearly large (over 330,000 tonnes CO_2-eq) but they are very hard to quantify for individual food items. The major constituents are meat, fruit and vegetables and 'catering services' which means 'eating out'. Similarly 'consumer items' contribute around 216,000 tonnes with the largest contributions coming from 'recreational equipment' and clothing, with lesser contributions from furniture and furnishings, audio-visual and photo equipment and 'personal care'.

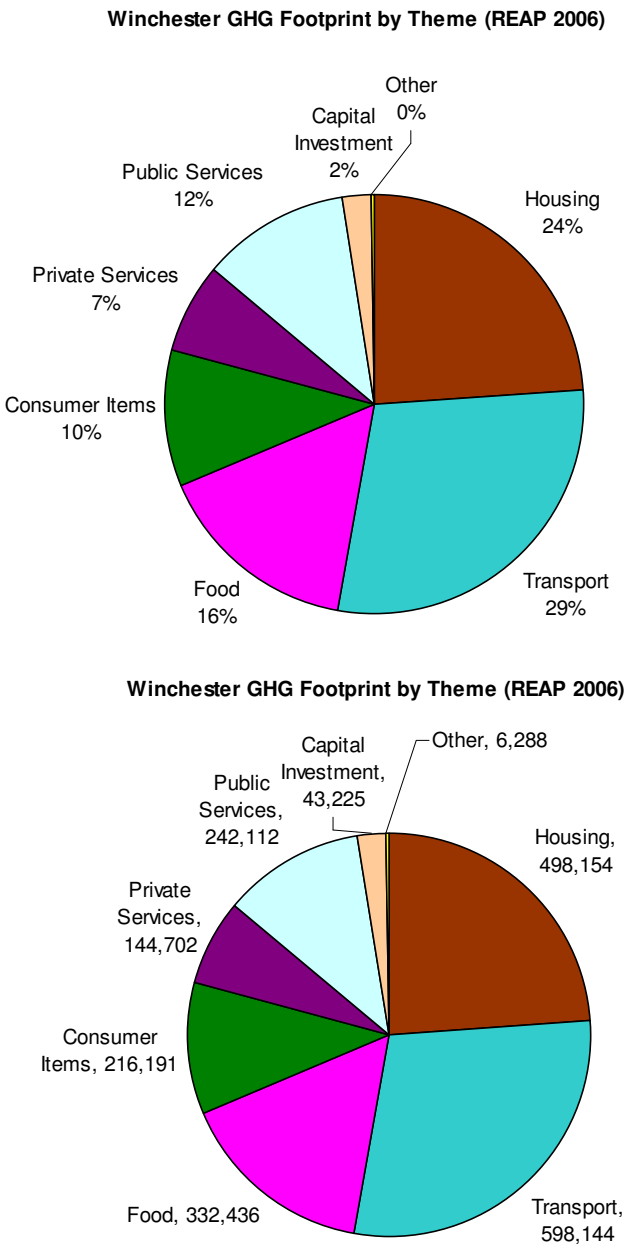


Figure 2. Emissions of CO_2-eq in Winchester district in 2006. (Top) Percentage emissions. (Bottom) Emissions in tonnes of CO_2-eq.

Because statistics for electricity and gas consumption and for various modes of transport in Winchester district are readily accessible the remainder of the report is largely devoted to just these sources of emissions which do not always match neatly the REAP sectors. Further, because 2007 has been chosen as the reference year for two Winchester district emissions targets, we first consider Winchester district's emissions in that year before investigating how emissions have changed since 2007.

Data supplied by DECC

DECC state in their guidance notes that 'the combined ['domestic'] electricity and gas consumption figures provide a good indication of overall household energy consumption at local authority level, based on mapped consumption from postcode information. Data for 2009 have been collected on a similar basis to the 2005, 2006, 2007 and 2008 data, and the data for subsequent years will be produced with a consistent methodology.'

They also state that 'It is also important to recognise that the gas consumption data is weather corrected, whereas all other fuel sources are unadjusted.'[14] Weather correction appears to mean that the metered gas consumption is adjusted as if the weather (temperature and wind speed) conditions were constant from year to year or at least follow a smoothed rolling 17-year trend of rising temperatures (to allow for global warming). It is not clear exactly what correction factors were applied each year.

Electricity

The use of electricity involves the generation of greenhouse gas emissions because around 75% of the UK's electricity is generated by power stations that burn fossil-fuels, whether coal or gas. Consequently every kWh of electricity[15] generated produces more than 2.5 times as much greenhouse gas as is released when gas is used to produce the same amount of energy. The exact amount depends on the mix of power stations in operation. Defra produces annual figures for converting from kWh to g CO_2 .

DECC provides figures for electricity consumption in Winchester district. The data are collected with the full co-operation of the electricity industry. Annualised consumption data are generated by the data aggregators, agents of the electricity suppliers, who collate/aggregate electricity consumption levels for each customer. In addition to this, information is obtained from the meter postcode address file, which provides the geographical location of each meter, including the full address and postcode. The geographical and electricity consumption data are then merged together to enable consumption data to be mapped to postcodes and aggregated to local authority levels.

The electricity consumption data are generated for both non-half-hourly meters (domestic and small/medium commercial/industrial customers) and for half-hourly meters (larger commercial/industrial customers). The actual annual consumption figures provided for non-half-hourly meters are estimates based on either the consumption recorded between two meter readings or, where two meter readings are not available, an estimate of annualised consumption is produced by the energy company using historical information and the profile information relating to the meter. These estimates include standard domestic and Economy 7 tariffs. To estimate consumption by half-hourly meters, data aggregators are asked to produce a simple report for each meter for the relevant calendar year. More details are provided in DECC's guidance notes.[16]

In 2007 the 46,600 'domestic' consumers in Winchester district, i.e. those with non-half-hourly meters, used 234.4 GWh of electricity (but there were only 43,132 residential households in 2001[17] so around 3,500 consumers may be SMEs). The ca. 5,700 commercial/industrial consumers, i.e. those with half-hourly meters, used 406.4 GWh (making a total of 640.8 GWh; Table 2). The corresponding average usages per meter were 5,033 kWh and 75,881 kWh, respectively. A conversion factor of 0.54820 kg CO_2-eq per kWh, appropriate to 2007, was used from Table 3c in the 2010 Guidelines to Defra /

DECC's GHG Conversion Factors for Company Reporting to compute the corresponding emissions.[18]

Table 2. Summary of electricity consumption and emissions in 2007

Electricity			Year 2007
	Energy used	Greenhouse gas emissions (tonnes CO_2-eq)	
	(GWh)	Total	Per meter
'Domestic'	234.4	128,501	2.8
'Comm/industr'	406.4	222,800	41.6
Total	640.8	351,300	

Table 2 shows that the 'commercial/industrial' sector contributes 1.73 times as much to emissions as the 'domestic' sector, even though there are 8.6 times as many 'domestic' meters. It is important to note that the 'commercial/industrial' sector is likely to include many large public sector buildings, e.g. council offices, schools, university campuses, Winchester prison and the Royal Hampshire County Hospital. I have used the terms 'domestic' and 'commercial/industrial' throughout the report, for consistency with the DECC classification.

Natural gas

Natural gas is essentially methane, a powerful greenhouse gas. It is often described as a (relatively) clean fuel since it produces less carbon dioxide per unit of energy delivered than either coal or oil. Nevertheless, when burnt, it produces a number of other gases such carbon monoxide, sulphur dioxide and nitrogen oxides, as well as particulates, when it is burnt. In addition, there may be leaks in the distribution network.

In November 2005, xoserve, the company responsible for the collation and aggregation of gas consumption data, agreed to generate annualised consumption estimates for all gas meters subject to permissions being provided by the owners of the distribution network. xoserve now provide annualised estimates of consumption for all the meters based on an Annual Quantity (AQ). An AQ is an estimate of annualised consumption using consumption recorded between two meter readings at least six months apart.

The estimate is then adjusted to take account of a 17-year smoothed, weather correction factor. The AQ for each meter represents consumption relating to the gas year – the period covering 1 October through to the following 30 September - rather than for a calendar year. It should be noted however that around 4 million meters (approximately 18% of all meters) have no new AQ value annually, because no new meter readings for these meters have been taken. The data also exclude any gas passing through other

Table 3. Summary of gas consumption and emissions in 2007

Gas			Year 2007
	Energy used	Greenhouse gas emissions (tonnes CO_2-eq)	
	(GWh)	Total	Per meter
'Domestic'	670.9	137,924	3.8
'Comm/industr'	256.6	52,752	66.6
Total	927.5	190,676	

transmission and distribution systems such as those owned by North Sea producers. This suggests that the gas consumption figures supplied are underestimates of the true consumption.

One of the major drawbacks of the data is the lack of a reliable split between the domestic and commercial/industrial sectors for consumers with a 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 commercial/industrial. Consequently, nationally, only around half a million businesses are allocated to the commercial/industrial sector, with around 2 million small and medium businesses allocated to the so-called 'domestic' sector.[19]

In 2007 the 36,600 'domestic' consumers in Winchester district used 670.9 GWh of gas and the ca. 800 'commercial/industrial' consumers 256.6 GWh (making a total of 927.5 GWh). The corresponding average usages per meter were 18,315 kWh and 324,053 kWh, respectively. A conversion factor of 0.20558 kg CO_2-eq per kWh was used from Table 1d in the 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting (Table 3) to compute the corresponding emissions.[20]

Motor vehicles

Vehicles that run off petrol or diesel emit greenhouse gases primarily in the form of carbon dioxide (exhaust emissions also include water vapour which is a greenhouse gas too but globally it has a more or less constant concentration in the atmosphere).

DECC estimates fuel consumption by type of vehicle (bus, motorcycle, petrol car, diesel car, HGV, petrol LGV and diesel LGV) and local authority. 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, and road consumption factors and traffic flow data from the Department for Transport (DfT). The latter are based on traffic flows from census count points, located on major roads including motorways, A roads and some B roads. Here average daily traffic patterns are recorded and simply multiplied by a factor of 365 to provide an annualised estimate. For more minor roads, this information is not available and therefore aggregated regional traffic flow data produced by DfT are used as an alternative source of information. Fuel consumption factors are expressed in grams of fuel per kilometre for each vehicle class and 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.

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 estimates are based on where the fuel was consumed rather than where it was purchased in order to make the dataset more comparable with both the electricity and gas datasets based on consumption from individual meters. Therefore the dataset includes all road fuel purchased abroad and consumed in the UK, though it excludes road fuel purchased in the UK and consumed abroad.[21]

It is not possible to independently estimate the total emissions from motor vehicles registered in the Winchester district because no source of vehicle annual mileages has yet been discovered, although this information is publicly available for Hampshire as a whole. A lot of other data on factors such as engine size, emissions per km and number and types of vehicles are sold by agents of the DVLA.

Here an indirect method has been used which is based on the use of the fuels for which statistics are available. The methodology is based on the fact that the CO_2 emissions per litre are relatively constant for petrol and diesel vehicles.[22] Thus, given the annual fuel consumption of a class of vehicle and the fact that a petrol car emits 2.32 kg CO_2/litre and a diesel car emits 2.66 kg CO_2/litre the annual emissions can be estimated from:

annual emissions (kg CO_2) =
1000 x annual fuel consumption (tonnes) x (kg CO_2 /litre) ÷ density of fuel (kg /litre)

Table 4. Vehicle fuel consumption and estimated emissions in Winchester district for 2007.[23]

	Buses *	Diesel Cars	Petrol Cars	Motor-cycles	HGV	Diesel LGV	Petrol LGV	Total
Fuel consumption (1000 tonnes)	3.5	32.6	57.8	0.8	33.0	19.7	1.3	148.7
Emissions (tonnes CO_2)	7,606	71,778	99,829	1,350	72,632	43,425	2,330	298,950
Percentage of total emissions	2.5	24.0	33.4	0.5	24.3	14.5	0.8	100.0

* assumed to run on diesel

In 2007 personal transport (motorcycles, cars and buses) emitted 180,563 tonnes of CO_2 and goods vehicles emitted 118,387 tonnes of CO_2 in Winchester district.

Rail travel

The numbers of journeys starting and ending at UK railway stations are published annually by the Rail Regulator.[24] Winchester district contains three railway stations at Micheldever, Shawford and Winchester. Winchester is by far the busiest station and 1,864,866 passengers departed from there in the year ending 31 March 2008.

It is hard to estimate the emissions associated with these passengers because I was unable to find statistics on journey lengths but if it is assumed that 40% of return journeys from Winchester are to London Waterloo and back (212 km) and the remaining return journeys are on average 40 km long then, using the Defra (2008) recommended conversion factor for national rail of 60.2 g CO_2/passenger.km, we obtain total emissions of 12,214 tonnes CO_2 in 2007. Even if all the Winchester passengers travelled as far as London Waterloo the total emissions would be only 23,800 tonnes CO_2. As we shall see this is a relatively small amount compared to the likely emissions from flying (or road transport; Table 4).

Flying

Southampton Airport, which is owned and operated by BAA, is the 20th largest airport in the UK. Although the airport is not in the Winchester district it serves as a regional airport and there is no doubt that Winchester district's inhabitants use it to travel elsewhere in the UK or to continental Europe. A 2010 survey by ONS suggested that 47% of UK adults had flown once in the past year with 16% making three or more flights. 37% had made a short-haul flight and 18% had made a long-haul flight.[25] However, people living in London or the South East were more likely to have travelled by plane than people in the rest of the country so the above figures probably underestimate the flights made by inhabitants of Winchester district.

The global warming effect of emissions from jet aircraft flying above 9000 m are taken by many experts to be greater than that caused by the emissions of CO_2 alone. Often a Radiative Forcing Index (RFI) or multiplier is applied of between 2 and 3.[26] Others argue that this is an oversimplification and the multiplier to be applied depends on other factors, not least the time scale over which the warming is being considered. In addition a correction factor of 9% may be applied to account for the average extra distance over a great circle route followed by aircraft. However aircraft on domestic flights do not reach 9000 m, so it is not appropriate to use a multiplier, and a multiplier of about 2.5 is appropriate for short-haul flights. Domestic flights on the other hand proportionally spend more time in high-emitting ascent and descent modes. Consequently, it is estimated that a typical domestic UK flight emits around 200 g CO_2-eq/passenger.km and a typical short-haul jet flight emits around 300 g CO_2-eq/passenger.km (Defra 2008; Shorter 2011).[27]

In 2009, Southampton airport handled 1,177,280 domestic passengers and 758,310 passengers to continental European destinations plus 10,177 to other international destinations. I assumed that the same proportions occurred in 2007 when the total number of passengers handled was 1,157,376. Using the above figures and assuming that the average length of a domestic return flight was 600 km and the average length of a European return flight was 1800 km one obtains an estimate of 546,761 tonnes of CO_2-eq emitted by return flights to/from Southampton airport in 2007. This is in striking contrast to the REAP estimate for air transport emissions in 2006 attributable to Winchester district of only 93,500 tonnes CO_2-eq.

Discounting uncertainties in the above assumptions of average trip lengths, there are several reasons why the two figures do not match. First, the REAP methodology for 'air transport' takes account of both direct (from the jet engines) and indirect (food, insurance, fuel supply) emissions associated with flying but does not apply a multiplier to the direct emissions.[28] Second, not everyone who flew from Southampton airport lives in Winchester district and, conversely, not all people in Winchester district who took a flight used Southampton airport. Third, REAP attributes 'package holidays', which from casual observation in Winchester district undoubtedly contribute substantially to air passenger traffic, to 'private services'. Thus, emissions from package holidays are not counted under 'air transport'. So, given the much higher emissions likely to be associated with Winchester district inhabitants flying long-haul from other airports in SE England, it is not surprising that it is hard to reconcile the two figures. There is simply not enough information available to resolve the discrepancy satisfactorily.

I would cautiously conclude that the REAP figure is likely to be an underestimate for the Winchester district, principally because REAP does not apply a multiplier in estimating emissions from short-haul or long-haul flights. The REAP figure of 0.85 tonnes per head

seems consistent with Chris Goodall's estimate that the average UK citizen emits 0.6 tonnes CO_2/year from flying, assuming a multiplier of unity.[29] Applying a multiplier of 1.6 (an average multiplier weighted by the relative numbers of domestic and short-haul passengers) to the figure of 0.6 tonnes/head, and adding 0.25 tonnes/head (0.85-0.60) for other contributions, an estimate of 135,520 tonnes CO_2 in 2007 is obtained for the emissions of passengers living in Winchester district. I think this figure is more plausible. It is about 25% of the above crude estimate of the total emissions from Southampton airport in 2007.

Central heating oil

Central heating oil is used to heat houses, mainly in rural areas, that have no connection to the natural gas pipeline network. It is very similar to diesel fuel. The estimated emissions from the use of 'domestic petroleum' in Winchester district in 2007 are 39,245 tonnes CO_2-eq.[30]

Presently unquantifiable contributions

There is no simple way of estimating the emissions in Winchester district attributable to purchases of food, clothes and consumer items and many of the components of public and private services as defined by the earlier described REAP analysis.

It is worth mentioning in passing that REAP identified food as contributing to 16% of greenhouse gas emissions, hence the embodied energy in food is substantial. It is estimated that 8.3 million tonnes of food and drink waste is generated by households in the UK every year (equivalent to about 15,520 tonnes in Winchester district)[31] so this is an obvious area in which greenhouse gas emissions can be reduced.

Summary of Winchester district's emissions in 2007

The above estimates of carbon dioxide equivalent emissions in 2007, which were arrived at independently of REAP using easily available statistics, are summarised in Table 5 and in Fig. 3. They can account for 50% of the REAP estimate of total emissions in the Winchester district in 2006. It should be reiterated that the 'domestic' category of both electricity and gas consumers will also include an unknown number of SMEs. Only

Table 5. Summary of some estimated emissions in Winchester district in 2007 (tonnes CO_2-eq).

Source of emissions	Emissions (thousand tonnes CO_2-eq)	Percentage of total REAP emissions
Electricity ('domestic')	129	6.2
Electricity ('comm/industr')	223	10.7
Gas ('domestic')	138	6.6
Gas ('comm/industr')	53	2.5
Personal transport*	182	8.8
Freight transport*	120	5.8
Rail transport**	15	0.6
Air transport**	136	6.5
Heating oil	39	1.9
TOTAL	**1,034**	**49.7**
REAP (2006)	2,081	

* converted to CO2-eq using Defra/DECC factors (2010).
** rough estimate

consumers with half-hourly electricity meter readings and only gas consumers exceeding 73,200 kWh p.a. count as 'commercial/industrial' users.

Note that the sum of emissions from electricity, gas and transport corresponds to only around 50% of the REAP estimate for 2006 which currently is the best available estimate of Winchester district's total emissions. In other words almost half of Winchester district's emissions are down to other sectors discussed at the beginning of this report such as food, consumerism and services.

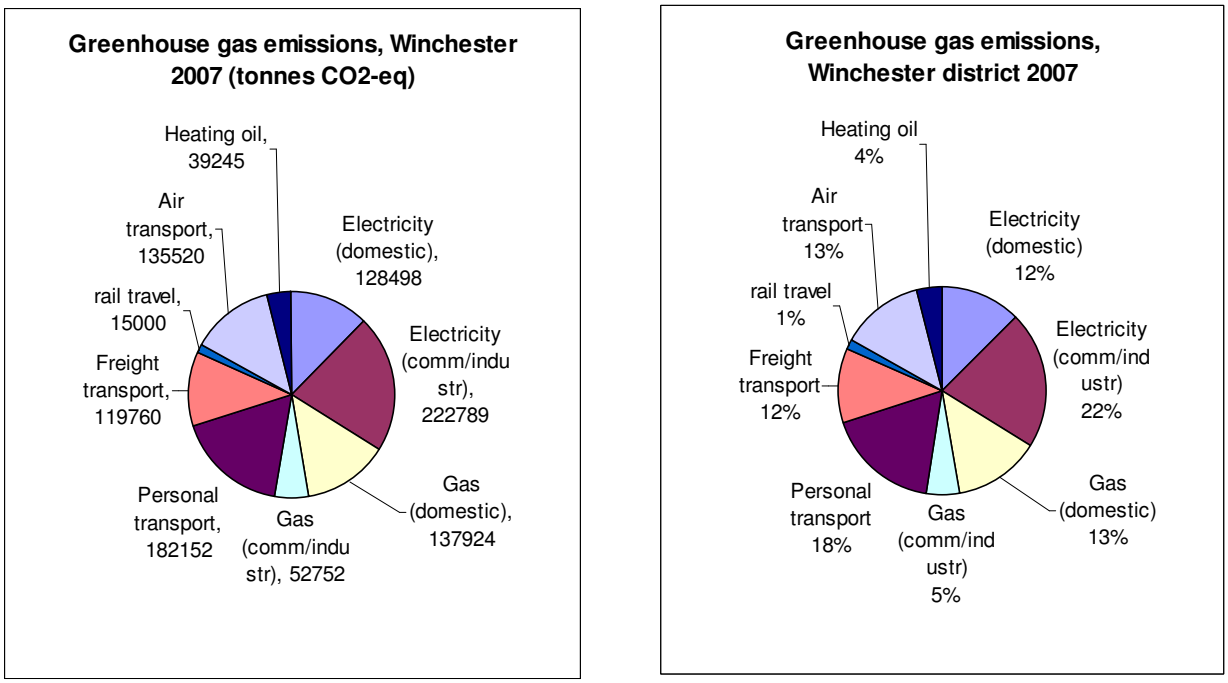


Figure 3. Summary of some greenhouse gas emissions in Winchester district in 2007 (Table 5). (Right) Percentage values for electricity, gas, transport and heating oil emissions. (Left) Absolute values in tonnes of CO2-eq.

Trends in Winchester district's emissions (2007-2009)

Global warming today is, at least partly if not entirely, a function of mankind's activities. In other words it is population dependent. In the following discussion no account is taken of possible changes in the ca. 112,000 population of Winchester district in the period 2007-2009 simply because the changes are not thought to be significant – for example NI 186 estimates that the population increased by only 3,300 between 2005 and 2008. In any event, we are discussing here the emissions of Winchester district as a whole and not the *per capita* emissions.

The sources of data used in the following sections are the same as used to determine emissions in 2007.

Electricity

The total electricity consumption of the district **increased** between 2007 and 2009 by 2.8% (Fig.4). Over that period however 'domestic' consumption has remained almost static, despite an increase in the number of meters, whereas the much larger

commercial/industrial consumption has increased by 4%. At the same time the average use of energy per 'domestic' meter has decreased, as part of a steady trend since 2005, whereas the average use of energy in the 'commercial/industrial' sector has dropped from 76,000 to around 74,000 kWh (Fig.5).

It is very clear that the 'commercial/industrial' sector consumes in total much more electricity than the 'domestic' sector in a ratio of about 1.8:1. Even more striking is the ratio of 15:1 between the average meter readings (Fig.5).

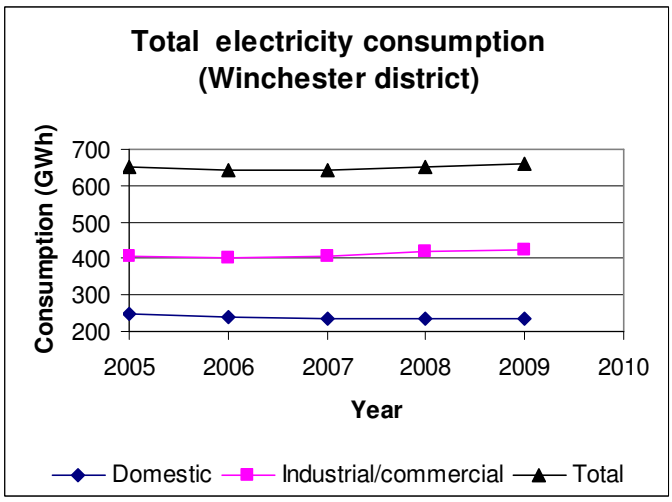
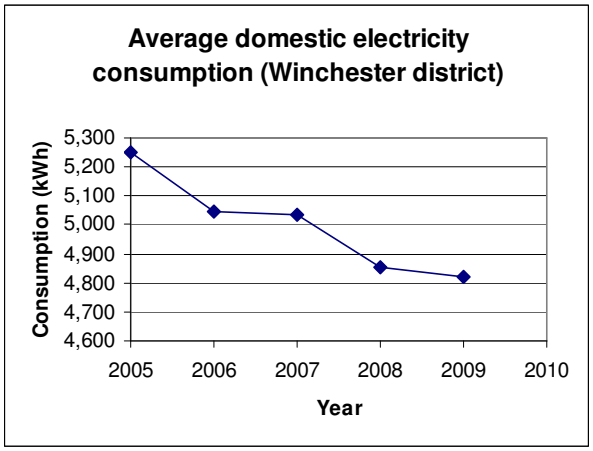


Figure 4. Trends in total electricity consumption in Winchester district (2005-2009).



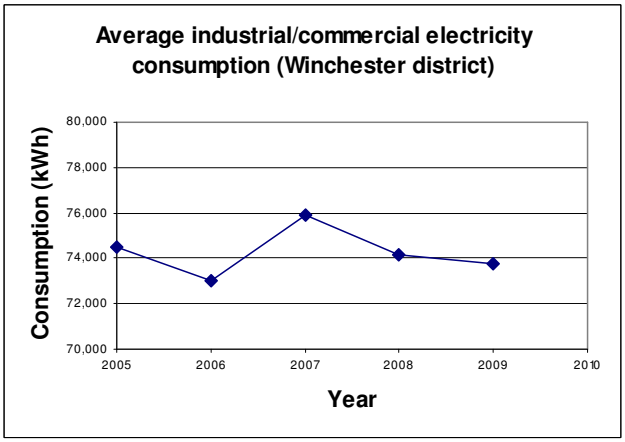


Figure 5. Trends in electricity consumption in Winchester district (2005-2009). (Left) Average 'domestic' consumption. (Right) Average commercial/industrial consumption.

The 'commercial/industrial' sector in Winchester district is likely to include consumers such as supermarkets, hotels, big offices (private and public), schools, university campuses, Winchester prison and the Royal Hampshire County Hospital but detailed information about the consumption by such organisations is not publicly available.

Gas

The total gas consumption in the district steadily decreased between 2007 and 2009[32], and

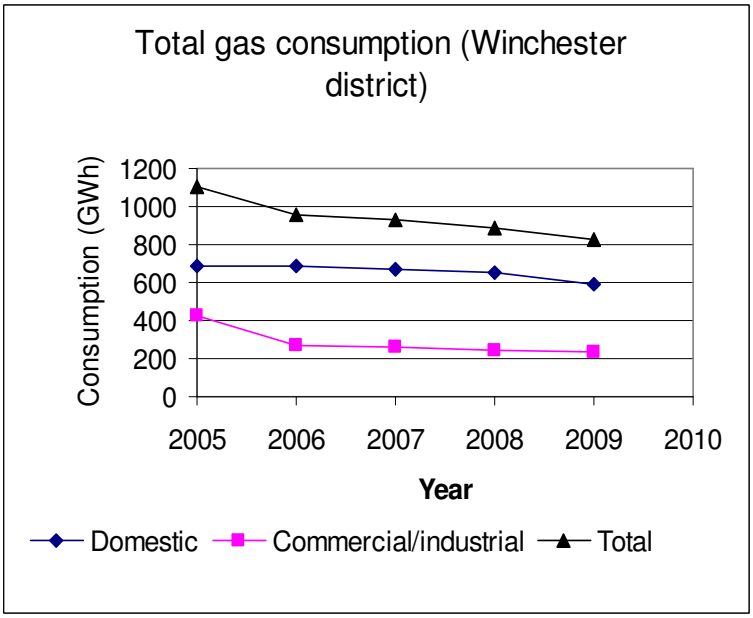


Figure 6. Trends in total gas consumption in Winchester district (2005-2009).

indeed since 2005 although the 'commercial/industrial' figure for 2005 appears suspiciously large (Fig. 6). Since 2007 the total gas consumption has dropped by almost 11%. Since the figures have been 'weather corrected' this may suggest an encouraging reduction in the use of gas for heating buildings. Gas consumption is dominated by the 'domestic' sector, which includes non-domestic users (consumers using less than 73,200 kWh p.a.), whose consumption is around 2.5 times greater than that of the 'commercial/industrial' sector.

A different picture emerges when the average figures per meter are examined. It is evident that, although the average 'domestic' consumption has decreased steadily and significantly since 2006, the consumption per meter in the 'commercial/industrial' sector has steadily increased even more significantly (Fig. 7)! As for electricity, we can only presume who the big gas consumers are. It may be that the average 'domestic' consumption has decreased as a result of a relative increase in smaller properties, particularly flats, in Winchester since 2006. This idea is partly substantiated by an increase of 2.5% in the number of 'domestic' meters.

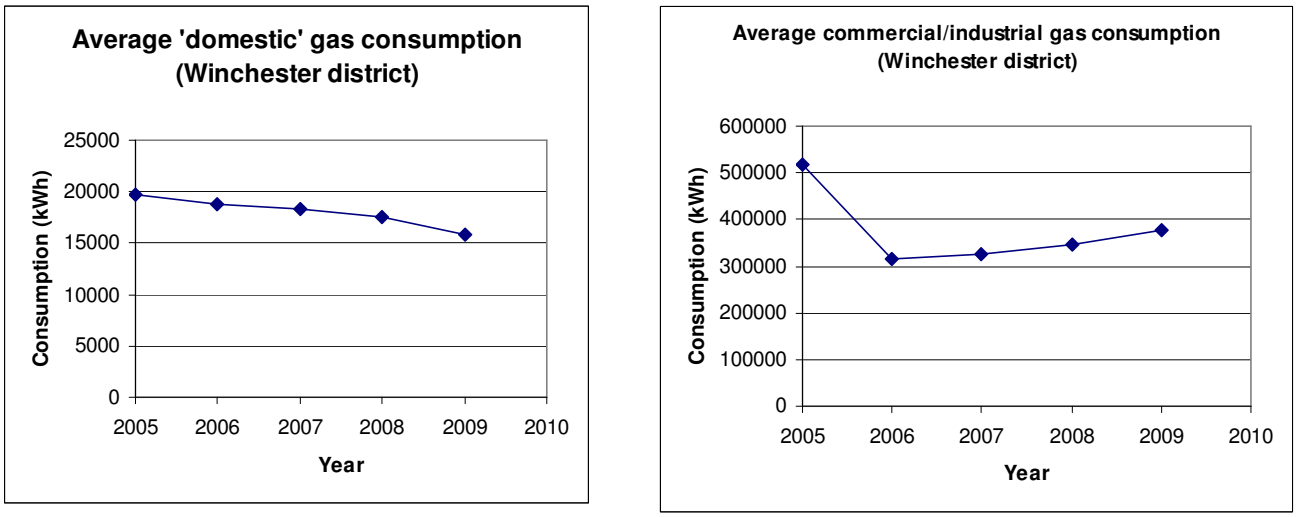


Figure 7. Trends in gas consumption in Winchester district (2005-2009). (Left) Average 'domestic' consumption. (Right) Average commercial/industrial consumption.

Motor vehicles

Analysing the trends in fuel consumption in recent years in Winchester district is complicated. First, changes in fuel consumption will depend on changes in the number of vehicles. This information is available but only at an unaffordable price from agents of the DVLA. Fig. 8 (left) shows that fuel consumption by petrol cars has declined markedly (by 13%) while for diesel cars, LGVs and HGVs there has been no decline since 2005. When 'personal' vehicles are considered, there has been a decline in fuel consumption since 2005 whereas fuel used by goods vehicles peaked in 2007 and declined only slightly thereafter (Fig. 8 right).

Because petrol and diesel engines contribute differently to greenhouse gas emissions (diesel engines emit 15% more CO_2 per litre although they tend to offer higher miles per gallon) a slightly more encouraging pattern emerges when emissions are considered. Fig. 9 (right) shows that the total estimated emissions peaked in 2007 and started to decline for both personal and goods vehicles in 2008.

The reasons for the 2.9% fall off in total emissions during 2008 could be manifold. In Hampshire as a whole vehicle mileages decreased by 2.6% from 2007 to 2009.[33] Car engines are becoming increasingly more efficient and drivers are being exhorted to drive in a more environmentally friendly fashion. More careful driving is set to continue as fuel prices rise. It was not possible to obtain data for free on the number of vehicles registered in the Winchester district from agents of the Department for Transport.

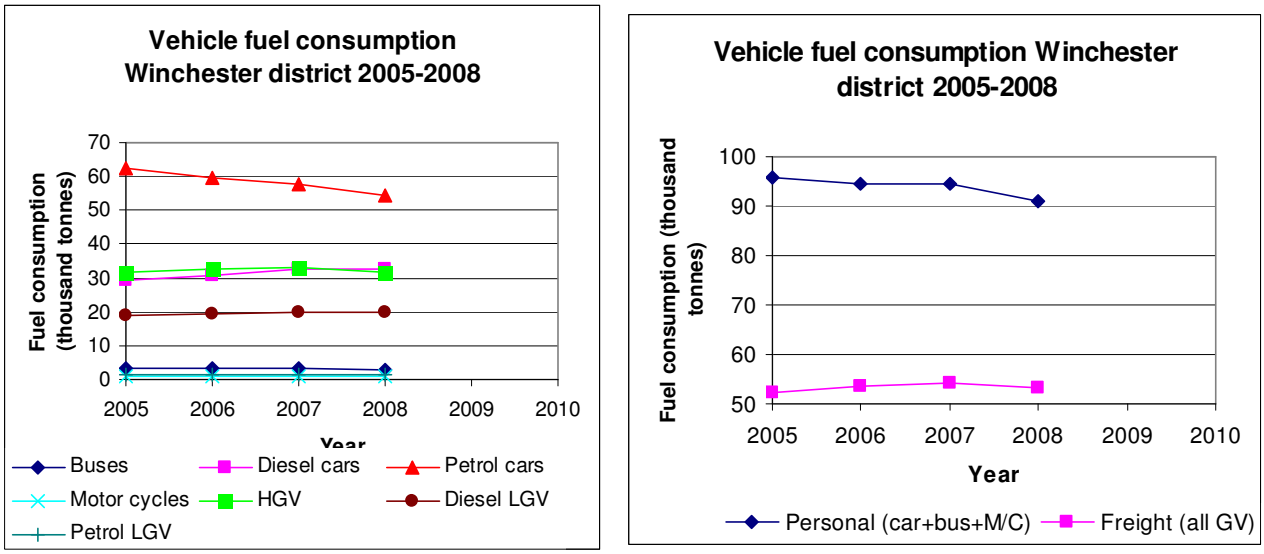


Figure 8. Fuel consumption in the Winchester district, 2005-2008. (Left) From seven classes of vehicle. (Right) From Personal vehicles (cars, buses and motor cycles) and from Goods vehicles (GVs).

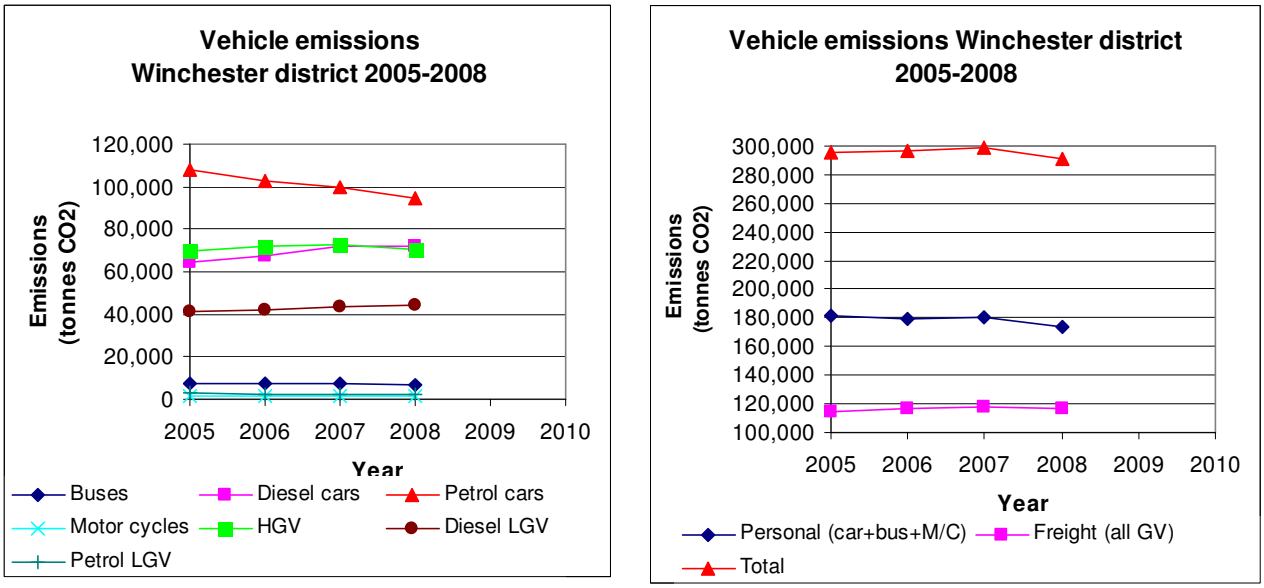


Figure 9. Vehicle emissions in the Winchester district 2005-2008. (Left) emissions from seven classes of vehicles. (Right) emissions from 'personal' transport and goods vehicles.

Rail travel

There has been a 22% rise in passenger entries at Winchester station since April 2005[34] (Fig. 10). This is encouraging, because of the lower emissions from trains than from most other forms of transport, provided that this represents a trend away from driving (or even flying) and not simply the passengers' increased mobility. Without further information it is hard to estimate any corresponding savings in carbon emissions. As already shown, the increase in emissions associated with the increase in rail passengers is likely to be relatively small.

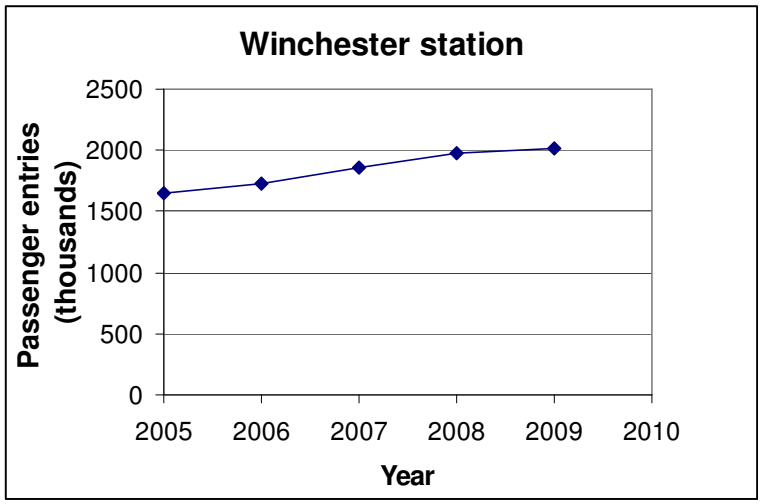


Figure 10. Trends in passenger entries to Winchester station (2005-2009).

Flying

According to the Civil Aviation Authority the number of passengers passing through Southampton airport increased relentlessly since 2002 but peaked at 1,965,422 in 2007 and since then has declined by 8.9% in 2009.[35] This timing of this peak and the subsequent fall in numbers coincides with the current economic recession.

The number of aircraft movements, which will also include freight traffic, peaked at 58,045 in 2005 and has declined by 21.6% since then. However this may partly reflect the operation of increasingly larger aircraft.

Without further information it is not possible to comment further on the changes in emissions attributable to the inhabitants of Winchester district, which may have occurred between 2005 and 2009, other than to point out that a possible 8.9% decrease in the estimated 2007 total emissions from Southampton airport corresponds to a possible reduction of 12,061 tonnes CO_2-eq attributable to Winchester district.

Comparison with NI 186 data

Fig. 11 presents Winchester district's emissions in the period 2005-2008 according to the ten classes used by NI 186. Note that the emissions are given in tonnes CO_2 and not tonnes CO_2-eq or even kWh. Figures for 2007 can be compared with some of the numbers in Table 3. Fig.12 presents the total emissions for all ten classes and shows how, according to NI 186, there has been little progress in reducing emissions since 2006.

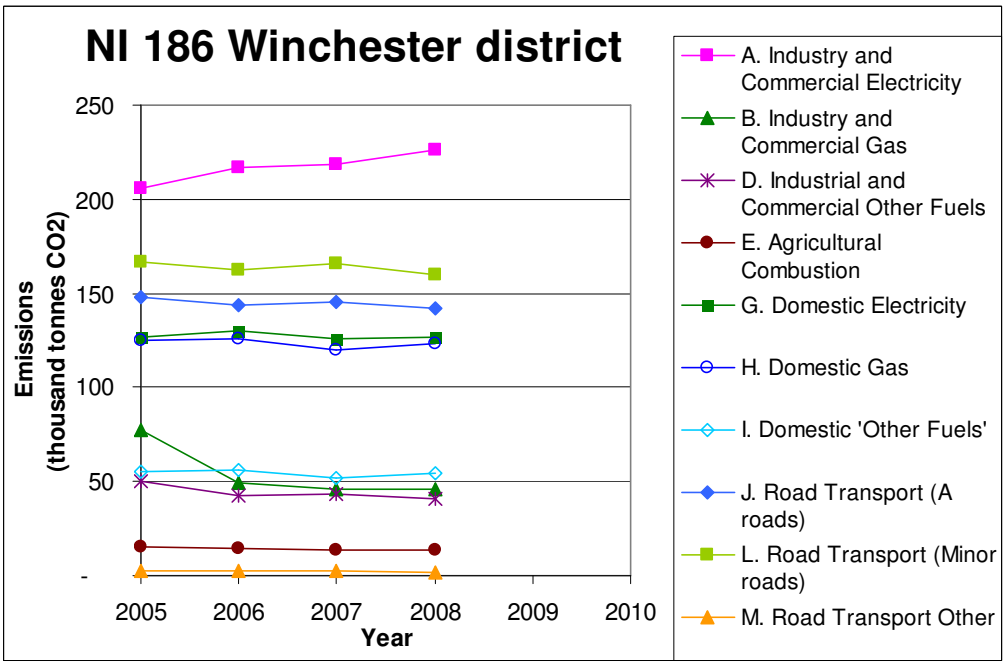


Figure 11. CO_2 emissions in Winchester district (2005-2008) from NI 186 data.

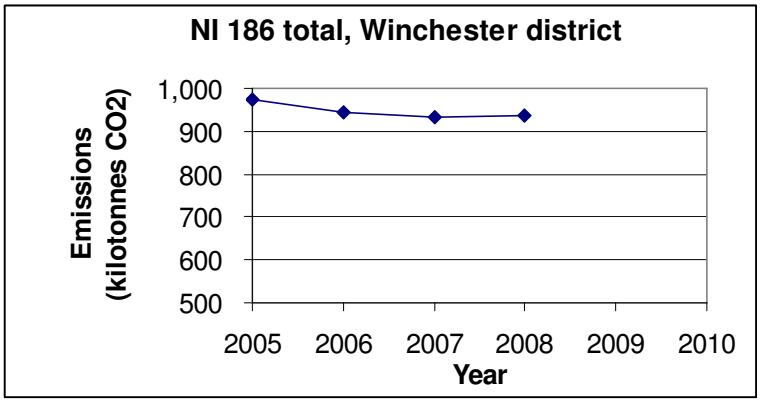


Figure 12. Total CO_2 emissions in Winchester district (2005-2008) from NI 186 data.

Winchester district's targets: how are we doing?

The principal national target set down by the Climate Change Act 2008 is an 80% reduction in CO_2 emissions by 2050 relative to 1990. Nearer term targets are a 20% reduction by 2020 with a preferred aim, if other EU countries comply, of 30% by 2020.

Winchester City Council signed the Winchester Declaration on

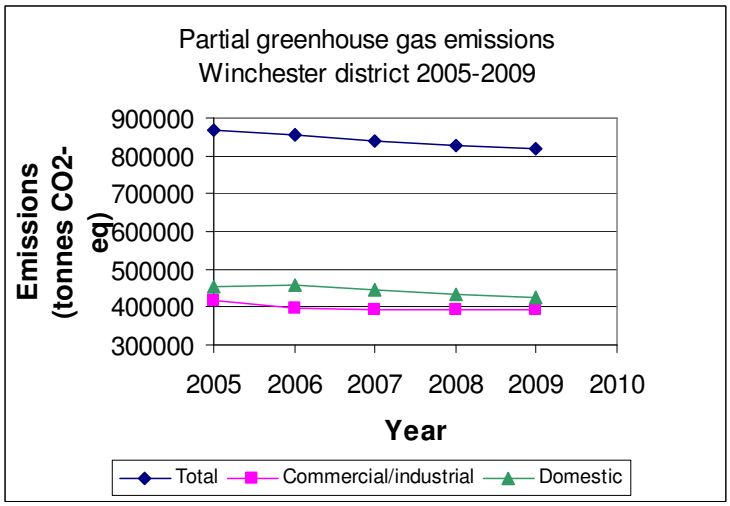


Figure 13. Greenhouse gas emissions from electricity, gas, transport and heating oil in Winchester district (2005-2009) from DECC data.

Climate Change - which commits signatories to reducing their carbon footprints by 20% by 2012 (relative to 2007) – in January 2010.

WinACC has also adopted a target of a one third reduction in the district's greenhouse gas emissions by 2015 relative to 2007.

All these targets imply slightly different emissions descent paths on the road to a low-carbon, or zero carbon, society. Here I shall concentrate on the two locally defined targets.

Fig. 13 shows total estimated emissions of CO_2-eq from the consumption of electricity, gas, transport and heating oil within Winchester district from 2005 to 2009 (lacking data, the vehicle emissions for 2009 were assumed to be the same as in 2008). Although the figure shows an encouraging overall decrease in emissions over the four-year period in fact it amounts to only 5.8%. Fig. 13 also shows that even though 'domestic' emissions declined those from the 'commercial' sector remained static since 2007. In addition, passengers using Southampton airport, and by implication their associated emissions, decreased by 8.9% over the period 2007-2009.

Fig. 14 compares the sums of electricity, gas and vehicle emissions with two pathways inferred from the local targets assuming that each target is met by a constant year on year percentage reduction. All the curves are set at 100% at the mid-point of 2007, the reference year. Each pathway is drawn from the mid-point of 2007 until the end of the target year. First, the thick line indicates that the actual electricity, gas and vehicle emissions are not descending fast enough to reach either the 2012 or the 2015 targets. The dotted line indicates one future descent path that would achieve both targets assuming that the past decrease continued until the end of 2010 and then emissions will decrease at a rate of 6.25% p.a. thereafter. Note that this implicitly assumes the same overall level of reduction is achieved in the sectors excluded from this analysis as in those sectors that have been included.

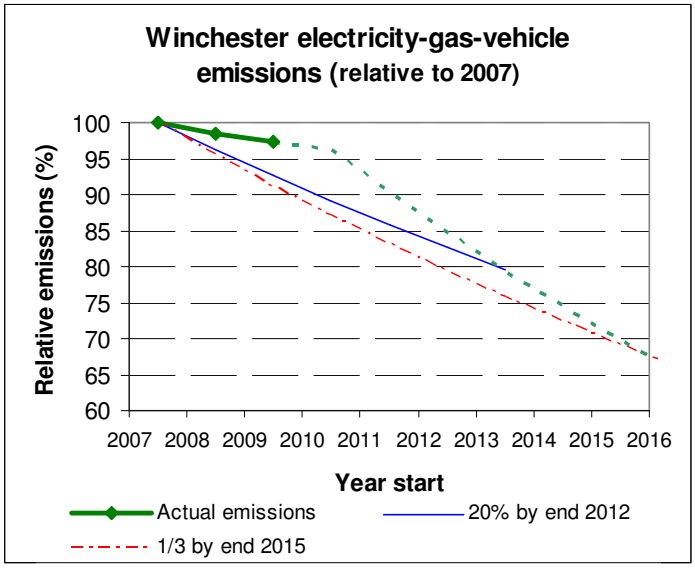


Figure 14. Estimated emissions pathways (2007-2009) from DECC data for Winchester district compared with two possible pathways to declared targets.

Summary and conclusions

The REAP tool provides the most comprehensive metrics covering emissions in local authority areas, yet they appear only infrequently and with considerable delay and so are not entirely suitable for tracking the emissions of such an area. The NI 186 metrics are produced annually with less delay (21 months) but, because they follow UNFCCC guidelines, do not include emissions from several significant sources. Further, the NI 186 figures are rounded, which hinders tracking of year to year trends, and the NI 186 road

transport emissions are not presented in a way that helps one to attribute emissions to particular types of vehicle.

For these reasons this report has attempted to locate and analyse statistics that are more immediately available and that include several sources of emissions excluded by NI 186. The results are patchy and imperfect but I believe the results provide greater insight.

The analysis of emissions in 2007, the base year for several emissions target pathways, revealed some interesting facts.

First, almost two-thirds of emissions from electricity come from the 'commercial' or large organisation sector (although the sector is described as commercial/industrial by DECC it certainly includes some large public sector organisations. NI 186 records zero emissions from industry in Winchester district). Further, although electricity emissions have fallen since 2007 in both 'commercial' and 'domestic' sectors the 'domestic' sector has performed 50% better in this regard. This suggests that targeting the 5,700 consumers in the commercial and large organisations sector, as well as the 'domestic' sector, should be a future imperative.

For gas the situation is almost reversed. Almost three-quarters of emissions are from the 'domestic' sector, presumably principally from heating homes although some SMEs will be included. Even so, the average 'commercial' consumer consumes 17.5 times as much gas as the average domestic consumer so one cannot but wonder whether some saving could also be made by the 800 consumers (large organisations of all sorts) that make up the 'commercial' sector. It should be remarked that gas consumption by the 'commercial' sector has grown steadily since 2007 whereas that of the 'domestic' sector has decreased. Again, this suggests that greater efforts to save gas are required by large organisations.

Transport accounts for 29% of Winchester district's emissions according to the REAP analysis (Table 2). The analysis of emissions from motor vehicles was constrained by a lack of information about the numbers of vehicles of different types registered in the Winchester district. For some reason this information is only available for sale from agents of the DVLA. Nevertheless, 40% of transport emissions come from private cars (petrol and diesel) and 26% from goods vehicles. When trends are considered there is a difference between the emissions from private vehicles and goods vehicles between 2007 and 2008; private vehicle emissions decreased over twice as fast as goods vehicle emissions.

Rail travel is far more environmentally friendly than road and air travel. The 22% increase in rail passenger traffic from Winchester station since 2005/06 is unlikely to have added significantly to Winchester district's emissions and may, if it took passengers out of cars, have actually helped to reduce emissions overall.

Southampton airport serves the Winchester district and handles a very large number of passengers annually who fly within the UK and to the near continent. Many of these passengers are likely to come from Winchester district. However, estimating emissions from air transport is a complex subject. The UK government and its departments assume that no multiplier needs to be applied to the CO_2 emissions from aircraft engines. However many experts suggest that a multiplier should be used, the question is how great a value. I have used a multiplier of 2.5 for short-haul flights. After making various assumptions it is concluded that air travel could contribute as much as 6.5% of Winchester district's total REAP emissions (Table 5). However one interprets the figures there is no doubt that flying,

and particularly long-haul flights for leisure purposes, make a significant and avoidable contribution to greenhouse gas emissions and global warming. Fortunately the number of passengers using Southampton airport has markedly decreased in recent years, possibly driven by the current economic climate, but there is no guarantee that this will continue.

Many presently unquantifiable sources of emissions remain. The analysis presented here has probably covered only around 50% of all the emissions identified by the earlier REAP analysis. Among the remainder the largest source is emissions from growing, transporting and storing food. In effect food that is wasted represents a significant waste of the energy, and emissions, that were used to bring the food from 'gate to plate'.

In conclusion one can say that broadly the 'domestic' sectors for electricity and gas, as measured by the average annual consumption, and the fuel use by private cars have all decreased steadily in recent years, albeit by not enough to be on track to meet Winchester district's targets. This is in strong contrast to the performance of the average big ('commercial') consumer of electricity and gas and, to a lesser extent, the operators of goods vehicles.

Recommendations

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

● flying, and flying for leisure purposes in particular, should be strongly discouraged.

● the use of electricity and gas should be reduced, particularly in the sector that includes large organisations such as supermarkets, hotels, big offices (private and public), schools, university campuses, Winchester prison and the Royal Hampshire County Hospital.

● the use of road vehicles that directly emit greenhouse gases should be reduced. The goods vehicle sector should be encouraged to reduce its emissions even more than has been achieved in recent years.

● rail travel is to be encouraged particularly where it reduces journeys made by road.

● Winchester district needs to cut its emissions by 6.25% each year from 2011 until 2015 inclusive to achieve the targets it has set itself. This figure is based on an analysis that excludes the mostly harder-to-quantify sectors of food, consumerism and services and may in fact be an underestimate.

It was not the purpose of this report to explore how the above recommendations should be implemented but I hope that the reader will be enthused to take them forward with a view to Winchester district achieving its emissions targets and leading the way in achieving the targets that have been set nationally.

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[3] http://carbonfootprintofnations.com/content/ranking/. Note that CO_2-eq refers to the equivalent amount of CO_2 that would cause the same amount of warming as all the greenhouse gases emitted from a given source. Converting between the two units depends on the source of emissions.

[4] The Guardian newspaper, after the US Energy Information Administration February 2011.

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[8] The Department for Communities and Local Government announced in October 2010 that it was decentralising Local Area Agreements and replacing the National Indicator Set with a single comprehensive data list from April 2011. The content of the single comprehensive data list has not yet been announced and will be drawn up by the Department for Communities and Local Government in consultation with other Government Departments and Local Authorities.

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[11] Stockholm Environment Institute, Biology Department, University of York, Footprint Results from BRIO model, October 2009. Available at http://www.resource-accounting.org.uk/downloads

[12] Private services include Water supply and miscellaneous dwelling services, Out-patient services, Hospital services, Postal services, Telephone & telefax services, Recreational & cultural services, Package holidays, Education, Accommodation services, Social protection, Insurance, Financial services nec, Other services nec and Capital Investment.

[13] Public services include Public administration (central), Education (central), Health & vet services (central), Social work activities (central), Recreational services (central), Public administration (local), Education (local), Health & vet services (local), Social work activities (local), Sanitary services (local), Recreational services (local), Capital Investment.

[14] http://www.decc.gov.uk/assets/decc/Statistics/regional/1087-guidance-note-regional-energy-data.pdf

[15] Kilowatt.hour (kWh) is a unit of energy such as recorded by an electricity meter. The kilowatt (one thousand watts or 1 kW) is a unit of power. For example, a power station might be able to generate 10 MW (10 million watts) of power when working at full capacity.

[16] http://www.decc.gov.uk/assets/decc/Statistics/regional/1087-guidance-note-regional-energy-data.pdf

[17] Figure for residential households in 2001 taken from http://www.statistics.gov.uk/census2001/profiles/printV/24UP.asp

[18] Defra/DECC (2010). 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. London, Defra/DECC**:** pp.48.

[19] http://www.decc.gov.uk/assets/decc/Statistics/regional/1087-guidance-note-regional-energy-data.pdf

[20] Defra/DECC (2010). 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. London, Defra/DECC**:** pp.48.

[21] http://www.decc.gov.uk/assets/decc/Statistics/regional/1087-guidance-note-regional-energy-data.pdf

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[31] Quested, T. and H. Johnson (2009). Final Report: Household Food and Drink Waste in the UK. Banbury, Oxon., WRAP**:** pp.95.

[32] The gas year runs from 1 October to 30 September.

[33] motor_vehicle_mileages_by_LA_2009_dft_tra0103.xls, Dept. for Transport 2010.

[34] Note that the rail year runs from 1 April to 31 March.

[35] http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=3&fld=2009Annual